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Public Service Commission of Wisconsin
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Wisconsin Power and Light Company

4902 North Biltmore Lane
P.O. Box 77007
Madison, WI 53707-1007

July 31, 2013

Ms. Sandra J. Paske
Secretary to the Commission
Public Service Commission of Wisconsin
610 North Whitney Way
PO Box 7854
Madison, WI 53707-7854

Re: **Joint Application of Wisconsin Power and Light Company, Wisconsin Public Service Corporation, and Madison Gas and Electric Company for a Certificate of Authority to upgrade the Coal Pulverizers and Steam Turbines at the Columbia Energy Center Units 1 and 2** **Docket No. 05-CE-141**

Dear Secretary Paske:

Please find enclosed an Application for Certificate of Authority in the above-captioned docket. The Application is submitted on behalf of Wisconsin Power and Light Company ("WPL"), Wisconsin Public Service Corporation ("WPS"), and Madison Gas and Electric Company ("MGE").

On behalf of WPL, WPS, and MGE, I also respectfully request that the following individuals be included on the service list for this docket:

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If you have any questions or concerns, please feel free to contact me.

Sincerely,

/s/ Michael Greiveldinger

Michael Greiveldinger
Attorney for Wisconsin Power and Light Company

Enclosure.

Certificate of Authority Application
Columbia Energy Center Units 1 and 2
Turbine and Pulverizer Upgrade Project

Project Description and Justification

05-CE-141

Wisconsin Power and Light Company
Wisconsin Public Service Corporation
Madison Gas and Electric Company

July 31, 2013

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BEFORE THE
PUBLIC SERVICE COMMISSION OF WISCONSIN

Joint Application of Wisconsin Power and Light Company, Wisconsin Public Service Corporation, And Madison Gas and Electric Company for a Certificate of Authority to upgrade the coal Pulverizers and steam turbines at the Columbia Energy Center Units 1 and 2	)	Docket No. 05-CE-141

APPLICATION

Wisconsin Power and Light Company (WPL), Wisconsin Public Service Corporation (WPS), and Madison Gas and Electric Company (MGE), referred to as "Applicants," apply, pursuant to Section 196.49 of the Wisconsin Statutes, Chapter PSC 112 of the Wisconsin Administrative Code and any other applicable statute or rule for a Certificate of Authority (CA), to replace twelve coal pulverizers and upgrade two steam turbines at the Columbia Energy Center located in Pardeeville, Wisconsin. This project is being proposed in order to provide added customer value by improving the efficiency and energy profile of Columbia Units 1 and 2 while maintaining reliable operations.

WPL is a public utility organized and existing under the laws of the State of Wisconsin with its principle offices located at 4902 North Biltmore Lane, Madison, Wisconsin 53707.

WPS is a public utility organized and existing under the laws of the State of Wisconsin with its principle offices located at 700 North Adams Street, Green Bay, Wisconsin 54301.

MGE is a public utility organized and existing under the laws of the State of Wisconsin with its principle offices located at 133 South Blair Street, Madison, Wisconsin 53788.

Dated this 31st day of July, 2013.

Respectfully submitted,

By:

Scott R. Smith Director, Regulatory Affairs *Wisconsin Power and Light Company*	Charles Cloninger President *Wisconsin Public Service Corporation*	Pete Waldron Vice President and CIO *Madison Gas and Electric Company*

EXECUTIVE SUMMARY

With this Certificate of Authority Application, Wisconsin Power and Light Company (WPL), Wisconsin Public Service Corporation (WPS), and Madison Gas and Electric Company (MGE) (collectively "the Applicants") request authorization to upgrade the coal pulverizers and steam turbines at the Columbia Energy Center (Columbia). Columbia Units 1 and 2 were placed into operation in 1975 and 1978, respectively. The Applicants jointly own Columbia, with WPL holding a 46.2% share, WPS holding a 31.8% share, and MGE owning a 22% share. WPL operates the facility.

The Applicants have identified a combination of upgrades to the Units that will enable greater efficiencies from the existing units, accruing benefits to customers. Since the Columbia units were placed in operation, several advances in the design of turbine and pulverizer technology have occurred. Examples include advanced three dimensional modeling software, which allows for more efficient design, and finite element analysis software, which allows for the design of components such that they carry lower stress and are less susceptible to failure.

The capital improvement project (the "Project") the Applicants are proposing utilizes this newer technology to design and install new turbine components and replacement pulverizers that provide the Applicant's customers with economic benefits. The Project is designed to increase the efficiency and energy generating capability of the Columbia Units. The primary benefits of the technology improvements are an estimated reduction in the heat rate of approximately 440 Btu per Kilowatt hour on each unit, and a total plant operating capacity increase of approximately 95 Megawatts. The heat rate reduction equates to approximately a 4% efficiency improvement on each unit, and the capacity increase equates to approximately a 9% increase in daily average energy production from each unit. With the efficiency and energy benefits, reduced by the capital and operating costs, the Project is estimated to provide a net customer benefit of $103 million in present value of revenue requirements (PVRR).

Since major components within the existing coal pulverizers are in need of major maintenance, there is currently an opportunity to implement the Project while avoiding substantial maintenance costs on the existing pulverizer equipment. In addition, the steam turbines have a corrosion condition which will require major maintenance in the near future. This corrosion condition is common to turbines of a similar age and design as those utilized at Columbia. This major turbine maintenance would also be avoided by implementing the Project.

The Alternative to the Project (the "Alternative") would address the pulverizer and turbine maintenance issues with a combination of repairs and replacement components. However, the Alternative would utilize the same technology that was deployed when the units were placed in service in the 1970s, and would not include improvements to efficiency or energy production.

The Applicants have chosen to pursue the Project, rather than the Alternative, in order to achieve the performance improvements in addition to resolving the maintenance issues. The capital

investment required for the Project is estimated at $130 million, but has a payback within approximately five years of the first full year of operation. The payback is driven primarily by an average increase in annual energy margin[1] of approximately $20 million as illustrated in Figure 1.

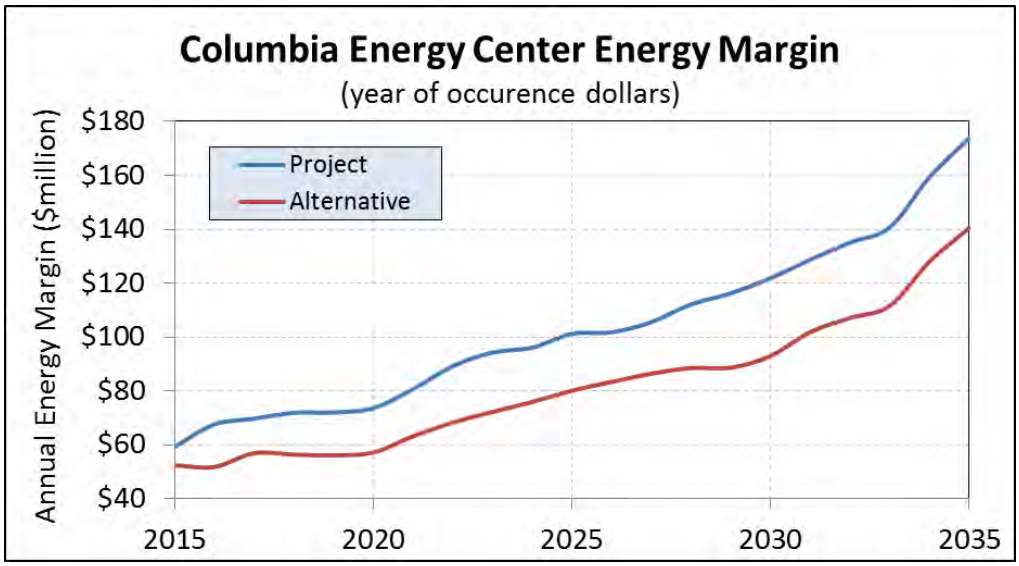

Figure 1 - Annual Energy Margin Forecast Comparison of the Project to the Alternative

The Applicants are proposing to complete the Project by Q2 2017 with material procurement beginning in Q2 2014. The twelve coal pulverizer replacements are proposed for sequential installation (one pulverizer per unit at a time) beginning in Q2 2015 and ending in Q2 2017. The pulverizers do not require an outage for installation. The turbine upgrades are proposed for installation during major outages in Q1-Q2 2016 and Q1-Q2 2017 for Unit 2 and Unit 1, respectively.

[1] Energy margin in this Application is defined as energy revenue from Megawatt Hour sales to MISO minus the fuel and non-fuel variable cost needed to produce those Megawatt Hours.

INTRODUCTION

The Columbia Energy Center consists of two generating units – Units 1 and 2 – each of which is a tangentially-fired boiler and an associated turbine generator. The nameplate generating capacities for Units 1 and 2 are 512 and 511 megawatts (MW), respectively.

The facility has two General Electric (GE) turbines which were installed during the construction of Unit 1 in 1975 and Unit 2 in 1978. Each of the turbines consists of one dual flow combined high pressure and intermediate pressure (HP/IP) section and two dual flow low pressure (LP) sections and is connected to a GE generator rated for 617.8 megavolt-ampere (MVA). The facility also has twelve Combustion Engineering (now Alstom) coal pulverizers, six per unit, which were installed during the construction of Unit 1 and Unit 2.

Equipment Maintenance History

Turbines

Steam turbine maintenance for Columbia is typically performed during major overhauls, approximately five to eight weeks in duration, which are scheduled to occur approximately once every seven years. Since being deployed in the 1970s, the Columbia turbines have undergone industry standard maintenance and inspections including the repair and replacement of individual seals and blades, and occasionally an entire row of seals and/or blades.

Pulverizers

Pulverizer maintenance is typically performed on an as-needed basis while the unit is online, or during annual unit outages. The Columbia coal pulverizers have undergone industry standard maintenance and inspections including the repair and replacement of standard wear components as well as repairs and replacements of components in the gearboxes and vertical pulverizer assembly.

Current Equipment Condition

Turbines

Over the past several years, the turbines have begun to show signs of wear and degradation that require additional maintenance investment. The LP turbine rotors have a corrosion condition known as "stress corrosion cracking." This condition is common to a significant number of turbine rotors of this vintage with the "dovetail" design.[2] The dovetail refers to the geometry of the connection used to attach the turbine blades to the turbine rotor. The corrosion condition can

[2] Appendix H is a report written by Alstom which describes a fleet-wide approach taken by Southern Company to perform repairs on 12 low-pressure turbines, between 1999 and 2001, due to indications of stress corrosion cracking.

result in a failure of these connections in the turbine. The failure begins with pitting that leads to cracking, and if proper maintenance precautions are not taken, could ultimately lead to failure.

Figure 2 illustrates an example of what a dovetail connection looks like when it is close to failure caused by stress corrosion cracking.

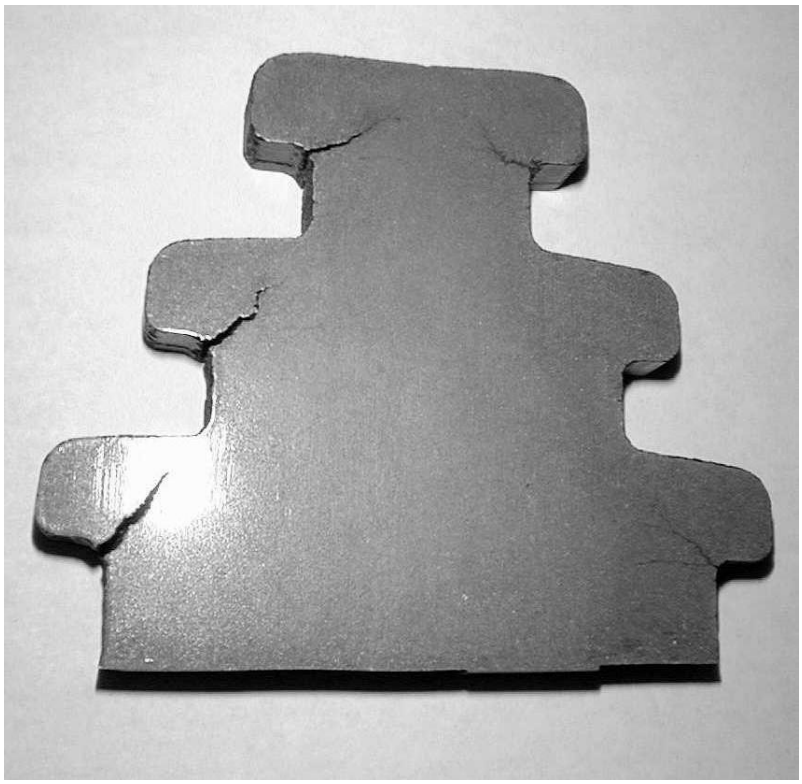

Figure 2 - An Example of Turbine Dovetail Cracking Nearing Failure
(Photo from Alstom report, page 20 in Appendix H)

Due to the location of the rotors, inspection of the rotors generally occurs during a major turbine inspection. During the Unit 1 and Unit 2 turbine outages in 2006 and 2005 respectively, the turbines were inspected for the status of this failure mode. At that time, pitting on the rotors was identified, but there was not any evidence of cracking. During the Unit 2 turbine outage in April 2013, the turbines were inspected again and several small cracks on the rotors were identified. The condition assessment was performed by Structural Integrity Associates, Inc. and is provided in Appendix D.[3] The condition assessment indicates that if the unit is returned to service for approximately 3 years, the probability of failure is 2.5%. This failure risk was deemed low enough to return the unit to service. The Applicants have decided to prepare for repair or replacement of the turbine components associated with the corrosion condition in order to prevent this failure risk from increasing.

[3] A similar condition assessment will be performed on Unit 1 during the 2014 outage.

Coal Pulverizers

Major components of the coal pulverizers have also reached the end of their useful life. Erosion issues in the main housing and the roofs result in thinning, cracking and deformation. If left unaddressed, coal leaks and associated fugitive dust problems could develop. Since fugitive dust poses a safety risk, pulverizers must be shut down and repaired when coal leaks are identified. The bodies and roofs of the existing pulverizers at Columbia require replacement in order to mitigate the impact to unit reliability from the aforementioned erosion issue.

Options to Address Maintenance Needs

Two options for addressing the needed maintenance were analyzed:

- "Maintenance by Replacement"; and
- "Maintenance by Repair and Replacement with Like Components".

The Project proposed in this Application is "Maintenance by Replacement" – more specifically, an equipment upgrade that utilizes components based on newer, more efficient technologies than are currently deployed. This option eliminates the maintenance issues by removing the damaged and worn components and replacing them with an improved design that is possible due to technological advancements since the units were designed in the 1970s. This option includes the complete replacement of the pulverizers and the upgrade of the internal turbine components. A partial cross-section illustration of the turbine components that will be upgraded is provided in Figure 3. The shaded components are included as part of the upgrade. The figure is provided for illustration purpose only, and does not represent any particular turbine supplier's technology.

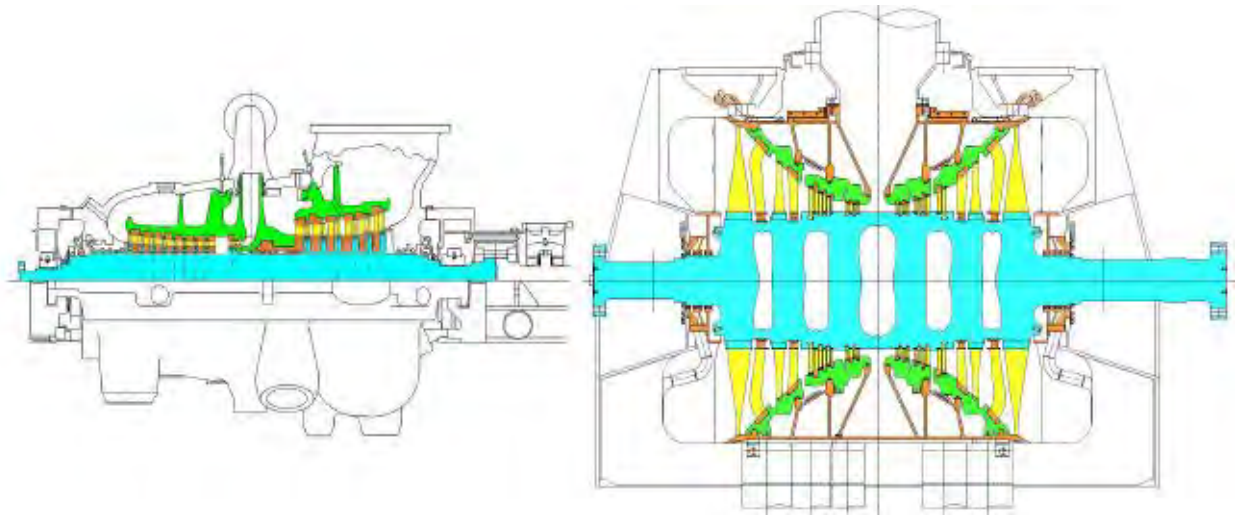

Figure 3 - Turbine Components Included in the Upgrade: HP/IP Turbine (Left) and LP Turbine (Right)

The Project resolves the previously mentioned maintenance issues and allows for the following estimated performance benefits:

- 440 Btu/kWh heat rate improvement, which equates to approximately a 4% efficiency improvement (4% reduction in coal burned) per Megawatt Hour (MWh) produced on each unit;
- 95 MW total plant operating capacity increase, which would result in an approximate 9% increase in energy production per year;
- 25 MW total plant unforced capacity increase, which could be used to offset capacity market purchases and may result in downward pressure on the need to build new capacity sources in the future; and
- A reduction in major overhaul frequency from 7 years to 10 or more years.

While the turbine maintenance benefits are driven primarily by the replacement of the LP turbine section, the HP/IP turbine sections must also be replaced in order to realize the efficiency and energy production improvements associated with the Project.

Additional benefits of the Project are:

- Improved coal particle size and distribution, allowing for improved combustion tuning capability that may help to sustain the currently achievable NOx emission rates more consistently and reliably than the existing pulverizers;
- Reduced wear of turbine components between major overhauls;
- Improved safety conditions due to the addition of a steam inerting system (fire protection system) with the new pulverizers;
- Improved auxiliary power consumption profile; and
- Improved combustion performance during low load operation.

The Alternative that was analyzed is "Repair and Replace with Like Components" and consists of major repairs to the existing equipment. This plan would address the aforementioned maintenance issues, but would not result in any technology driven performance improvements.

Economics

An economic analysis of the Project relative to the Alternative shows that the Project provides $103 million in PVRR net economic benefits to customers relative to the Alternative over the life of the plant. The customer benefits associated with the Project are driven primarily by increased energy production at reduced fuel consumption per megawatt hour. The economic analysis is provided in Section 3.1.

A sensitivity analysis was also performed in order to assess the impact of variation in the key modeling inputs. Eighteen sensitivities were conducted as part of the analysis, which varied key costs, operating characteristics and market forecasts that affect the Columbia Units. The analysis indicates that the sensitivity that varied energy price had the greatest impact on the benefit of the Project relative to the Alternative. In the sensitivities that varied the energy price forecast by-25% and +25%, the Project was favored over the Alternative by approximately $27 million and $179 million respectively as shown in Table 1. More detail on the economic analysis and sensitivity analysis can be found in Section 3.1 of this Application. The complete sensitivity matrix tables are provided in Appendix B, Schedule 6.

Table 1 - Present Value of Customer Benefit for the Base Case and Two Sensitivities

	Present Value of Net Customer Benefit ($ Million)
Base Case	$103
Energy Price Forecast Varied by -25%	$27
Energy Price Forecast Varied by +25%	$179

Proposed Project

The Project consists of the upgrade of the HP/IP and LP turbines on both units. The new steam turbines will include new rotors and inner turbine casings, while utilizing the existing foundation, outer turbine casing, generator, exciter, valves and other balance of plant turbine equipment and connections.

The Project also consists of the replacement of all six pulverizers on both units (twelve total). The new pulverizers will be complete assemblies of the vertical spindle type with dynamic classifiers. The dynamic classifiers assist with improving coal particle size and distribution which supports improved boiler performance.

Schedule

The Applicants are proposing to complete the Project by Q2 2017 with material procurement beginning in Q2 2014. The twelve coal pulverizer replacements are proposed for sequential installation (one pulverizer per unit at a time) beginning in Q2 2015 and ending in Q2 2017. The pulverizers do not require an outage for installation. The turbine upgrades are proposed for installation during major outages in Q1-Q2 2016 and Q1-Q2 2017 for Unit 2 and Unit 1, respectively.

1.0 Project Description

1.1. Columbia Energy Center

The Columbia Energy Center (Columbia) is located in Pardeeville, Wisconsin. A site location map is provided in Figure 4. A larger version of the map is provided in Appendix A. Columbia Units 1 and 2 began operation in 1975 and 1978 and have nameplate generation capacities of 512 and 511 MW, respectively. The Units are jointly owned by Wisconsin Power and Light Company (WPL), Wisconsin Public Service Corporation (WPS), and Madison Gas and Electric (MGE), who own respective shares of 46.2%, 31.8%, and 22%. The Units are operated by WPL.

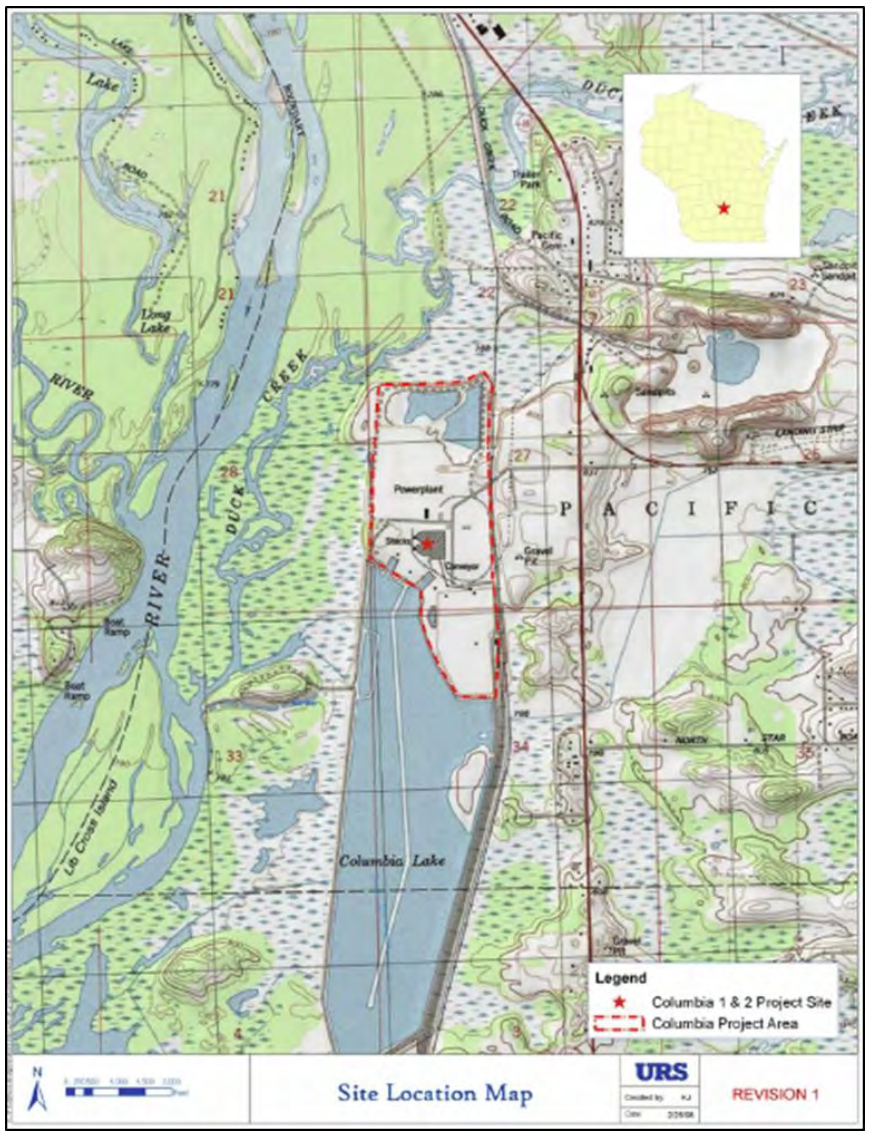

Figure 4 - Columbia Site Location

1.2. Project purpose

The Project includes the replacement of the coal pulverizers and the upgrade of the steam turbine rotors and inner casings. The Project is being proposed in order to maintain reliable operations and to improve the efficiency and energy profile for both Columbia Units 1 and 2 with the following key attributes:

- Resolve the stress corrosion cracking issue in the LP steam turbine rotors;
- Improve the reliability of the coal pulverization system;
- Reduce annual pulverizer maintenance cost;
- Improve the heat rate (efficiency) by approximately 4%;
- Reduce emission intensity on a pounds per megawatt hour basis;
- Increase the annual average hourly capacity offer to the MISO[4] market for energy production;
- Increase the average tested capacity (MW) for resource adequacy.

1.3. Project Background

WPL evaluates capital improvement projects which can be implemented to improve plant operating performance and reliability. That evaluation has indicated that, for Columbia, the combination of steam turbine upgrades and coal pulverizer replacements offers the greatest customer benefit.

Steam Turbine

The Columbia Units 1 and 2 existing steam turbines are GE G2-Series turbines.[5] The Unit 1 and Unit 2 steam turbines' original nameplate ratings are 512 MW and 511 MW, respectively, at 0.9 power factor (PF). Each steam turbine is coupled to a GE 617.8 Megavolt-ampere (MVA) hydrogen and water cooled generator. The efficiency of the existing steam turbines has experienced typical degradation over their more than 35 years of operation. In addition to full recovery of this performance degradation, a steam turbine upgrade will incorporate advances in steam turbine technology that have taken place over the past 35 years, making the Project economically advantageous.

[4] MISO is the acronym for Midcontinent Independent System Operator, Inc.

[5] General Electric (GE) tandem compound, single reheat, three casing, four flow, condensing, with main steam conditions of 2,400 pounds per square inch gauge (psig), 1,000°F superheat, 1,000°F reheat, and a turbine exhaust backpressure of 1.0 inches Mercury absolute (HgA).

Coal Pulverizers

The Columbia Units 1 and 2 boilers were manufactured by Combustion Engineering (now Alstom) and have six pulverizers per unit. Each pulverizer supplies fuel to four burners (one on each corner of the furnace) and has a design capacity of approximately 138,000 pounds per hour.[6] Each pulverizer is supplied fuel by a gravimetric type feeder. Major components within the existing pulverizers are reaching the end of their useful life. In the event that more than one pulverizer is out of service on a unit at one time, the unit will be forced to derate. Depending on the severity of the failure, the pulverizer could be out of service for up to approximately four months. The installation of new pulverizers would improve equipment availability, reliability and efficiency, reduce maintenance costs, and reduce the likelihood of future unit derates.

When coupled with the turbine upgrade, the installation of new coal pulverizers presents an opportunity to improve energy output from the facility beyond what is achievable from a steam turbine upgrade alone. The pulverizer replacements result in a sustainable improvement in overall fineness, including the virtual elimination of large particles. This sustainable improvement in fineness is expected to allow the units to operate at a higher average heat input more frequently without resulting in an increased rate of oxides of nitrogen (NOx) production, increased boiler fouling or increased carbon monoxide (CO) production, which are all associated with the current pulverizers at the higher heat input.

SCR

When evaluating the economic and performance impact of the Project, the Applicants included assumptions for the financial and operating impact of a selective catalytic reduction (SCR) system on Unit 2. The total cost estimated for the SCR assumed in this analysis was approximately $230 million with an in service date of December 31, 2018. The inclusion of the SCR assumption is consistent with the consent decree that the Applicants have entered into with the United States Environmental Protection Agency and the Sierra Club. For this analysis, an auxiliary power consumption of approximately 3 MW was assumed, along with fixed and variable operation and maintenance costs associated with the SCR.

Other projects

The Project was identified and evaluated as part of an evaluation of the entire plant referred to as the comprehensive asset management program (CAMP). This evaluation process was used at several plants operated by WPL in order to evaluate all opportunities, ranging from routine preventative maintenance to major capital investments, that could potentially improve the customer value of the plant. Some opportunities can be implemented immediately through

[6] 138,000 pounds per hour is the design capacity when grinding coal with a Hardgrove Grindability Index (HGI) of 52 and moisture content of 26.5 percent.

adjustments to processes or procedures, while other opportunities require more time and a capital investment such as this Project. Several other capital projects were identified during this evaluation process, which are either in progress or currently undergoing further consideration for implementation at Columbia. Specifically, circulating water pump overhauls (pump efficiency) and flame scanner improvements (boiler stability at minimum load) are currently in progress.[7] Consideration is also being given to projects such as:

- Condensate polishers (boiler water treatment);
- Air heater seal design improvements (air heater efficiency); and
- Cold reheat steam supply for soot blowing (soot blowing energy use).

These other projects neither contain cross-project design considerations with the Project, nor do they impact the design of the Project, so they can be implemented independently from the Project. The total plant aggregate cost for the additional capital projects being implemented or considered is approximately $6 million. These projects, if selected for implementation, are tentatively scheduled to be placed into service between 2013 and 2017. The cost, timing, and estimated benefit of these additional projects have been incorporated into the economic analysis of both the Project and the Alternative.

1.4. Project Scope

The steam turbine upgrade portion of the Project includes the supply and installation of a modified steam path consisting of the following:

- Fully bladed High Pressure (HP)/Intermediate Pressure (IP) and Low Pressure (LP) rotors;
- Fully bladed HP/IP and LP inner casings; and
- Replacement and upgrade of all steam seals.

The proposed coal pulverizer replacement project includes the following:

- Removal of the existing pulverizer maintenance platform and support structure;
- Demolition and removal of the existing pulverizers and motor pedestals;
- Installation of new pulverizer and motor pedestals;
- Installation of new pulverizers with dynamic classifiers and motors;
- Installation of a new seal air system; and
- Installation of a new inerting steam, seal air system, instrument air and cooling water piping system.

[7] The estimated cost of these two projects is approximately $1-2 million.

The steam turbine upgrades and coal pulverizer replacements will occur within the primary plant building. On-site storage and laydown is expected to be accommodated within existing space surrounding the primary plant buildings. There will be a slight increase in site congestion associated with normal plant operations. The impacts are expected to be minimal.

The steam turbine upgrades will be installed during a scheduled turbine overhaul outage between five and eight weeks in duration for each unit. The pulverizers do not require an outage and will be installed during normal plant operations. It is anticipated that no more than one coal pulverizer will be out of service per unit for replacement at any given time. The schedule is based on having five pulverizers available on each unit at all times, absent a reliability issue unrelated to the replacements.

1.5. Technology

1.5.1. Technology Overview

1.5.1.1. Turbine Upgrades

Significant turbine steam path efficiency improvements have been realized in the industry during the years since the existing steam turbines at Columbia Energy Center were commissioned. These improvements have resulted in improved turbine efficiency and output for turbines of the same footprint. The improved techniques used to design and manufacture the modern components have also led to better steam turbine component reliability.

Most steam turbine Original Equipment Manufacturers ("OEMs") have aftermarket retrofit solutions for both their original equipment and, in some cases, other OEM's equipment. To improve steam turbine performance through steam path efficiency improvements, a modified steam path consisting of fully bladed rotors and associated stationary components (blade diaphragms, seals, glands, etc.) will be supplied for the Project.

Drawing on gas turbine and aircraft engine technology, the OEMs have developed new steam turbine designs with higher reaction, lower pitch diameters, longer blades and often an increased exhaust annulus area. These designs allow for increased energy production from the same amount of steam by extracting more energy out of each pound of steam passing through the turbine. In addition, the designers have increased stage count, generally without increasing the overall length of the machine, giving rise to the name "dense pack" as shown in Figure 5. The term "dense pack" is a GE term and is being illustrated in Figure 5 for discussion purposes only. The Applicants have not selected any vendors for the Project.

Figure 5 - Example of a Baseline (left) and Dense Pack (right) Test Rotors. (Potter & Olear, 2005)

In most cases, the turbine outer cylinders (i.e., outer casings) are retained, as is the case for the Project. The outer cylinders are generally only replaced when maintenance needs require it. The electrical generators for the Columbia Units do not require modifications beyond possible machining of the drive coupling to match the new rotor coupling requirements.

Primary design improvements associated with the steam turbine upgrade include the following:

Improved Steam Cycle Efficiency – The upgraded steam turbine will require less steam per Megawatt hour (MWh) of power produced. A reduction in steam per MWh directly translates into an equivalent reduction in coal burned per MWh and therefore a reduction in both fuel cost and emission production per MWh.

Increased Energy Production – The improved steam cycle efficiency is directly correlated to increased energy production for a given heat input. The increased energy production potential of the steam turbine will provide for better utilization of the existing generator capacity. The energy benefits would be realized in the MISO markets as described in Section 1.5.2, Technology Application at Columbia Energy Center.

1.5.1.2. Coal Pulverizer Replacements

Six pulverizers supply the boiler of each Unit with pulverized coal (total of twelve pulverizers for two units). Each pulverizer has a design capacity to grind and deliver approximately 138,000 pounds per hour to the boiler. Each pulverizer is supplied fuel by a gravimetric type feeder.

The Project will replace the existing coal pulverizers with new coal pulverizers which require less maintenance, are more reliable, and have improved grinding performance. The new pulverizers will deliver a more consistent coal grind and improved fineness, which in turn results in improved combustion performance and boiler efficiency. The pulverizers will be sized such that the unit's normal operating output can be obtained with one pulverizer out of service, as it is currently designed. The intent, however, is to have all six pulverizers in service during all full

load operating hours for efficiency purposes. Primary design improvements associated with the new coal pulverizers will include the following:

Improved Coal Fineness – The Project design incorporates additional internal rotating components known as a "rotating classifier" which, when compared to the existing "static classifier" design, is more efficient at allowing fine coal particles to exit the pulverizer while returning coarse coal particles back to be "reground." A rotating classifier will offer the potential for better coal particle size distribution and more even distribution of the coal to the burners within the boiler, improving combustion and efficiency.

Reduced NOx Emissions – The improved delivered coal fineness to the burners and pipe-to-pipe balance coming out of each pulverizer to the burners is expected to allow both Columbia units to sustain the currently achievable NOx emission rates more consistently and reliably than the existing pulverizers. This will help assure that the units can fully utilize the Project's increased energy production potential while operating at or below the annual tons of NOx emissions set forth by the air permit application. Although the fineness improvement will be guaranteed by the pulverizer supplier, the resulting expected NOx performance is not one of the guarantee parameters. Therefore, in the economic analysis, the economic risk of not achieving the expected NOx performance is accounted for in the sensitivity study, specifically case 11.

Pulverizer Inerting – Pulverizer explosions can lead to costly repairs and potential safety concerns. To reduce the likelihood of these events, a pulverizer inerting (fire protection) system will be installed with the new pulverizers.

Improved Reliability – The pulverizer OEMs have made considerable improvements in component performance and reliability since the Columbia units were constructed. Primary areas of focus have been design improvements which reduce stress in failure prone areas, improved accessibility of components that require maintenance, and compliance with National Fire Protection Association (NFPA) standards.

Capacity – The new pulverizers will be designed to have sufficient capacity to maintain normal operation of the existing steam generator, with design fineness, when firing the expected range of fuels with worn rollers and any one pulverizer out of service per unit.

1.5.2. Technology Application at Columbia Energy Center

The primary maintenance benefits for the turbine project are the avoidance of the high cost repairs for the low pressure turbine dovetail cracking issue, and the ability to increase the duration between major turbine overhauls. The primary maintenance benefit for the pulverizers

is the elimination of major pulverizer rebuilds for the first 10 years, and significant reductions in major pulverizer rebuild costs from that point forward.

The capacity available at Columbia is provided to the market through a daily offer to MISO which in turn results in the daily energy demand from the unit. This offer consists of the following three hourly maximum capacity values:

> **Regulation Maximum –** Commonly referred to as the **"Cruise"** rating of the unit, this is defined by MISO as "the maximum operating level, in MW, at which the Resource can operate while scheduled to potentially provide Regulating Reserves." (MISO, February 06, 2013) It is essentially the maximum amount of the resource that the can be dispatched via automatic control.
>
> **Economic Maximum –** Commonly referred to as the **"Max Load"** rating of the unit, this is defined by MISO as "the maximum Energy available, in MW, from the Resource under non-Emergency conditions." (MISO, February 06, 2013) When MISO calls on a resource for Max Load, the electronic control of the unit is released from the dispatch center to the local operators at the plant.
>
> **Emergency Maximum –** This is currently determined by the MISO Generation Verification Test Capacity (GVTC) test, which is conducted by WPL. The Emergency Maximum is defined by MISO as "the highest level of Energy, in MW, the Resource can produce and maintain a stable level of operation under Emergency conditions." (MISO, February 06, 2013) An annual test is performed to determine this rating. Runs at an Emergency Maximum output cannot be sustained for an extended period of time. The results of the test are also used to define the Installed Capacity (ICAP).[8]

The turbine upgrades and pulverizer replacements can provide improvements to all three capacity offers. The current system prevents sustainable Max Load offers greater than approximately 510-515MW net, and Cruise Load offers greater than approximately 500-505 MW net on either unit at standard operating conditions. Upgrading the turbines would result in a Cruise, Max Load and GVTC test capacity increase due to efficiency improvements. However, in order to fully utilize the potential of the steam turbine upgrade, combustion control limitations related to gas temperatures, steam temperatures and emission production also need to be overcome. Combustion improvements attributable to the pulverizer replacements will overcome those combustion control limitations.

The Project allows for the system to be designed and optimized for the full utilization of the existing capability of the electrical systems. The optimized system will result in a sustainable increase in both the Cruise Load and Max Load offers to approximately 555 MW net on each

[8] ICAP, when reduced by the equivalent forced outage rate, equals the unforced capacity (UCAP).

unit by fall 2017, when the Project is expected to be completed and tested. This accounts for the auxiliary power from the new dry flue gas desulphurization equipment being installed.

The typical average full load MISO capacity demand from Columbia, resulting from the aforementioned MISO capacity offers, is referred to here as the "Operating Capacity." The Operating Capacity is used to determine the daily energy production from each unit. The increase in energy production attributable to the Project (relative to the Alternative) is a primary driver in the economic justification of the Project.

The Unforced Capacity (UCAP) is the available capacity in the short term capacity market, and is also higher for the Project relative to the Alternative. The UCAP holds lower significance than the Operating Capacity in the economic analysis.

Table 2 shows the estimated ICAP, UCAP, and Operating Capacity for the Project and the Alternative in fall 2017.

Table 2 - Estimated Capacities for the Project and the Alternative (fall 2017)

	Unit 1 Net Capacities		
	Installed Capacity (ICAP)	Unforced Capacity (UCAP)	Operating Capacity
Project	568	537	555
Alternative	552	522	508

	Unit 2 Net Capacities		
	Installed Capacity (ICAP)	Unforced Capacity (UCAP)	Operating Capacity
Project	563	544	555
Alternative	553	534	507

	Total Plant Net Capacities		
	Installed Capacity (ICAP)	Unforced Capacity (UCAP)	Operating Capacity
Project	1131	1081	1110
Alternative	1105	1056	1015
Delta	**26**	**25**	**95**

1.6. Construction Approach

The following is a high-level overview of the construction approach for the turbine upgrade and pulverizer replacement projects. The approaches for each project will be different and are described in the following sections.

1.6.1. Turbine Upgrade

When the steam turbines are upgraded, the external cross-section and all of the interconnecting piping will remain unchanged. The only components that are replaced are the internal HP/IP and LP stationary and rotating components within the steam path, from the high pressure nozzle blocks to the steam outlet after the last stage blades. The front standard, lower outer casings, valves, generator, exciter, and other electrical and ancillary systems are not part of the upgrade and remain unchanged. However the turbine upgrade will be completed concurrent with a scheduled major overhaul, so all of the aforementioned systems will receive inspections and/or maintenance that are deemed prudent during the major overhaul when the turbine steam path is being upgraded.

The construction process is expected to be similar to a turbine major overhaul. After the unit is taken off-line and systems are locked out, all of the turbine casings are disassembled and the rotating shafts removed. The stationary blading, or diaphragms, are removed from the slots in the casings. After performing a number of dimensional checks, the new/upgraded diaphragms are inserted into the casings. Following further dimensional checks, the new rotating blades and shafts are set back into each casing. After all three new shafts are installed, shaft to shaft alignments are checked and adjusted if necessary, the upper casings are re-installed, and shaft to casing clearances are checked. If alignments or clearances are not within specified tolerances, each casing and shaft may need to be removed so that proper adjustments can be made. It is not uncommon for disassembly and reassembly to take place several times to make sure alignments and clearances are within the specified tolerances. Once completed, casings are bolted together, shaft couplings are bolted together, and all other reassembly is completed.

After reassembly, the lubricating oil system is turned on to flush the system so that any debris that has entered the system through the installation and reassembly process gets flushed out of the bearings. After checking that the lubricating oil is clean, the reassembled turbine-generator is slowly rotated by the turning gear. Further checks and adjustments are made until the completely assembled machine is ready for start-up. The start-up process itself is essentially the same as the start-up process for the existing equipment. The entire process will take place over a five to eight week period. The Unit 1 and Unit 2 major outages are planned for spring of 2017 and 2016 respectively. A preliminary turbine upgrade project level 1 schedule is provided in Appendix E, Schedule 1.

Other Turbine Overhaul Work

An overhaul of the turbine and generator components not being upgraded will be performed at the same time as the upgrade so as to best utilize the time and resources while the turbine is apart for the upgrade. It is important to note the following:

- The overhaul of these components is not part of, or required for, the upgrade;
- The aggregate cost of the overhaul items for both units is estimated at approximately five to nine million dollars; and
- The overhaul scope is required regardless of whether or not the upgrade is approved.

While this work does not meet the cost threshold for a CA under Wis. Stat. 196.49, and, the Applicants are not requesting specific approval of the overhaul scope, it is important to recognize this work, as it will be performed by the same contractor selected to perform the upgrade. The driver for awarding the overhaul scope to the turbine upgrade contractor is to mitigate outage schedule risk and coordination of work. Having one contractor responsible for work related to the turbine/generator system will mitigate the risk of voiding schedule and performance guarantees. The non-upgrade overhaul scope that may potentially be concurrent with the upgrade, and therefore awarded to the turbine upgrade contractor, may include items on the following list:

- General overhaul of retained steam turbine components and auxiliaries;
- Steam turbine valve refurbishment;
- Generator rotor rewind (Unit 2 only);
- Exciter rotor rewind and retaining ring replacement (Unit 2 only);
- Generator/exciter testing; and
- Turbine supervisory instrumentation upgrade (Unit 2 only).

1.6.2. Coal Pulverizer Replacement

The implementation plan for the pulverizers includes keeping five pulverizers available on each unit at all times. The complete disassembly, demolition and reassembly process will be completed on one pulverizer (per unit) before the next pulverizer is started. Because the units can achieve normal full load output with only five pulverizers, unit output is not affected with this approach. This allows the project to continue uninterrupted until all twelve of the pulverizers are replaced. If a pulverizer that is not being worked on has a failure while a different one is being replaced, unit output will be reduced by approximately 100 MW until one

of the pulverizers returns to service.[9] This risk will be mitigated by giving consideration to existing mill condition when determining the mill replacement sequence.

The pulverizer supplier will be required to be flexible in order to accommodate a potential change in sequence due to a potential unplanned equipment failure. To facilitate such a flexible installation sequence, during a scheduled unit outage, all utility services, including service water, cooling water, sluice water, seal air, and instrument air systems will be relocated outside of the pulverizer demolition and installation work area. Additional isolation valves would be added to all station services to enable isolation of the utility services to each pulverizer.

Each pulverizer is expected to be disassembled from the top down, starting with isolating the hot air duct and the coal piping. Disassembly will include removal of the coal inlet and outlet piping, drive motor, hot air inlet duct, access platforms, auxiliary equipment and internal grinding elements followed by disassembly of the pulverizer body, and the internal gearbox. This process takes approximately three weeks.

The lubricating oil, cooling water, motor platform, seal air, and all electrical hardware and instrumentation are removed prior to any foundation modifications that may be required depending on the selected supplier. The existing pulverizers sit on piers tied into the main boiler room foundation. These piers may need to be removed and the existing boiler room foundations modified by installing new anchor bolts and sole plates that the new pulverizers, gearboxes, and motors will be mounted on. After any necessary foundation modifications are made, the pulverizer bases are installed, followed by the bodies, grinding rotating and stationary coal grinding elements, the dynamic classifier, and roof. The construction process is finalized by installing the coal inlet and outlet piping, hot air duct, seal air system connections, electrical power connections, inerting system, pyrites removal system, and instrumentation. The complete demolition and construction process will be determined by the equipment supplier and will be finalized after a supplier has been selected.

The removal of the old pulverizers and installation of the new pulverizers is estimated to take approximately four months per pulverizer. Therefore, if construction begins in Q2 2015, installation of the final pulverizers should be completed by Q1-Q2 2017. The order of installation will be based on pulverizer condition, performance, and the number of years since the previous major overhaul. A preliminary pulverizer replacement project level 1 schedule is provided in Appendix E, Schedule 2.

[9] This same risk exists when major maintenance is being performed on one of the existing pulverizers.

1.7. Constructability Summary

All of the equipment is being installed within the existing footprint of the plant and is contained almost entirely within the space occupied by the equipment being removed. The turbine room will essentially be identical before and after the upgrades. The pulverizer bay will have some equipment repositioned to provide improved access for maintenance. A preliminary layout of the pulverizer bay is provided in Appendix F.

When the equipment supplier completes the dissasembly of the existing equipment, the supplier will transfer the material to a location where it will be sold or scrapped. After the equipment suppliers complete the assembly of the replacement components, the suppliers will coordinate a turnover of the equipment to the plant in order to facilitate the startup and testing process.

1.8. Milestone Schedule

The schedule in Table 3 is a preliminary milestone schedule for the Project. This schedule assumes that the Unit 1 and Unit 2 turbine will be placed in-service during Q1-Q2 2017 and 2016 respectively. It also assumes that pulverizer replacements will begin in Q2 2015 and be completed by Q1-Q2 2017. This schedule will be refined after the turbine and pulverizer suppliers have been selected and detailed engineering begins.

Table 3 - Milestone Schedule

Milestone	Anticipated Date
Start preliminary engineering and technical specifications [a]	January 2013 (actual)
Submit CA Application to PSCW	July 2013 (actual)
Award limited contract to start engineering for the Turbine Upgrade (limited notice to proceed)	August 2013
Award limited contract to start engineering for the Pulverizer Replacement (limited notice to proceed)	September 2013
Receive PSCW CA approval (expected)	2nd Quarter 2014
Receive environmental permits (expected)	2nd Quarter 2014
Issue Final Notice to Proceed to Turbine and Pulverizer Suppliers (initiate material commitments and fabrication)	2nd Quarter 2014
Materials on-site and start demolition of first two pulverizers followed by new pulverizer construction	April 2015
New turbine materials on-site for Unit 2 upgrade outage	1st Quarter 2016
Complete installation of Unit 2 upgraded turbine components and start-up	2nd Quarter 2016
New turbine materials on-site for Unit 1 upgrade outage	1st Quarter 2017
Complete installation of Unit 1 upgraded turbine components and start-up	2nd Quarter 2017
Complete replacement of final Unit 1 and 2 pulverizers	2nd Quarter 2017
Turbine Upgrade Project Completion	4th Quarter 2017
Pulverizer Replacement Project completion	4th Quarter 2017

a. Includes balance of plant engineering and preparation of the specifications for the required equipment.

In order to plan for timely fabrication while minimizing cost risk, the schedule contemplates the selected suppliers starting engineering for both the turbine upgrades and the pulverizer replacements while the CA application is being reviewed by the Public Service Commission of Wisconsin (PSCW). However, fabrication of components and construction will not begin until after the receipt of a CA.

2.0 Cost and Financing Estimates

An engineering consultant developed capital and operating and maintenance (O&M) cost estimates for both the turbine upgrade and pulverizer replacement projects. These estimates include the following key items for each project.

2.1. Turbine Upgrade

Mechanical Equipment

The new mechanical equipment is a replacement of most of the internal components known as the steam path. This includes the high pressure (HP), Intermediate Pressure (IP) and Low Pressure (LP) rotors, inner casings, and seals. In order to replace these components, the turbine must be disassembled and reassembled, similar to a major turbine overhaul.

Instrumentation

For accurate performance guarantee testing[10], several key instruments will need to be replaced. The most notable is a calibrated condensate flow nozzle, plus several high temperature thermocouples.

Post Installation Guarantee Performance Testing

Performance guarantee testing will be performed upon completion of the installation and startup of the new equipment. Testing is expected to start within approximately one month of the completion of successful startup including vibration adjustments. Testing is expected to last approximately two weeks, with a full report completed within six weeks if turbine performance guarantees are met.

Engineering

An engineering consultant will assist in developing specifications and in reviewing proposals from the bidders. The bulk of their work will be to review all of the drawings and other submittals required as part of the contract.

Owner's Costs

Owner's costs include, but are not limited to, the costs for WPL project personnel to manage the project, procure spare parts, obtain the necessary State and local permits, administrative and general costs, perform testing and allow for contingency.

[10] Testing is expected to follow the procedures specified in ASME Power Test Code 6.

2.2. Coal Pulverizer Replacement

Mechanical Equipment

The new equipment includes new pulverizers from the foundations to the interfaces with the existing coal inlet and outlet piping, primary air ductwork, pyrites removal system, steam inerting system, and lube oil cooling system.

Electrical Systems

New electrical power feeds will be required for the dynamic classifier motors. New main power feeds for the pulverizer motors will likely be relocated to improve maintenance access.

Instrumentation and Controls

The distributed control system (DCS) will require modification of control logic.

Balance of Plant

Interfaces with the plant auxiliary steam system for inerting (fire protection) will be required. Interfaces will also be needed for the service water and seal air systems.

Engineering

An engineering consultant will assist in developing specifications and in reviewing proposals from the bidders. The bulk of their work will be to review all of the drawings and other submittals required as part of the contract and to ensure proper tie-in to the existing plant auxiliary systems.

Owner's Costs

Owner's costs include, but are not limited to, the costs for WPL project personnel to manage the project, procure spare parts, obtain the necessary State and local permits, administrative and general costs, perform testing and allow for contingency.

Costs presented in the CA application represent the engineering consultant's estimate based on budgetary quotations received from several suppliers of each furnish and erect contract. Cost for the balance of plant equipment and installation was developed by the engineering consultant using their internal database and cost development tools. The costs have an expected accuracy of -10%/+15%.

Bidder selections and preliminary work under a limited notice to proceed are expected to take place during Q3 2013. Final notice to proceed will not be granted until after receiving a CA for the Project.

2.3. Estimated Capital Cost and Cash Flow

Estimated capital costs for the Columbia Turbine Upgrades and the Pulverizer Replacements are provided in Table 4 and are based upon the schedule presented in Section 1.8. These costs do not include Allowance for Funds Used During Construction (AFUDC)[11].

Table 4 - Columbia Turbine Upgrade and Pulverizer Replacement Estimated Capital Cost

Line	Scope Description	Estimated Cost
1	**Turbine**	
2	Furnish and Erect	$ 65,500,000
3	Post installation heat rate guarantee testing	$ 700,000
4	New and upgraded instrumentation	$ 500,000
5	Sub-total	$ 66,700,000
6	Engineering and fee	$ 600,000
7	Owner's Cost	$ 7,600,000
8	Turbine Sub-Total	$ 74,900,000
9		
10	**Pulverizer**	
11	Furnish and Erect	$ 34,000,000
12	Balance of plant material and installation	$ 9,500,000
13	Engineering and fee	$ 3,200,000
14	Construction management, indirect, and G&A	$ 2,200,000
15	Sub-total	$ 48,900,000
16	Owner's Cost	$ 6,200,000
17	Pulverizer Sub-Total	$ 55,100,000
18	**Grand Total**	**$ 130,000,000**

Cash flow estimates for the project schedule in Section 1.8 are shown in Table 5 in year-of-occurrence dollars.

[11] AFUDC is the process of including as a part of the total project costs, the applicable carrying costs on Construction Work in Progress (CWIP) expenditures. If such CWIP balances are included in net investment rate base in a rate proceeding, the AFUDC would not be included or computed on such amounts.

Table 5 - Columbia Turbine Upgrade and Pulverizer Replacement Project Annual Cash Flow

		Annual Cash Flow($)[a]			
Year	**Annual % of Total Cost**	**WPL**	**WPS**	**MGE**	**Total**
2013	**0.7%**	$ 425,040	$ 292,560	$ 202,400	**$ 920,000**
2014	**14.5%**	$ 8,731,800	$ 6,010,200	$ 4,158,000	**$ 18,900,000**
2015	**25.4%**	$ 15,248,310	$ 10,495,590	$ 7,261,100	**$ 33,005,000**
2016	**38.5%**	$ 23,123,100	$ 15,915,900	$ 11,011,000	**$ 50,050,000**
2017	**20.9%**	$ 12,531,750	$ 8,625,750	$ 5,967,500	**$ 27,125,000**
Total	**100.0%**	$ 60,060,000	$ 41,340,000	$ 28,600,000	**$ 130,000,000**

a. Costs are represented in year-of-occurrence dollars.

Actual project costs and cash flow will vary depending upon project approval timing, actual project schedule, and market conditions. Timely approval of this project may allow WPL the opportunity to procure the equipment and services at more favorable pricing. It will also allow WPL to better manage risks associated with long-lead time fabrication and assembly and overseas manufacture and shipment.

2.4. Financing Mechanism

The Project is expected to be financed in a manner consistent and compliant with the individual Applicants' utility capital structures and Commission-approved financing authorizations. For its respective portion of the project, MGE requests the authority to accrue AFUDC on 100% of the CWIP. This is consistent with recent rate orders for WPL and WPS. Accordingly, the costs for the Project identified in this Application exclude AFUDC.

However, for the purpose of the economic analysis, the Applicants have modeled the accrual of AFUDC on 50% of the CWIP balances for this project. Specifically, the economic analysis has incorporated AFUDC in the revenue requirement calculations using the financing assumptions provided in Appendix B, Schedule 2. With AFUDC on 50% of CWIP, the total cumulative AFUDC for the Project amounts to approximately $8,267,000.

Applicants anticipate traditional rate treatment of all project costs in future rate proceedings.

3.0 Need and Alternative Analysis

The proposed Project addresses the aforementioned maintenance needs with the complete replacement of the coal pulverizers and the upgrade of the turbine steam path internals. The Project also results in performance improvements due to technological advances that have been made since the Columbia units were constructed. The improvements provide a significant benefit to customers through increased efficiency and energy margins.

The Alternative to the Project retains the existing turbines and coal pulverizers through major repairs. There are no technology-driven performance improvements associated with the Alternative.

The appropriate comparison in this analysis is maintenance with replacement components based on improved technology (i.e. the Project) versus maintenance with like-in-kind components based on original technology (i.e. the Alternative). None of the higher-ranked priorities identified in Wis. Stat. section 1.12(4) provide a cost effective and technically feasible alternative to the Project because none of them are solutions that address turbine or pulverizer maintenance needs.

For this Application, a net customer benefit economic analysis was performed using a spread-sheet tool developed by the Applicants for both the Project and the Alternative. The analysis relies on comparing the present value of the revenue requirements (PVRR) for the Project and the Alternative. The difference between the Project and the Alternative on a PVRR basis is referred to hereinafter as the "net customer benefit."

3.1. Economic Analysis

3.1.1. Evaluation Tool

The evaluation tool chosen for this analysis is a spreadsheet analysis. This was chosen for the following reasons:

- The primary driver for the Project is increased energy margin with improved efficiency on an existing unit which already has an established history of market performance. A spreadsheet tool can easily and efficiently be used to evaluate a base case and sensitivities on assumptions for a project of this nature;
- The Project is not being proposed to fulfill a capacity need and therefore does not require a long term capacity expansion alternatives analysis; and
- Generally, the assumptions that will have an impact on the economic analysis of the Project are limited to those that have a specific impact on the Columbia's position in the energy and capacity market. Potential effects of variation in such assumptions have been captured in the spreadsheet analysis performed.

3.1.2. Analysis Summary

Over the study period, using the spreadsheet tool to perform a PVRR analysis, the net customer benefit of implementing the Project relative to implementing the Alternative is $103 million. The net customer benefit by year is illustrated in Figure 6.

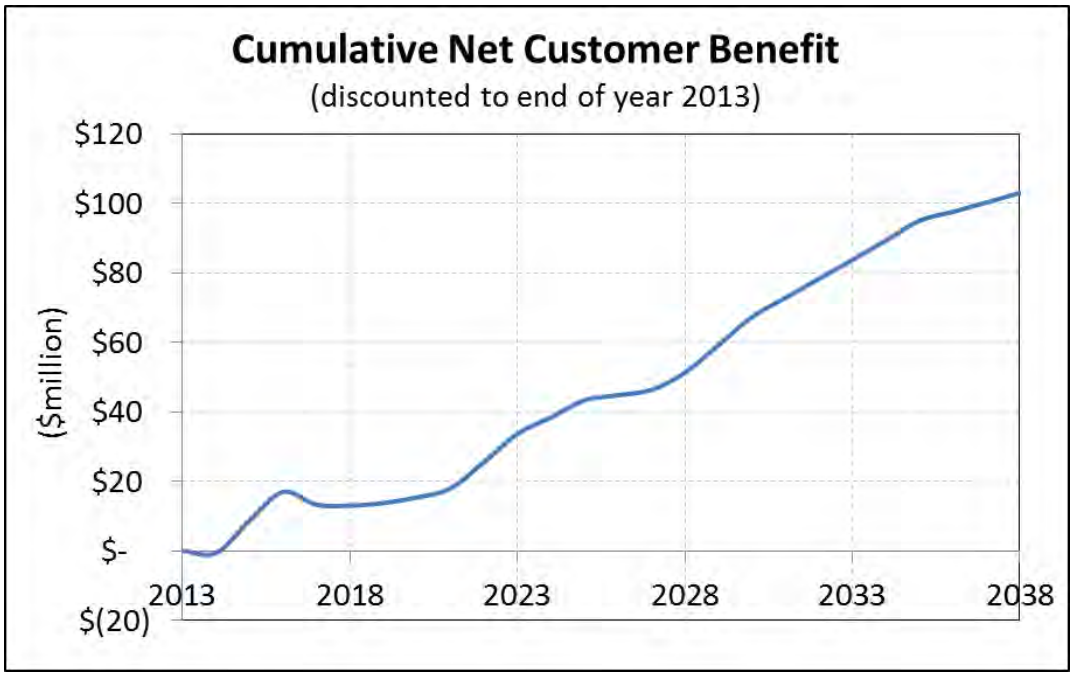

Figure 6 - Cumulative Present Value of Net Customer Benefits

The following is a summary of the calculations used to determine net customer benefit:

Net customer benefit each year is a comparison between the Project and the Alternative and is determined by subtracting the incremental customer costs from the incremental customer benefits.

Incremental Customer cost is defined by the incremental revenue requirements from capital and operation and maintenance (O&M) expenditures for the Project relative to the Alternative.

Incremental Customer benefit of the Project relative to the Alternative each year is defined by the incremental energy revenue and capacity value of the Project relative to the Alternative minus the incremental production cost of the Project relative to the Alternative.

The annual incremental customer cost and benefit, in year of occurrence dollars, is shown in Figure 7. Those costs that are depicted as negative recognize the avoided cost of maintaining the existing turbines and pulverizers. For example: In 2015 the Alternative includes the costs associated with a major overhaul. These overhaul costs are not included in the Project due to that outage taking place in 2016.

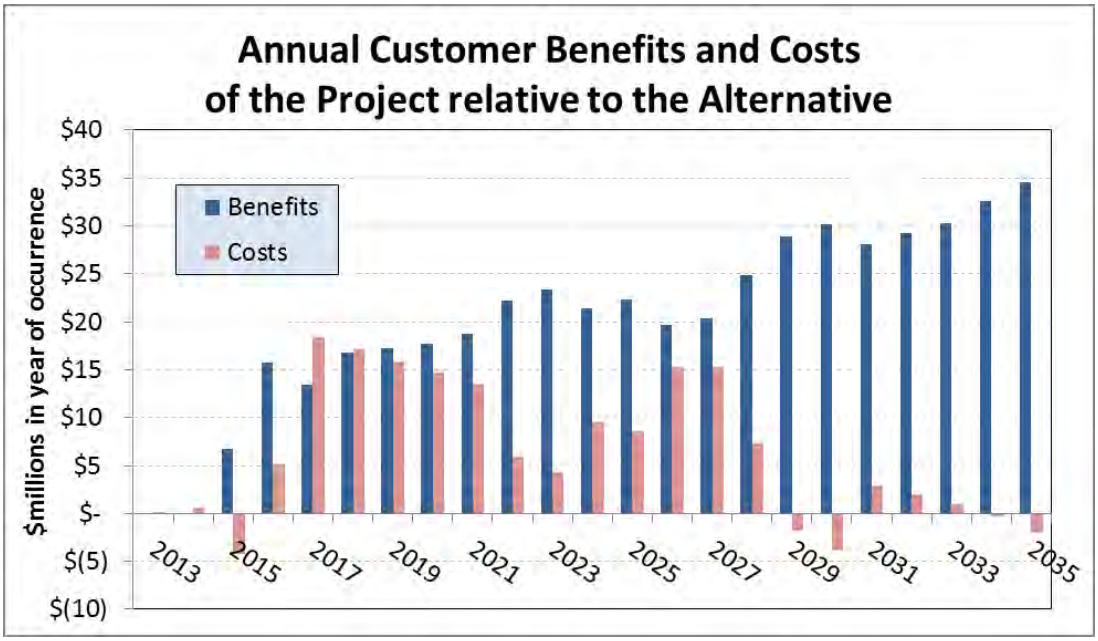

Figure 7 - Annual Customer Benefits and Costs

The data used to develop the bar chart in Figure 7 can be found in the following Appendices:

- Appendix B, Schedule 1 – Fuel and Energy Price Projection Assumptions
- Appendix B, Schedule 3 – Input Tables
- Appendix B, Schedule 4 – Calculation Tables
- Appendix B, Schedule 5 – Summary Tables

3.1.3. Primary Project Benefits: Performance Improvement

3.1.3.1. Efficiency (Heat Rate) Improvement

The efficiency benefit that has been quantified is the result of the turbine steam path technology improvements. The heat rate benefit identified for each unit is approximately 440 Btu/kWh. This equates to an approximate 4% heat rate improvement, which is consistent with the typical improvements seen across the industry.

An article in POWER Magazine (Peltier, 2006) titled "*Steam turbine upgrading: Low-hanging fruit*" is included in Appendix C and references similar projects that have experienced even greater benefits. Of particular interest in that article is Labadie Units 3 and 4 which received upgrades to comparable General Electric G2 turbines that were exhibiting signs of stress corrosion cracking. As mentioned in the article, Labadie Units 3 and 4 measured efficiency improvements of 7% on the HP turbine sections and 5% on the LP turbine sections.

The efficiency improvement applies to every MWh of energy generated, including the energy from the existing installed capacity. Therefore, the units will be able to produce each MWh of energy using approximately 4% less fuel. This translates into an emission rate reduction per MWh of approximately 4% for all emissions that are directly correlated to fuel consumption.

3.1.3.2. Energy and Capacity Increase

The capacity available at Columbia is provided to the market through a daily offer to MISO which in turn results in the daily energy demand from the unit. The three maximum capacity values, as described in section 1.5.2, are all impacted by the proposed project.

Daily Energy Benefit

The regulation maximum and economic maximum are the two components of the offer to MISO that determine the daily energy demand during non-emergency conditions. For the purpose of economic modeling, the regulation and economic maximum capacities were consolidated into the "Operating Capacity" which was used to determine the daily energy production. Table 6 depicts the Operating Capacity projection for both units for both the Project and the Alternative.

Table 6 - Operating Capacity Projections for the Project and the Alternative

	Unit 1			Unit 2			TOTAL PLANT		
	Project	Alternative	DELTA	Project	Alternative	DELTA	Project	Alternative	DELTA
	MW	MW	MW	MW	MW	MW	MW	MW	MW
2011	512	512	0	511	511	0	1,023	1,023	0
2012	512	512	0	511	511	0	1,023	1,023	0
2013	514	514	0	513	513	0	1,026	1,026	0
2014	508	508	0	507	507	0	1,015	1,015	0
2015	508	508	0	507	507	0	1,015	1,015	0
2016	508	508	0	555	507	48	1,063	1,015	48
2017	555	508	47	555	507	48	1,110	1,015	95
2018	555	508	47	555	507	48	1,110	1,015	95
2019	555	508	47	552	504	48	1,107	1,012	95
2020	555	508	47	552	504	48	1,107	1,012	95
2021	555	508	47	552	504	48	1,107	1,012	95
2022	555	508	47	552	504	48	1,107	1,012	95
2023	555	508	47	552	504	48	1,107	1,012	95
2024	555	508	47	552	504	48	1,107	1,012	95
2025	555	508	47	552	504	48	1,107	1,012	95
2026	555	508	47	552	504	48	1,107	1,012	95
2027	555	508	47	552	504	48	1,107	1,012	95
2028	555	508	47	552	504	48	1,107	1,012	95
2029	555	508	47	552	504	48	1,107	1,012	95
2030	555	508	47	552	504	48	1,107	1,012	95
2031	555	508	47	552	504	48	1,107	1,012	95
2032	555	508	47	552	504	48	1,107	1,012	95
2033	555	508	47	552	504	48	1,107	1,012	95
2034	555	508	47	552	504	48	1,107	1,012	95
2035	555	508	47	552	504	48	1,107	1,012	95
2036	The current Unit 1 depreciation study period ends in 2035			552	504	48	552	504	48
2037				552	504	48	552	504	48
2038				552	504	48	552	504	48

The Operating capacities were evaluated with the fuel and O&M costs, energy price projections, and other operating assumptions shown in Appendix B, Schedule 3 to produce annual production costs and energy revenues. The production costs, energy revenue, and resulting energy margin by year is shown in detail in Appendix B, Schedule 4 and is summarized in Table 7. The energy margin is the primary driver of the economic benefit associated with the Project relative to the Alternative.

Table 7 - Energy Margin Projection for the Project and the Alternative ($ Millions in Year of Occurrence)

	Project			Alternative			DELTA		
	Revenue	Cost	Margin	Revenue	Cost	Margin	Revenue	Cost	Margin
2013	$226	$129	$96	$226	$129	$96	$-	$-	$-
2014	$228	$142	$85	$228	$142	$85	$-	$-	$-
2015	$260	$201	$59	$231	$179	$52	$29	$22	$7
2016	$269	$201	$68	$236	$184	$52	$33	$17	$16
2017	$288	$218	$70	$272	$215	$57	$16	$3	$13
2018	$307	$235	$72	$280	$224	$56	$26	$11	$16
2019	$317	$245	$72	$290	$234	$56	$27	$11	$16
2020	$328	$255	$74	$300	$243	$57	$28	$12	$16
2021	$345	$265	$81	$316	$252	$63	$30	$12	$17
2022	$365	$276	$89	$322	$254	$68	$43	$22	$21
2023	$382	$288	$94	$337	$265	$72	$45	$23	$22
2024	$396	$300	$96	$362	$286	$76	$34	$14	$20
2025	$413	$312	$101	$378	$297	$80	$36	$14	$21
2026	$416	$314	$102	$393	$310	$83	$23	$4	$18
2027	$432	$327	$106	$409	$323	$86	$23	$4	$19
2028	$464	$352	$112	$425	$336	$89	$40	$16	$24
2029	$483	$367	$116	$427	$338	$89	$56	$29	$28
2030	$504	$382	$122	$445	$352	$93	$59	$30	$29
2031	$526	$397	$129	$481	$379	$102	$45	$18	$27
2032	$548	$413	$135	$501	$394	$107	$47	$19	$28
2033	$568	$428	$141	$520	$408	$112	$49	$20	$29
2034	$604	$444	$159	$552	$424	$128	$52	$21	$31
2035	$636	$462	$174	$581	$441	$141	$55	$21	$33

A graph of Table 7 was provided in Figure 1 in the Executive Summary.

Capacity Benefit

For the purpose of the economic analysis performed with the spreadsheet tool, UCAP increases were treated as MWs available for capacity market sales or offsetting capacity market purchases. The expected increases in UCAP are approximately 16 MW and 9 MW for Unit 1 and Unit 2, respectively. The economic analysis did not assume that the approximate 25 MW capacity increase would be substantial enough to delay the construction of new capacity resources in the future.

3.1.3.3. Maintenance Cost Reduction

There are two ways to address the maintenance needs associated with the turbines and pulverizers. The Project addresses these maintenance issues with replacement components. The internal components of the turbines and the complete pulverizer assemblies would be replaced. The capital project cost associated with the Project results in a significant reduction in the long term maintenance cost. With the new internal components in the turbine, the duration between major turbine outages can be extended from 7 years to 10 years.

If the projects are not done as described in the Project, the turbines will incur high repair costs and extended outages to address the dovetail cracking problem. The coal pulverizers would also require major component replacements and continued major rebuilds over the remaining life of the plant. This alternative maintenance plan is referred to as the Alternative.

The long term maintenance cost of the replacement components in the Project is lower than the long term maintenance cost of existing components in the Alternative. The annual turbine and pulverizer maintenance cost associated with the Project and the Alternative is included in Appendix B, Schedule 4 in the "Revenue Requirements" section with the row titles, "Cap adder Turbine Maintenance," "Cap adder Mill Maintenance," and "Fixed O&M adder Turbine Maintenance. Note that the term "mill" is interchangeable with the term "pulverizer."

The long term maintenance cost results in an offset to a portion of the rate base revenue requirements associated with the upfront capital cost of the Project.

3.1.4. Project Cost

The total capital cost of the Project exclusive of AFUDC is $130,000,000. The annual total project cash flow was provided in Table 5 in Section 2.3. Revenue requirements were developed using the financial modeling assumptions shown in Appendix B, Schedule 2.[12] Due to the aforementioned long term maintenance cost reduction, the resulting net increase in the present value of revenue requirements for capital and operations and maintenance projects for the Project relative to the Alternative is $72 million.

[12] As discussed above, while the total capital costs are exclusive of AFUDC, the Applicants assumed AFUDC on 50% of the CWIP balance in the economic modeling, which amounts to approximately $8,267,000.

3.1.5. Combined Analysis

3.1.5.1. Economic Modeling Assumptions

Unit Operating Characteristics

The unit operating characteristics that have the most significant effect to this analysis are:

- Operating Capacity Increase
- Operating Factor
- Heat Rate Improvement

The Operating Capacity increase of approximately 95 MW and heat rate improvement of approximately 440 Btu/kWh were discussed with the project benefits and project synergies, sections 3.1.3 and 1.5.2 respectively. The operating factor is essentially the capacity factor during the hours of the year when the unit is available and is defined by the following equation:

$$Operating\ Factor\ (\%) = \frac{Annual\ MWh\ Generation\ (Megawatt\ hours)}{Rated\ Capacity\ (MW) \times\ total\ hours\ per\ year - PM - UPM\ \ (hours)}$$

where PM = Planned Maintenance (hours/year)
UPM = Unplanned Maintenance (i.e. forced outages) (hours/year)

The operating factor was set at 90% for the base case analysis and held constant for each year of the analysis. When the annual forced outage rate and the annual planned maintenance is applied to the operating factor of 90%, the result is an annual capacity factor in the low 70's during major outage years and high 70's during non-major outage years which is comparable to recent operating history. The capacity factor is used in the energy margin calculations and is defined by the following equation:

$$Capacity\ Factor\ (\%) = \frac{Annual\ MWh\ Generation\ (Megawatt\ \ hours)}{Rated\ Capacity\ \ \ MW\ \ \times total\ hours\ per\ year}$$

Fuel and Energy Price Forecasts

The applicants each have internal fuel and energy price projections that are used for integrated resource planning purposes. In order to have a common fuel and energy price forecast for the Columbia units in this analysis, the applicants used a generic data set comprised primarily of publicly available forecasts from the Energy Information Agency (EIA).[13]

The energy price is a blended energy price comprised of 4600 hours of off-peak energy and 4160 hours of on-peak energy. Off-peak energy was calculated using a weighted average of the dispatch cost for coal and natural gas combined cycle (NGCC) units. The weight was 75% coal and 25% NGCC. On-peak energy was calculated using a weighted average of the dispatch cost for NGCC and natural gas simple cycle peaking units. The weight was 75% NGCC and 25% simple cycle peaking. A complete description of the sources used to develop the fuel and energy price forecasts can be found in Appendix B, Schedule 1. The resulting blended energy price and delivered fuel price is included in Appendix B, Schedule 3.

Capacity Value

The additional capacity from this project was assumed to provide value through the capacity market. It was assumed that a reasonable upper bound on market value of capacity is the cost of new entry (CONE), which corresponds to the annualized cost of a new simple cycle combustion turbine.

The capacity value was set to 50% of CONE and then varied from $0 to CONE in the sensitivity analysis, which is discussed in the following Results section. The value of CONE in this analysis is 98,380 $/MW/yr and is based on the first annual MISO calculation of the Cost of New Entry in Local Resource Zone 2 (Wisconsin).[14]

[13] The EIA data is from the 2012 Annual Energy Outlook available at http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf .

[14] Per FERC Docket No. ER12-2580-000 filed with the Federal Energy Regulatory Commission by MISO on September 4, 2012.

3.1.5.2. Results and Sensitivity Analysis

The results of the economic analysis show that the Project is a lower cost option than the Alternative by $103 million. This analysis is based on the base case assumptions discussed in the previous sections, and listed in Appendix B, Schedule 3.

In order to assess a range of potential outcomes, a sensitivity analysis was performed on the primary inputs that could potentially vary from the projected base case values. The reference case consisting of the base case values is identified as case one.

The sensitivity analysis is identified as cases 2 through 17. These cases analyzed the impact of variation of the inputs listed in Table 8:

Table 8 - List of Sensitivities

Case #	Description
2	Higher Cost of the Project by 10%
3	Lower Cost of the Project by 10%
4	Higher Cost of the Alternative by 10%
5	Lower Cost of the Alternative by 10%
6	Higher Heat Rate Improvement by 10%
7	Lower Heat Rate Improvement by 10%
8	Higher Operating and Unforced Capacity Increase by 10%
9	Lower Operating and Unforced Capacity Increase by 10%
10	Higher Operating Factor by 10%
11	Lower Operating Factor by 10%
12	Capacity Value equal to CONE
13	Capacity Value equal to $0
14	Higher MISO Market Energy Price by 25%
15	Lower MISO Market Energy Price by 25%
16	Higher Delivered Fuel Price by 25%
17	Lower Delivered Fuel Price by 25%

The sensitivity analysis matrix of inputs and outputs is included in Appendix B, Schedule 6. In each case, the Project proved to provide more customer benefit than the Alternative, with outcomes ranging from $27 million to $179 million as shown in Table 9.

Table 9 - Sensitivity Analysis Results (Columbia Plant PVRR in 2013 millions of dollars)

Case #	The Project	The Alternative	Delta* (Project less Alternative)
1 (base)	655	758	(103)
2	670	758	(88)
3	639	758	(119)
4	655	765	(110)
5	655	751	(96)
6	644	758	(113)
7	665	758	(93)
8	648	758	(110)
9	661	758	(96)
10	556	676	(120)
11	753	840	(86)
12	230	342	(111)
13	1,079	1,174	(95)
14	(290)	(111)	(179)
15	1,599	1,626	(27)
16	1,307	1,378	(71)
17	2	137	(135)

* A negative delta means that the Project is a lower cost option for customers

In the event that the pulverizers do not allow for more consistent and reliable operation at the currently achievable NOx emission rates, as described in Section 1.5.1.2, the total annual energy production could potentially be lower than what has been evaluated in the reference case. Although the Applicants believe this to be a low probability, this potential risk is accounted for in the sensitivity case that lowers annual operating factor by 10% (Case 11 - Lower Operating Factor by 10%). Case 11 indicates that the PVRR of the Project is $86 million more favorable than the PVRR of the Alternative.

An upper and lower bound were also evaluated. The upper bound, case 19, combined those sensitivities that would generally be more favorable to the Project. The lower bound, case 18, combined sensitivity inputs that would generally favor the Alternative. The upper and lower bounds were analyzed to demonstrate the magnitude of the impact that all of the sensitivities have in aggregate. The bounds provide a spectrum for study purposes as shown in Table 10.

Table 10 - Sensitivity Spectrum for Study Purposes (Columbia Plant PVRR in 2013 millions of dollars)

Case #	The Project	The Alternative	Delta* (Project less Alternative)
18	2,637	2,589	48
19	(1,669)	(1,372)	(298)

* A negative delta means that the Project is a lower cost option for customers

The results of the upper bound favored the Project by approximately $298 million. The results of the lower bound favored the Alternative by approximately $48 million. The upper and lower bounds suggest that there is far greater upside potential to the Project than there is to the Alternative.

3.1.6. Potential Monetization of CO_2

As of the date of the filing of this Application, Columbia is not subject to legislation or regulation which monetizes the production of Carbon Dioxide (CO_2) emissions (such as cap and trade or a carbon tax). The Applicants, however, recognized the potential for monetization of CO_2 emissions, and have evaluated the potential economic impact associated with such monetization of CO_2 emissions.

The Applicants believe that Wood Mackenzie presents a reasonable CO_2 price forecast. Wood Mackenzie's forecast is represented in the application for the Dry Flue Gas Desulfurization project for Edgewater Unit 5, Docket No. 6680-CE-174, as shown in Table 11.

The Project includes an efficiency improvement. This efficiency improvement corresponds to a lower CO_2 emission intensity (when compared to the Alternative); in other words, for a given amount of MWh production, there will be fewer CO_2 emissions. Accordingly, the cost associated with CO_2 emissions per MWh will be reduced by the amount corresponding to the price placed on CO_2 emissions, as shown in Table 11.

Table 11 - Wood Mackenzie CO2 Price Forecast and Resulting CO2 Cost for the Project and the Alternative

Year	Wood Mackenzie CO2 Prices[15] (nominal $ per ton)	Average CO2 cost for the Project ($/MWh)	Average CO2 cost for the Alternative ($/MWh)	Average CO2 Cost Reduction per MWh ($/MWh)
2013	$ -	$ -	$ -	$ -
2014	$ -	$ -	$ -	$ -
2015	$ -	$ -	$ -	$ -
2016	$ -	$ -	$ -	$ -
2017	$ -	$ -	$ -	$ -
2018	$ -	$ -	$ -	$ -
2019	$ -	$ -	$ -	$ -
2020	$ -	$ -	$ -	$ -
2021	$ -	$ -	$ -	$ -
2022	$ 16.07	$ 17.50	$ 18.26	$ 0.76
2023	$ 17.37	$ 18.88	$ 19.70	$ 0.82
2024	$ 18.79	$ 20.44	$ 21.33	$ 0.89
2025	$ 20.31	$ 22.10	$ 23.05	$ 0.96
2026	$ 21.96	$ 23.89	$ 24.93	$ 1.03
2027	$ 23.74	$ 25.83	$ 26.95	$ 1.12
2028	$ 25.67	$ 27.93	$ 29.14	$ 1.21
2029	$ 27.75	$ 30.22	$ 31.53	$ 1.31
2030	$ 30.01	$ 32.62	$ 34.03	$ 1.41
2031	$ 32.44	$ 35.29	$ 36.82	$ 1.53
2032	$ 35.07	$ 38.15	$ 39.81	$ 1.65
2033	$ 37.92	$ 41.25	$ 43.04	$ 1.79
2034	$ 41.00	$ 44.61	$ 46.54	$ 1.93
2035	$ 44.33	$ 48.23	$ 50.32	$ 2.09
2036	$ 47.93	$ 50.63	$ 52.83	$ 2.20
2037	$ 51.82	$ 54.74	$ 57.12	$ 2.38
2038	$ 56.03	$ 59.19	$ 61.76	$ 2.57

[15] Wood Mackenzie CO_2 Price Forecast from North America Long-Term View October 2011

The Wood Mackenzie CO_2 prices listed in Table 11 were incorporated into two economic analyses, Case 20 and Case 21, using the spreadsheet tool. Case 20 reflects a scenario where CO_2 monetization could result in upward pressure on natural gas prices and downward pressure on coal prices. Case 21 reflects a scenario where CO_2 monetization could result in downward pressure on energy production from coal units while natural gas and coal price projections remain unchanged. In order to perform an evaluation of Case 20 and 21, the following changes were made to the economic assumptions in the reference case:

Case 20

a. CO_2 prices were applied to the production cost of coal and gas units as a per MWh production cost adder using:
    i. The Wood Mackenzie CO_2 price projection from Table 11;
    ii. The EPA prime mover heat rates described in Appendix B, Schedule 1; and
    iii. The eGRID2010 annual CO_2 emission rates for coal and natural gas units in the MRO East region.[16]
b. Natural gas price projections were increased by 10% beginning in the first year of CO_2 monetization (2022);
c. Coal price projections were decreased by 10% beginning in the first year of CO_2 monetization;
d. The average energy price proxy was developed using the same assumptions and references listed in Appendix B, Schedule 1, but with the adjustments listed in parts a, b and c; and
e. All other variables were held consistent with the reference case.

Case 21

a. CO_2 prices were applied to the production cost of coal and gas units as a per MWh production cost adder using the same assumptions described for Case 20;
b. The average energy price proxy was developed using the same assumptions and references listed in Appendix B, Schedule 1, but with the adjustment listed in part a;
c. The Columbia Operating Factor was reduced by 10% beginning in the first year of CO_2 monetization; and
d. All other variables were held consistent with the reference case.

[16] 'eGRID2010 Version 1.0 Subregion File (Year 2009 Data)

The economic analysis of Case 20 and Case 21, using the spreadsheet tool, favors the Project over the Alternative by $125 million and $100 million respectively. The economic modeling inputs, calculations and outputs for Case 20 and 21 can be found Appendix B, Schedules 3, 4 and 5, respectively.

3.1.7. Present Value Payback Analysis

The present value payback analysis considered the incremental capital and O&M costs and the incremental energy and capacity benefits of the Project relative to the Alternative.

Capital and O&M

The total capital investment required for the Project is estimated at $130 million. However, the net increase in the present value of revenue requirements for capital and operation and maintenance expenditures for the Project, relative to the Alternative, is estimated at $72 million, in 2013 present value dollars. This present value of net revenue requirements is lower than the cost of the Project due to the following reasons:

- The repair costs associated with the Alternative are avoided, resulting in a lower net cost of the Project; and
- The present value of revenue requirements are in 2013 dollars while the majority of cash flow for the Project is in 2015 through 2017; and
- Maintenance frequency is reduced.

Energy and Capacity

By performing a present value payback analysis using $72 million as the cost in 2013, the Project has a present value payback of approximately five years as shown in Table 12. The payback period is calculated as follows. First, the year-to-year cumulative present value of revenue requirements (PVRR) of energy and capacity market value of the Project and the Alternative are calculated (column headings a and b). Next, the difference in year-to-year net cumulative PVRR is calculated (column heading c). Third, the total cumulative PVRR for the capital and operations and maintenance (O&M) costs for the Project relative to the Alternative (column heading d) is compared to the annual differences in net cumulative PVRR. The year in which the total net cumulative PVRR of energy and capacity value exceeds the cumulative PVRR of the capital and O&M cost delta is the year prior to the year of payback. The number of payback years equals the year of pay back less the first full year of operations plus one.

Table 12 - Present Value Payback Analysis (Columbia Plant PVRR in 2013 millions of dollars)

	a	b	c	d	e	f	g
Year	The Project Cumulative PVRR of Energy and Capacity Market Value	The Alternative Cumulative PVRR of Energy and Capacity Market Value	Net the Project Less the Alternative	Total PVRR of Capital and Operation and Maintenance Cost of the Project Relative to the Alternative	**Payback Period:** The Year of Payback Less the First Full Year of Operations (2018) Plus One	Number of Years Since Start of Construction of the First Pulverizer	Event
2013	(96.3)	(96.3)	-				
2014	(174.8)	(174.8)	-				
2015	(224.8)	(219.1)	(5.7)				Construction starts on first pulverizer
2016	(317.6)	(299.6)	(18.0)			1	
2017	(404.8)	(377.3)	(27.4)			2	Construction complete on all turbines and pulverizers
2018	(486.8)	(448.4)	(38.4)			3	First Full Year of Operation
2019	(562.3)	(513.6)	(48.8)			4	
2020	(632.5)	(573.9)	(58.5)			5	
2021	(700.6)	(632.5)	(68.0)			6	
2022	(767.2)	(688.7)	(78.4)	72.3	5	7	
2023	(830.5)	(742.1)	(88.4)				
2024	(889.5)	(792.6)	(96.9)				
2025	(945.6)	(840.6)	(105.0)				
2026	(997.3)	(885.7)	(111.6)				
2027	(1,046.0)	(928.2)	(117.8)				
2028	(1,092.6)	(967.8)	(124.8)				
2029	(1,136.5)	(1,004.2)	(132.3)				
2030	(1,178.2)	(1,038.8)	(139.5)				
2031	(1,218.1)	(1,072.4)	(145.6)				
2032	(1,255.9)	(1,104.4)	(151.5)				
2033	(1,291.8)	(1,134.7)	(157.1)				
2034	(1,327.9)	(1,165.3)	(162.7)				
2035	(1,363.4)	(1,195.4)	(168.1)				
2036	(1,379.6)	(1,209.1)	(170.5)				
2037	(1,396.0)	(1,223.0)	(173.0)		**PVRR of Net Customer Benefit**		
2038	(1,411.7)	(1,236.3)	**(175.4)**	**72.3**	**(103.1)**		

4.0 Operating Parameters

The steam turbine upgrades and coal pulverizer replacements will be designed to fit into and operate within the existing balance of plant systems. The metrics that can be used to monitor turbine upgrade operating performance are gross unit output (MW) and gross turbine cycle heat rate (Btu/kWh). The metrics that can be used to monitor pulverizer performance are coal throughput (lbs/hr) and fineness (% retained on a given screen size).

4.1. Operating Characteristics

The installation of the replacement coal pulverizers and upgraded steam turbines on Columbia Units 1 and 2 will have a negligible effect on the processes associated with operating the units and offering them into the market. Unit performance will be improved; however, the degree of operator interaction required to achieve the performance improvement is no greater than the operator interaction required for the existing coal pulverizers and steam turbines. The areas of operation that may change are discussed below.

4.1.1. Full Load

As described in section 1.5.2, the daily capacity offer to MISO could increase to approximately 555 MW net per unit.[17] Each unit is currently only capable of generating loads of 555 MW net during off-design operating conditions that are not sustainable for a daily offer to MISO. The Project will be designed so that each unit is capable of daily operation of approximately 555 MW net.[18]

4.1.2. Reduced Loads

The steam turbines will be evaluated with consideration for the full load range. Current operation of the units is at a constant pressure. If the pressure is allowed to be reduced when loads are reduced, it is possible to maintain design steam temperatures at reduced loads in support of improved overall unit efficiency without compromising the full load efficiency.

[17] It is expected that the unit will typically generate 592 MW gross while operating at full load. After auxiliary power is accounted for, it is estimated that 555 MW will be available for sale.

[18] The upgraded turbine will be designed so that 555 MW net is possible at sustainable operating conditions of 2400psig and 1000F main steam and reheat steam temperature.

4.1.3. All Loads

Auxiliary Power

The new coal pulverizers are expected to have reduced auxiliary power consumption across the full load range. The average auxiliary power reduction is estimated at approximately 0.4 MW per unit relative to the auxilary power consumption required for the existing pulverizers.

Inerting System

An inerting system and water spray system with all provisions for complete isolation of each pulverizer and control of water, steam, pulverizer operation, and pyrites gates (if required) will be furnished. The existing pulverizers do not have a steam inerting system so the DCS control logic will be developed and implemented prior to the new coal pulverizers being placed into service. The steam inerting system will offer an additional level of fire protection for personnel and equipment when passing through fuel lean conditions during pulverizer trips and shutdowns.

5.0 Description and Cost of Property Being Removed

Based on preliminary engineering completed, the following major facilities are planned for demolition or removal on each unit:

Turbine

- HP/IP rotor;
- LP rotors;
- HP/IP inner casings, upper and lower half; and
- LP inner casings, upper and lower halves.

Coal Pulverizers

- Complete Pulverizer Assembly; and
- Pulverizer motors.

The total cost estimate of $130 million for the Columbia Unit 1 and Unit 2 turbine upgrades and pulverizer replacement is estimated to contain less than $1 million for demolition and removal, due to the expected offsetting salvage value of the components being removed. The current net book value of the facilities is approximately $10 million for turbine equipment and $5 million for coal pulverizer equipment as of December 31, 2012. No other major facilities are anticipated for demolition as part of this project.

6.0 Technology Selection

6.1. Technology Selection Process

Turbine

An engineering study was performed to optimize the steam turbine upgrade. The governing objectives for this study included:

- Achieve an improvement in the unit sustained heat rate.
- Maximize the sustained unit generating capacity (regulation and economic maximums as described in Section 1.5.2) of the existing electrical generator.
- Extend the scheduled duration between planned major maintenance intervals from seven years, to a target of ten years between steam turbine shell openings.

The complete version of this steam turbine and heat rejection optimization study has been included as Appendix I.

Pulverizers

Three types of pulverizers have been used on coal-fueled utility steam generators; ball tube mill, vertical spindle pulverizer and attrition mill. Over the years, the vertical spindle pulverizer has proven to offer the best combination of performance, cost, power consumption and reliability.

The vertical spindle pulverizer can be either a bowl-and-roller or ball-and-race arrangement. The bowl-and-roller pulverizer is characterized by medium to high maintenance and low power consumption. Pulverizer overhauls for replacement and/or renewal of roller wear surfaces are required at a frequency dependent on the OEM design and abrasion characteristics of the coal. The bowl-and-roller type is used predominantly in utility scale power installations.

The technology in use at Columbia is the vertical spindle pulverizer with bowl and roller arrangement. This design was selected for the replacement because it is the technology that best fits within the existing plant arrangement foot print and, as mentioned, provides the best combination of performance, cost, power consumption and reliability.

The coal pulverizers are being designed for improved fineness which will support good combustion and boiler efficiency at the slight increase in heat input requirements for the daily market offer. The fineness specifications being considered when reviewing supplier proposals include 80% passing a 200 mesh screen and 99.95% passing a 50 mesh screen.

The coal pulverizers will also be designed to attain a minimum fineness requirement of 70% passing 200 mesh and 99.8% passing 50 mesh at design throughput when firing the full range of fuels currently being fired at Columbia, with worn pulverizers and any one pulverizer out-of-service per unit. Worn pulverizers are defined as having 90 percent of the pulverizing capacity of a new pulverizer. These fineness requirements must be met in order to maintain the heat input (coal supply) required for daily operation at 555 MW net without leading to combustion problems such as increased emission production, boiler efficiency reduction, and boiler fouling.

6.1.1. Design Constraints

Turbine

The scope of the steam turbine upgrade modifications was constrained by planned reuse of the existing steam turbine outer cylinders along with existing foundations and connecting piping. The steam turbine upgrade was constrained by the existing maximum capabilities of the electrical generator, steam generator (boiler), heat rejection system, primary balance of plant equipment in the steam cycle and transmission limitation.

Pulverizer

The coal pulverizer replacement was constrained by the existing maximum capabilities of the coal handling and delivery systems as well as the primary air supply system. This limitation was imposed because the Units do not require an increase in the current boiler heat input (fuel firing rate) capability in order to achieve the design performance of the Project. Space available within the existing boiler room also poses a design limitation for some technologies.

6.1.2. Steam Turbine Upgrade Optimization Approach

The analytical study was performed by an engineering firm and has been provided as Attachment I. The approach taken in the study was as follows:

- Existing steam turbine generator, turbine cycle, and steam generator arrangements and operating parameters were identified and documented using thermodynamic modeling software.
- A “base case” heat balance model was created using heat balance diagrams and other thermal kit data from Columbia Units 1 and 2 design documents. Initial model results were compared to actual plant performance data to determine the approximate turbine capacity degradation. At rated steam flow corrected to design conditions, based on the

operating data over the last five years, when compared to the heat balance predicted output, the difference would indicate approximately 11.5 MW of output degradation.

- The design gross capacity of the steam turbine upgrade was targeted to be 600 MW at rated steam conditions. This load was chosen based on previously demonstrated capability of electrical and balance of plant equipment to support this load, as well as to optimize the use of the existing transmission interconnect service of 571 MW net and 563 MW net for Unit 1 and Unit 2, respectively. With a projected auxiliary power of approximately 37 MW, the net design capability of each unit under design conditions would be 563 MW.

- At the conclusion of the steam turbine upgrade analysis, an economic optimization was performed on the existing heat rejection system to determine economically optimal modifications and upgrades that support the upgraded steam design basis performance. Columbia's heat rejection system includes the cooling pond and two seasonal cooling towers. The economic optimization also considered compatibility with the LP exhaust conditions, based on the 30 inch last stage blade exhaust loss curve, for plant operating conditions throughout the year. At the time of the optimization study, the cooling towers were at the end of their expected life and complete rebuilds were necessary for reliability purposes. This provided an opportunity to optimize the size and capability of the cooling tower and cooling tower pumps. The cooling tower and cooling tower pumps allow for performance to be efficiently matched with the upgraded steam turbine.[19]

- Based on the evaluation of the past five years of plant data, and preliminary performance estimates obtained from the steam turbine OEMs, it was estimated that the net plant heat rate could be improved by approximately 440 Btu/kWh at rated steam flow and steady state design conditions.

- The improved efficiency from the upgraded HP turbine will result in lower steam temperatures exhausting from the HP turbine and returning to the steam generator reheater. In order to evaluate the capability of the boiler to generate design steam temperatures, a study was performed by Babcock and Wilcox, a steam generator OEM, to determine if any steam generator reheater surface modifications are required to accommodate the steam turbine upgrade. The draft results of this study are included in Appendix G and indicate that no reheater surface area modifications are required to support the operation of the upgraded turbine.

- Turbine cycle balance of plant equipment design capabilities were reviewed to verify the ability to support the upgraded steam turbine and turbine cycle operating conditions.

[19] Public Service Commission of Wisconsin Docket No. 05-CE-140

The turbine is being designed and optimized for 600 MW gross; however, the economic analysis is based on 555 MW net, which corresponds to 592 MW gross. The result is approximately an 8 MW of design capacity that was not factored into the economic analysis. This was done to allow for:

- Unforeseen limitations or uncertainties that could potentially compromise the sustained operation at 600 MW gross.
- Adequate margin between the Operating Capacity and the existing transmission interconnect service such that routine daily load variation, while operating at full load, does not result in exceeding the transmission interconnect service.

The turbines will be evaluated with consideration for the full load range. Current operation of the units is at a constant pressure. If the pressure is allowed to be reduced when loads are reduced, it is possible to maintain design steam temperatures at reduced loads in support of improved overall unit efficiency without compromising the full load efficiency.

6.1.3. Steam Generator Impacts

The higher efficiency steam turbine path will result in modified steam exhaust properties from the individual turbine sections. For example, the higher efficiency HP turbine would result in lower temperature steam exhausting the HP turbine and returning to the boiler reheater. The boiler must provide additional heat input to the steam entering the reheater to maintain the hot reheat steam temperatures at design conditions. A steam generator analysis must be performed to determine whether or not additional steam generator reheater surface is required to maintain the proper design steam temperatures following the turbine upgrade project.

Babcock & Wilcox was hired to build a thermal model of the boiler and to determine if any boiler reheater surface modifications would be required. Results from this study do not indicate a need to add reheat surface in the boiler. The draft boiler modeling engineering study report is included in Appendix G. A final draft of the engineering study report is anticipated in Q3-Q4 2013, after a turbine supplier is selected and detailed engineering is complete.

As illustrated by Figure 8, the boiler full load fuel heat input (MBtu/hr burn rate) would typically increase in proportion to load if increasing beyond the typical maximum capacity of 550 MW gross.

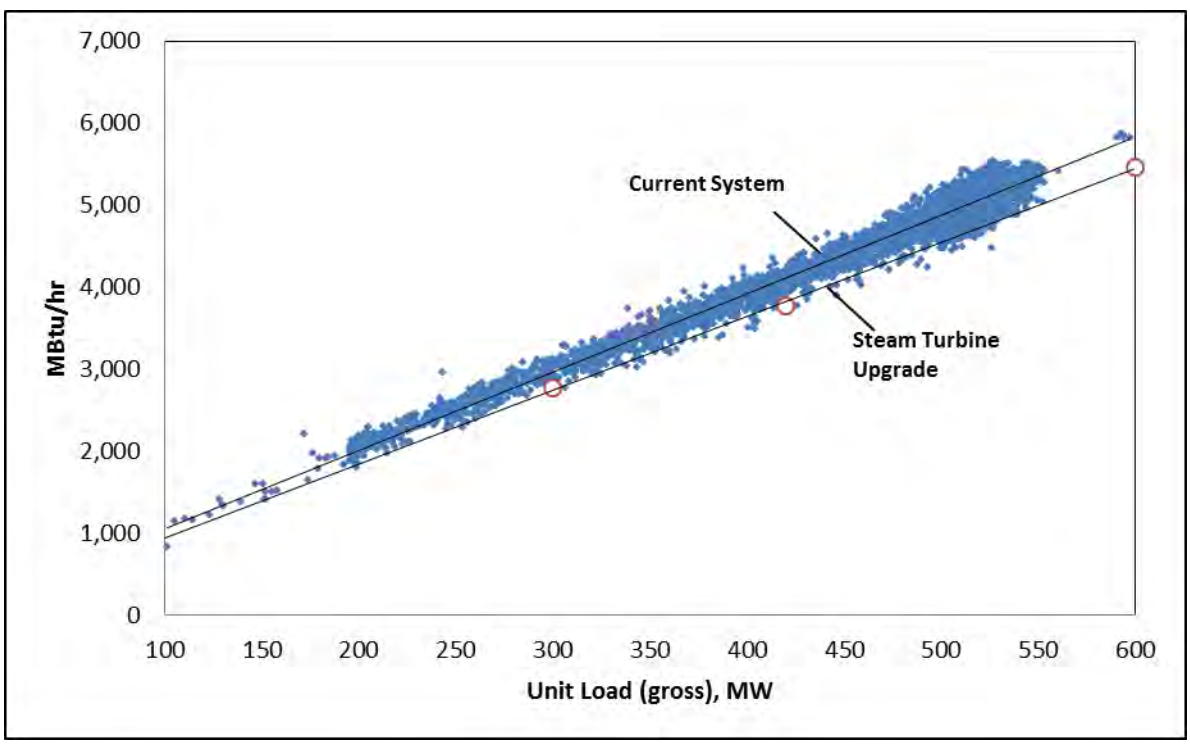

Figure 8 - Boiler Heat Input vs Load

The increased efficiency of the upgraded steam turbine, however, would reduce the boiler burn rate per MW of gross generation. The projected fuel burn rate for the upgraded steam turbine and heat rejection system would result in a decrease in boiler fuel heat input, as shown in Table 13.

Table 13 - Differential Fuel Burn Rate

		600 MW	420 MW	300 MW
Current System	(MMBtu/hr)	5,834	4,115	2,969
After Upgrading the Turbine*	(MMBtu/hr)	5,468	3,775	2,779
Differential	**(MMBtu/hr)**	**366**	**340**	**190**

*This fuel burn rate includes the benefit of the upgraded Heat Rejection System. The total plant improvement is approximately 6%. Approximately 4% is attributable to the Project being proposed in this Application.

6.1.4. Electrical Systems

The existing generator is sized at 617.8 megavolt-ampere (MVA) with a nameplate power factor of 0.9. It was determined that the plant consistently operates near a unity power factor (0.98 - 1.0). In order to maximize steam turbine upgrade potential, while maintaining power factor design margin to stay within the existing transmission interconnect service of 571 MW on Unit 1 and 563 MW on Unit 2, the upgraded steam turbine generating capacity was targeted for 600 MW maximum gross output.

Based on an evaluation of the existing generator step-up design, with applicable design codes,[20] the generator step-up transformers should be capable of a minimum of approximately 602 MVA for the maximum ambient conditions at the site without loss of normal life expectancy. Therefore, modifications to the step-up transformers are not required to support the Project.

[20] IEEE Std C57.91 (IEEE Guide for Loading Mineral-Oil-Immersed Transformers)

6.1.5. Mechanical Balance of Plant

The following turbine cycle mechanical balance of plant systems were reviewed to confirm that the design basis of existing components would support the upgraded unit performance. This review was led by Black and Veatch and included the following key balance of plant systems:

- Condensate Pumps;
- Boiler Feed Pumps and Drive Turbines;
- Feedwater Heaters and Deaerator; and
- Main Steam and Reheat Steam Piping Systems.

Based upon an initial review, the mechanical balance of plant systems are anticipated to be capable of supporting 600 MW gross for standard operation. These systems will be evaluated in further detail after the steam turbine upgrade OEM has been selected and detailed engineering begins.

6.1.6. Heat Rejection Upgrade Analysis

The unit turbine cycle and heat rejection system perform as an integrated system. The unit capacity and efficiency improvements associated with the steam turbine upgrade analysis can be optimized if the heat rejection system equipment has comparable design and operating capabilities that are aligned with the upgraded steam turbine performance. A heat rejection system optimization analysis was performed to identify and economically optimize the scope of heat rejection system equipment modifications and upgrades required to support the optimized performance of the upgrades. This included providing for increased overall system cooling capacity so that the 600 MW gross steam turbine output could be achieved at the site average annual wet bulb temperature. The optimization also determined the best overall match-up of heat rejection equipment sizing to the upgraded steam turbine low pressure section exhaust conditions, based on the 30 inch last stage blade exhaust loss curve, for plant operating conditions throughout the year. The 30 inch last stage blades were selected for the engineering analysis.

The cooling tower replacement project was also evaluated during the heat rejection and optimization study and was expected to be included in this application. However due to structural damage that posed an immediate threat to the reliability of the towers, the project was accelerated and filed as part of PSCW Docket 05-CE-140. Tower B was placed into service in May, 2013. Tower A is expected to be placed into service in Q2 2014.

6.1.7. Coal Pulverizer Replacements

As identified previously, the steam turbine upgrade gross capacity was targeted to be 600 MW at rated steam conditions. If the steam turbine is upgraded with the existing pulverizers, the upgraded unit capacity would not be sustainable for the following reasons:

- The historical reliability profile of the existing pulverizers indicates that one or more pulverizers will frequently be out-of-service for maintenance and overhauls. The forward looking reliability is based on the assumption that reliability will continue to decline; and

- The coal grinding performance of the existing pulverizers is inadequate to support the sustained approximate 5% increase in the average full load burn rate of required to support a sustained gross output of approximately 600 MW gross. In order for the design capacity of 600 MW gross to be sustainable, there needs to be an improvement in coal grinding performance in order to improve fineness and improved coal and air distribution. The coal grinding improvements are expected to reduce the potential for boiler fouling and help to maintain currently achievable NOx emissions more reliably so that annual NOx emissions do not increase relative to the annual NOx cap that could be established in an air permit. The existing pulverizers have not been, and will not be capable of the reliable grinding performance required to sustainably operate at 600 MW gross.

- If the turbine upgrades were implemented without addressing the pulverizer reliability and grinding performance issues, the design capacity of the upgraded turbine would need to be lowered to match the capability of the existing coal pulverizers, and the units would incur an increased risk of future derates due to one or more pulverizers out-of-service.

6.2. Summary of Technology Selection

The selected technologies for Columbia Energy Center are as follows:

- Upgraded combined High Pressure/Intermediate Pressure turbine rotors and inner casings;
- Upgraded Low Pressure turbine rotors and inner casings; and
- New vertical spindle coal pulverizers with dynamic classifiers and steam inerting.

It is anticipated that the Operating Capacity of both units will be approximately 555 MW net with a 440 Btu/kWh improvement in unit heat rate after the completion of the projects in this Application.[21]

[21] With the installation of the SCR, this capacity will drop by approximately 3 MW to 552 MW net on Unit 2.

7.0 Environmental Impacts/Permits

7.1. Emissions Reductions

The project site layout is shown in Section 1.1 on Figure 4, and in Appendix A. The proposed pulverizer replacement and steam turbine upgrade project will not result in any increase in air pollutant emissions rate at this site on a pound per hour basis. It is expected that the pulverizer replacement will actually improve the boiler's emission profile for oxides of nitrogen (NOx). Additionally, the combination of the pulverizer replacement and steam turbine upgrade will improve the generation efficiency of the Columbia Energy Center, resulting in a decrease in emissions on a pound per megawatt output basis.

There is however a potential after installation of these efficiency improvements for an increased utilization of the plant, which could increase emissions on an annual basis. This potential annual increase in emissions will be quantified and an appropriate air permit will be obtained from the Wisconsin Department of Natural Resources (WDNR) for this upgrade project. It is also likely that emission changes from this project will be required to be aggregated with emission changes associated with the AQCS permitting project, however project aggregation is not expected to impact the need for or type of air permit required. An air permit is required before construction can begin.

7.2. Proximity to Floodplains

The area chosen for the location of the Columbia performance improvement project is not within a 100 year floodplain.

7.3. Information on Applicable Environmental Factors

Several environmental factors have been considered for the proposed project. Studies have been performed at the site as part of the Columbia Energy Center Emissions Reduction and Cooling Tower Replacement Projects. When these applications were filed, specific WDNR permits were obtained for these projects. Nothing has changed for evaluating the presence of features that could be impacted by the pulverizer replacement and steam turbine upgrade project. The studies performed during the Columbia Energy Center Emissions Reduction Project included the following:

- Archaeological and historic resources;
- Threatened or endangered species;

- Solid waste;
- Water resources; and
- Wastewater discharge.

Additional information is found in the following sections.

7.3.1. Archaeological and Historic Resources

There are no known archaeological or historic resources in the construction footprint of the project. The Wisconsin Historical Society was recently consulted in permitting the adjacent AQCS project, and did not identify any concerns or needs for investigations.

7.3.2. Threatened and Endangered Species

A detailed analysis was performed on threatened/endangered species at the Columbia Energy Center as part of Public Service Commission of Wisconsin Docket 6680-CE-170. Construction of the pulverizer replacement and steam turbine upgrade will occur almost entirely inside the existing plant, with limited construction laydown on already developed WPL property.

It is not expected that there will be any adverse impacts to critical habitats for endangered, threatened, or special concern species. WPL had engaged in consultations with the Wisconsin Department of Natural Resources Bureau of Endangered Species (BES) as part of the AQCS project, in which an expert habitat assessment was conducted and a mitigation plan was developed and approved by the BES. Due to the assumption that the existing AQCS warehouse will be an adequate laydown area for all of the material for these projects, it is anticipated that no further investigations or actions will be required.

7.3.3. Solid Waste

There should be no increase in the current rate of production of waste material resulting from the pulverizer replacement and steam turbine upgrade project. Since this project will increase unit efficiency, there will actually be a corresponding decrease in coal combustion by-products and other solid waste production on an output (MWh) basis. However, as a result of the proposed increased utilization, solid waste production may increase.

7.3.4. Water Resources

There will be no change in water consumption to operate the proposed plant following pulverizer replacement and steam turbine upgrade.

7.3.5. Wastewater Discharge

There will be no change in wastewater discharge constituents or rates from plant operations following the pulverizer replacement and steam turbine upgrade project.

7.3.6. List of Permits and Approvals Needed

Table 14 provides a list of permits and approvals that may be required for the project.

Table 14 - List of Possible Permits and Approvals

Agency	Permit/Plan/Approval/Report	Regulated Activity	Needed
STATE			
PSCW	Certificate of Authority	Initiation of construction cost exceeds $10 million	Prior to construction
WDNR, Division of Air and Waste, Air Management	Prevention of Significant Deterioration Air Construction Permit	Potential changes in annual emissions profiles from construction and installation of the new pulverizers and upgrades to the steam turbine	Prior to construction
WDNR, Division of Water, Bureau of Watershed Management	Construction Site Storm Water Runoff General Permit	Land disturbances greater than 1 acre	Prior to construction
LOCAL			
Town of Pacific	Erosion Control Permit	Site clearing and grading	Prior to construction

8.0 Designation of Public Utilities and Others Affected

Columbia Units 1 and 2 are jointly owned by Wisconsin Power and Light Company (WPL), Wisconsin Public Service Corporation (WPS), and Madison Gas and Electric (MGE). WPL owns 46.2%, WPS owns 31.8%, and MGE owns 22% of Units 1 and 2 at Columbia.

No other public utilities will be affected by this project.

9.0 Other Statutory Considerations

9.1. Wisconsin Environmental Policy Act

The PSCW is required to conduct an environmental review of the Project in accordance with Wis. Stat. § 1.11 and Wis. Admin. Code ch. PSC 4. The project is not expected to result in any unusual circumstances suggesting the likelihood of significant environmental effects on the human environment. Consequently, this is a Type III action under Wis. Admin. Code § PSC 4.10(3). Neither an environmental impact statement under Wis. Stat. § 1.11 nor an environmental assessment is expected to be required.

9.2. Brownfield Sites

Wisconsin Stat. § 196.49(4) requires the use of brownfields, as defined in Wis. Stat. § 560.13(I)(a), to the extent practicable. Because the Project proposes the upgrade to equipment within the footprint of Columbia, no other site is appropriate.

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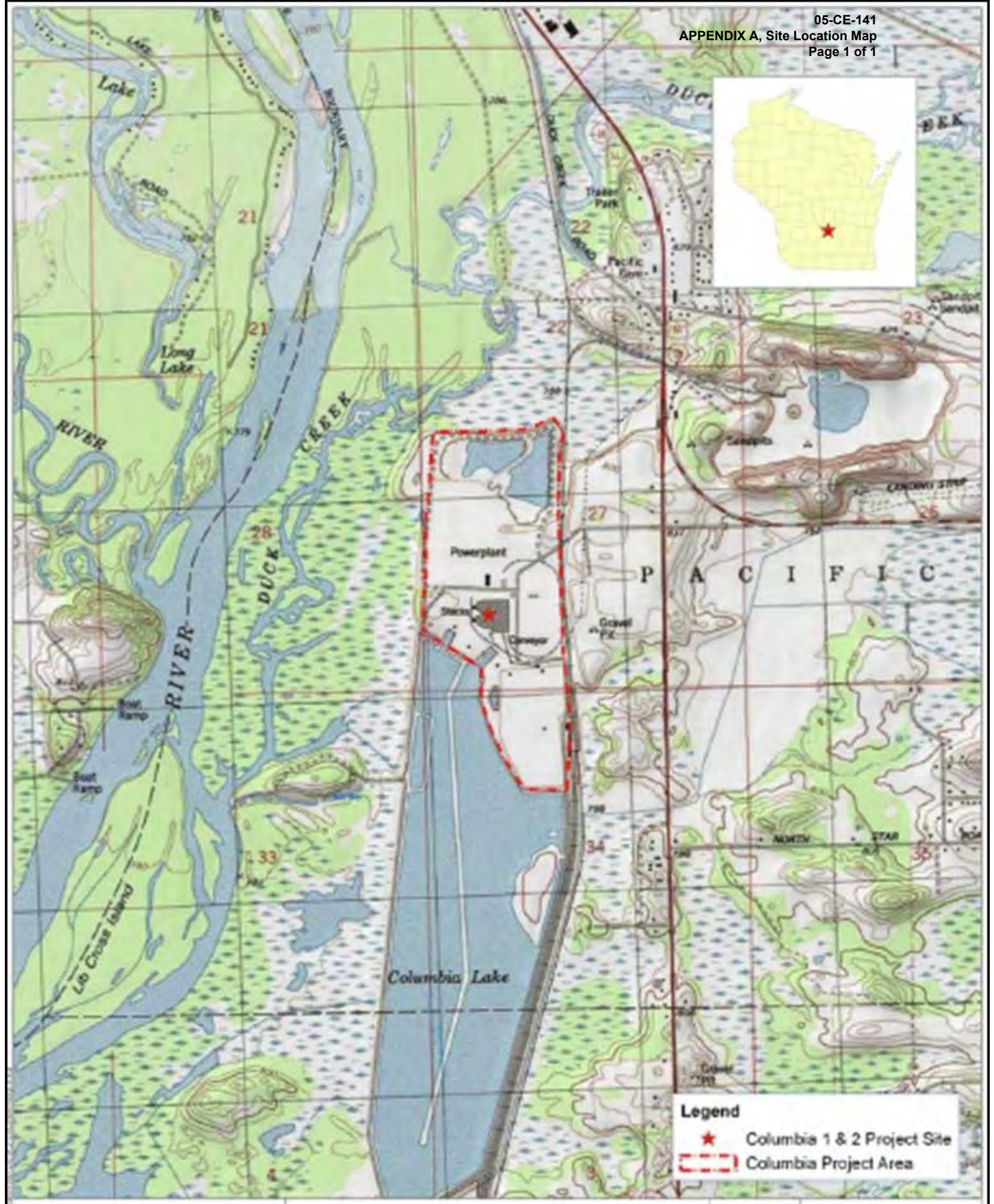
Potter, K., & Olear, D. (2005, November 1). *Power Engineering: The Value of Steam Turbine Upgrades.* Retrieved May 31, 2013, from Power Engineering Web site: http://www.power-eng.com/articles/print/volume-109/issue-11/features/the-value-of-steam-turbine-upgrades.html

APPENDIX A - SITE LOCATION MAP



Site Location Map

URS

Checked by KJ

Date 3/26/08

REVISION 1

APPENDIX B – ECONOMIC MODELING INFORMATION

Economic Modeling Fuel and Energy Price Assumptions

1. **Delivered Fuel Price** to the Columbia node
    a. **Coal Price** is the sum of fuel and transport cost:
        i. Fuel:
            1. Mine mouth coal from the EIA 2012-AEO for WY PRB Low Sulfur (Sub-Bituminous)
        ii. Transport:
            1. 2013-2016: WPL transport cost projection through 2016 from WPL's fuel supply and transportation group
            2. 2017-2038: The 2016 transport cost was inflated using a constant escalation rate per the recommendation of WPL's fuel supply and transportation group

2. **Blended Energy Price** (round the clock) at the Columbia node is a weighted average of 4600hrs of off-peak energy price and 4160hrs of on-peak energy price
    a. Off-Peak energy price ($/MWh) is based on the weighted average of a coal unit and a natural gas combined cycle unit dispatch cost
        i. **Coal dispatch cost (75% weight)** is a function of the delivered coal price, variable O&M, and average coal heat rate
            1. Delivered Coal Price – per 1.a
            2. Variable O&M is based on the 2010$ for a 600MW coal unit "CFB2 P 600MW", from the Black & Veatch 2010 Power Station Characterization Study, dated May 2010, and is escalated at 2.2% per year
            3. Average Coal heat rate is based on the 2007-2011 average coal prime mover heat rate from U.S. EIA, Form EIA-860, 'Annual Electric Generator Report.'
        ii. **Natural Gas Combined Cycle dispatch cost (25% weight)** is a function of delivered Natural Gas Price, Variable O&M, and Average Natural Gas Combined Cycle (NGCC) heat rate
            1. Delivered Natural Gas price is based on EIA 2012-AEO for the MRO-East region
            2. Variable O&M is based on the 2010$ for a 579MW NGCC unit "NCC2 P 579MW", from the Black & Veatch 2010 Power Station Characterization Study, dated May 2010, and is escalated at 2.2% per year
            3. Average NGCC heat rate is based on the 2007-2011 average NGCC prime mover heat rate from U.S. EIA, Form EIA-860, 'Annual Electric Generator Report.'
    b. On-Peak energy price ($/MWh) is based on the weighted average of a NGCC unit and a Natural Gas simple cycle unit dispatch cost
        i. Natural Gas Combined Cycle dispatch cost (75% weight)
            1. Same as described in 2.a.ii
        ii. **Natural Gas Simple Cycle dispatch cost (25% weight)** is a function of delivered Natural Gas Price, Variable O&M, and Average Natural Gas Simple Cycle (NGSC) heat rate
            1. Delivered Natural Gas Price is based on EIA 2012-AEO for the MRO-East region
            2. Variable O&M is based on the 2010$ for an 88MW Natural Gas CT unit "NCT2 P 88MW", from the Black & Veatch 2010 Power Station Characterization Study, dated May 2010, and is escalated at 2.2% per year
            3. Average NGCT heat rate is based on the 2007-2011 NGSC prime mover heat rate from U.S. EIA, Form EIA-860, 'Annual Electric Generator Report.'

These fuel and energy price assumptions are only for use in the Economic Analysis portion of the CA for the Columbia turbine upgrade and mill replacement project to be filed with the PSCW in Q2 of 2013. They represent a generic forecast for modeling 100% share of the Joint Owned units.

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Originator: WPL

Wisconsin Power and Light Company
Computation of Revenue Requirements
Miscellaneous Assumptions
Columbia 1 - Scenarios

Line #	Weighted Average Cost of Capital					Effective Income Tax Rate			
1				After Tax	Pre Tax				
2	Capital Source	% of Total	Cost Rate	WACC	WACC	Federal Tax Rate	35.00%	Retail AFUDC Rate = WACC AfterTax	8.81%
3									
4	Common Equity	55.00%	11.500%	6.33%	10.574%	Wisconsin Tax Rate	7.90%	Tax Capitalized Interest Rate at LTD Rate	5.50%
5									
6	Long Term Debt	45.00%	5.500%	2.48%	2.480%	Weighted Average Tax Rate	40.14%		
7									
8	Preferred Stock	0.00%	0.000%	0.00%	0.000%	Effective Tax Rate Reciprical	59.87%		
9									
10	Short Term Debt	0.00%	0.000%	0.00%	0.000%	Effective Tax Rate Multiplier	1.670		
11									
12	Totals	100.00%		8.81%	13.054%				
13									
14	**Discount Rate**	8.80%							
15									
16	**CWIP Treatment:**								
17	Current Return on CWIP:	50%							
18	AFUDC	50%							
19									
20	**Cost Component - In Service Date Assumptions:**								
21	Existing NBV	2011							
22	Ongoing Maintenance Capital	As Spent							
23	Scrubber & Baghouse	2014		First Half of 2014					
24	Turbine & Mill Mtnce. Cap.	As Spent							
25	Mill Upgrades - Set 1, 2 & 3	2016		Last Half of 2015 (1&2) First Half of 2016 (3)					
26	Mill Upgrades - Set 4 & 5	2017		Last Half of 2016					
27	Mill Upgrades - Set 6	2017		First Half of 2017					
28	Turbine Upgrade	2017		First Half of 2017					
29	Turbine & Mill - w/o Upgrade	As Spent							
30									
31	**Retirement Date Assumption**	2035		See Page II-27 of WPL Application in Docket No. 6680-DU-107					

For purposes of modeling: If installed in first half of a year, costs were modeled it as in service for the full year. If installed in the last half of a year, costs were modeled as in service for the full next year.

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Originator: WPL

Wisconsin Power and Light Company
Computation of Revenue Requirements
Miscellaneous Assumptions
Columbia 2 - Scenarios

Line #	Weighted Average Cost of Capital					Effective Income Tax Rate			
1				After Tax	Pre Tax				
2	Capital Source	% of Total	Cost Rate	WACC	WACC	Federal Tax Rate	35.00%	Retail AFUDC Rate = WACC AfterTax	8.81%
3									
4	Common Equity	55.00%	11.500%	6.33%	10.574%	Wisconsin Tax Rate	7.90%	Tax Capitalized Interest Rate at LTD Rate	5.50%
5									
6	Long Term Debt	45.00%	5.500%	2.48%	2.480%	Weighted Average Tax Rate	40.14%		
7									
8	Preferred Stock	0.00%	0.000%	0.00%	0.000%	Effective Tax Rate Reciprical	59.87%		
9									
10	Short Term Debt	0.00%	0.000%	0.00%	0.000%	Effective Tax Rate Multiplier	1.670		
11									
12	Totals	100.00%		8.81%	13.054%				
13									
14	**Discount Rate**	8.80%							
15									
16	**CWIP Treatment:**								
17	Current Return on CWIP:	50%							
18	AFUDC	50%							
19									
20	**Cost Component - In Service Date Assumptions:**								
21	Existing NBV	2011							
22	Ongoing Maintenance Capital	As Spent							
23	Scrubber & Baghouse	2014		First Half of 2014					
24	Turbine & Mill Mtnce. Cap.	As Spent							
25	Mill Upgrades - Set 1, 2 & 3	2016		Last Half of 2015 (1&2) First Half of 2016 (3)					
26	Mill Upgrades - Set 4, & 5	2017		Last Half of 2016					
27	Mill Upgrades - Set 6	2017		First Half of 2017					
28	Turbine Upgrade	2016		First Half of 2016					
29	Turbine & Mill - w/o Upgrade	As Spent							
30	SCR	2019		First Half of 2019					
31									
32	**Retirement Date Assumption**	2038		See Page II-27 of WPL Application in Docket No. 6680-DU-107					

For purposes of modeling: If installed in first half of a year, we've modeled it as in service for the full year. If installed in the last half of a year we've modeled it as in service for the full next year.

Case 1 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	219.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	47.1	1.00	
		Installed Capacity (ICAP) Increase	MW	16.4	1.00	
		Heat Rate Improvement	Btu/kWh	-141	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,991.4		included as a reference point only

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
		Discount Year		2013																								
		Discount Rate		8.50%	Multiplier																							
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																							
F		CO2 Credit Cost	$/ton																									
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.10	$ 0.43	$ 1.21	$ 4.26	$ 13.17	$ 12.82	$ 12.22	$ 11.64	$ 11.08	$ 10.53	$ 10.00	$ 9.48	$ 9.00	$ 8.54	$ 8.82	$ 8.32	$ 7.82	$ 7.32	$ 6.84	$ 6.39	$ 5.91	$ 5.50	$ 4.87
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	588	588	588	588	588	588	588	588	588	568	568	568	568	568	568	568	568	568
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
M		Operating Capacity	MW			514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									
Q		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.08	$ 0.21	$ 0.38	$ 2.56	$ 3.73	$ 3.78	$ 3.83	$ 3.88	$ 3.91	$ 3.96	$ 4.01	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.48	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)				556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 2	Appendix B, Schedule 3 - Economic Modeling Input Tables Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information - Highlighted in Grey

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	89%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	216.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	47.1	1.00	
		Installed Capacity (ICAP) Increase	MW	-18.4	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,891.4		included as a reference point only

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
		Discount Year		2013																								
		Discount Rate		8.80%	Multiplier																							
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																							
F		CO2 Credit Cost	$/ton																									
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.10	$ 0.10	$ 0.43	$ 1.21	$ 4.26	$ 13.17	$ 12.82	$ 12.22	$ 11.64	$ 11.08	$ 10.55	$ 10.00	$ 9.46	$ 9.00	$ 8.54	$ 8.62	$ 8.37	$ 7.82	$ 7.37	$ 6.84	$ 6.36	$ 5.91	$ 5.50	$ 4.67
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
M		Operating Capacity	MW			514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									
Q		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.08	$ 0.21	$ 0.38	$ 2.58	$ 3.73	$ 3.78	$ 3.83	$ 3.88	$ 3.91	$ 3.95	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.48	$ 5.53	$ 5.67	$ 6.01	$ 6.49
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)				556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 3 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	80%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	219.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	47.1	1.00	
		Installed Capacity (ICAP) Increase	MW	16.4	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,891.4		included as a reference point only

	Common Unit and Market Assumptions	Discount Year		2013																								
		Discount Rate		8.80%	Multiplier	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
D		Average MISO Energy Price	$/MWh		1.00	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00	[redacted]																						
F		CO2 Credit Cost	$/ton																									
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		0.99	$ 0.10	$ 0.43	$ 1.21	$ 4.26	$ 13.17	$ 12.67	$ 12.22	$ 11.64	$ 11.08	$ 10.53	$ 10.00	$ 9.46	$ 9.00	$ 8.54	$ 8.62	$ 8.32	$ 7.82	$ 7.32	$ 6.84	$ 6.36	$ 5.91	$ 5.50	$ 4.67
K		Scheduled Maintenance	Weeks			5	7	5	5	6	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
M		Operating Capacity	MW			514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh			[redacted]																						
Q		Heat Rate	Btu/MWh			10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.08	$ 0.21	$ 0.38	$ 2.58	$ 3.73	$ 3.78	$ 3.83	$ 3.88	$ 3.91	$ 3.86	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.48	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)				556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh			[redacted]																						
Y		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 4 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	80%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	219.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	47.1	1.00	
		Installed Capacity (ICAP) Increase	MW	18.4	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,891.4		Included as a reference point only

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
		Discount Year		2013																								
		Discount Rate		8.80%	Multiplier																							
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																							
F		CO2 Credit Cost	$/ton																									
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.10	$ 0.43	$ 1.21	$ 4.26	$ 13.11	$ 12.82	$ 12.22	$ 11.64	$ 11.08	$ 10.53	$ 10.00	$ 9.48	$ 9.00	$ 8.54	$ 8.62	$ 8.32	$ 7.82	$ 7.32	$ 6.84	$ 6.36	$ 5.91	$ 5.50	$ 4.67
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
M		Operating Capacity	MW			514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									
Q		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.10	$ 0.08	$ 0.21	$ 0.38	$ 2.58	$ 3.73	$ 3.78	$ 3.83	$ 3.88	$ 3.91	$ 3.96	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.48	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)				556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 5 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	219.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	47.1	1.00	
		Installed Capacity (ICAP) Increase	MW	16.4	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,891.4		included as a reference point only

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
	Common Unit and Market Assumptions	Discount Year		2013																								
		Discount Rate		8.80%	Multiplier																							
D		Average MISO Energy Price	$/MWh		1.00	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																							
F		CO2 Credit Cost	$/ton																									
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.10	$ 0.43	$ 1.21	$ 4.26	$ 13.17	$ 12.82	$ 12.22	$ 11.64	$ 11.08	$ 10.53	$ 10.00	$ 9.48	$ 9.00	$ 8.54	$ 8.62	$ 8.32	$ 7.82	$ 7.32	$ 6.84	$ 6.36	$ 5.91	$ 5.50	$ 4.67
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
M		Operating Capacity	MW			514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									
Q		Heat Rate	Btu/kWh			10,656	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		0.00	$ 0.05	$ 0.21	$ 0.38	$ 2.56	$ 3.73	$ 3.78	$ 3.83	$ 3.88	$ 3.91	$ 3.99	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.48	$ 5.53	$ 5.87	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,656	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 6 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Potential Information is Highlighted in Grey

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	218.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	47.1	1.00	
		Installed Capacity (ICAP) Increase	MW	15.4	1.00	
		Heat Rate Improvement	Btu/kWh	485.1	1.10	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,891.4		included as a reference point only

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
		Discount Year		2013																								
		Discount Rate		8.00%	Multiplier																							
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																							
F		CO2 Credit Cost	$/ton																									
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.10	$ 0.43	$ 1.21	$ 4.20	$ 13.17	$ 12.82	$ 12.22	$ 11.64	$ 11.08	$ 10.53	$ 10.00	$ 9.48	$ 9.00	$ 8.54	$ 8.62	$ 8.32	$ 7.82	$ 7.32	$ 6.84	$ 6.36	$ 5.91	$ 5.50	$ 4.67
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
M		Operating Capacity	MW			514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									
Q		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.08	$ 0.21	$ 0.38	$ 2.58	$ 3.73	$ 3.78	$ 3.81	$ 3.88	$ 3.91	$ 3.96	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.43	$ 5.27	$ 5.48	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			8	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)				556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 7 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	Capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	219.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating/ Capacity Increase	MW	47.1	1.00	
		Installed Capacity (ICAP) Increase	MW	16.4	1.00	
		Heat Rate Improvement	Btu/kWh	396.9	0.90	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,891.4		included as a reference point only

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
		Discount Year		2013																								
		Discount Rate		8.80%	Multiplier																							
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																							
F		CO2 Credit Cost	$/ton																									
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.10	$ 0.43	$ 1.21	$ 4.26	$ 13.17	$ 12.92	$ 12.22	$ 11.54	$ 11.08	$ 10.53	$ 10.00	$ 9.48	$ 9.00	$ 8.54	$ 8.62	$ 8.32	$ 7.82	$ 7.32	$ 6.84	$ 6.36	$ 5.91	$ 5.58	$ 4.67
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
M		Operating Capacity	MW			514	508	506	506	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									
Q		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.08	$ 0.21	$ 0.38	$ 2.58	$ 3.73	$ 3.78	$ 3.83	$ 3.88	$ 3.91	$ 3.96	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.48	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	8	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	506	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,655	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 8 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capacity factor when unit is available (aka. operating factor)
B		Emission Rate CO_2	lbs/MMBtu	216.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	51.81	1.10	
		Installed Capacity (ICAP) Increase	MW	18.0	1.10	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,891.4		included as a reference point only

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
	Common Unit and Market Assumptions	Discount Year		2013																								
		Discount Rate		8.80%	Multiplier																							
D		Average MISO Energy Price	$/MWh		1.00	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																							
F		CO2 Credit Cost	$/ton																									
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.10	$ 0.43	$ 1.21	$ 4.26	$ 13.17	$ 12.82	$ 12.22	$ 11.64	$ 11.08	$ 10.53	$ 10.00	$ 9.48	$ 9.00	$ 8.54	$ 8.02	$ 8.32	$ 7.92	$ 7.32	$ 6.84	$ 6.39	$ 5.91	$ 5.50	$ 4.87
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	570	570	570	570	570	570	570	570	570	570	570	570	570	570	570	570	570	570
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	539	539	539	539	539	539	539	539	539	539	539	539	539	539	539	539	539	539
M		Operating Capacity	MW			514	508	508	508	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									5
Q		Heat Rate	Btu/kWh			10,858	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.08	$ 0.21	$ 0.38	$ 2.58	$ 3.73	$ 3.78	$ 3.83	$ 3.88	$ 3.91	$ 3.96	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.48	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)				556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,858	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 9 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lb/MMBtu	219.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	42.39	0.90	
		Installed Capacity (ICAP) Increase	MW	14.8	0.90	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,801.4		included as a reference point only

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
		Discount Year		2013																								
		Discount Rate		8.60%	Multiplier																							
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																							
F		CO2 Credit Cost	$/ton																									
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.10	$ 0.43	$ 1.21	$ 4.26	$ 13.17	$ 12.87	$ 12.22	$ 11.64	$ 11.05	$ 10.53	$ 10.00	$ 8.48	$ 9.00	$ 8.54	$ 8.62	$ 8.32	$ 7.82	$ 7.32	$ 6.84	$ 6.36	$ 5.91	$ 5.50	$ 4.67
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	6	5
		Installed Capacity (ICAP)	MW			566	557	552	552	552	566	566	566	566	566	566	566	566	566	566	565	566	566	566	566	566	566	566
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	536	536	536	536	536	536	536	536	536	536	536	536	536	536	536	536	536	536
M		Operating Capacity	MW			514	508	508	508	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									
Q		Heat Rate	Btu/kWh			10,656	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.06	$ 0.21	$ 0.38	$ 2.56	$ 3.73	$ 3.78	$ 3.83	$ 3.88	$ 3.91	$ 3.96	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.48	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)				558	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,656	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 10 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	99%	1.10	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	219.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	47.1	1.00	
		Installed Capacity (ICAP) Increase	MW	16.4	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,691.4		included as a reference point only

	Common Unit and Market Assumptions	Discount Year		2013																								
		Discount Rate		6.60%	Multiplier	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
D		Average MISO Energy Price	$/MWh		1.00	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00	[redacted]																						
F		CO2 Credit Cost	$/ton																									
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.10	$ 0.43	$ 1.21	$ 4.20	$ 13.17	$ 12.82	$ 12.22	$ 11.64	$ 11.08	$ 10.53	$ 10.00	$ 9.48	$ 9.00	$ 8.54	$ 8.62	$ 8.32	$ 7.82	$ 7.32	$ 6.84	$ 6.36	$ 5.91	$ 5.50	$ 4.67
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
M		Operating Capacity	MW			514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh			[redacted]																						
Q		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.08	$ 0.21	$ 0.38	$ 2.58	$ 3.73	$ 3.78	$ 3.83	$ 3.88	$ 3.91	$ 3.96	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.46	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)				556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh			[redacted]																						
Y		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 11 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	81%	0.80	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	219.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	47.1	1.00	
		Installed Capacity (ICAP) Increase	MW	16.4	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,891.4		included as a reference point only

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
		Discount Year		2013																								
		Discount Rate		8.00%	Multiplier																							
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																							
F		CO2 Credit Cost	$/ton																									
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.10	$ 0.43	$ 1.21	$ 4.26	$ 13.17	$ 12.82	$ 12.27	$ 11.64	$ 11.08	$ 10.53	$ 10.00	$ 9.48	$ 9.00	$ 8.54	$ 8.62	$ 8.32	$ 7.82	$ 7.32	$ 6.84	$ 6.36	$ 5.91	$ 5.50	$ 4.67
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
M		Operating Capacity	MW			514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									
Q		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.08	$ 0.21	$ 0.38	$ 2.58	$ 3.73	$ 3.76	$ 3.63	$ 3.38	$ 3.81	$ 3.96	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.49	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)				556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 12 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	219.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	47.1	1.00	
		Installed Capacity (ICAP) Increase	MW	16.4	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,881.4		included as a reference point only

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
	Common Unit and Market Assumptions	Discount Year		2013																								
		Discount Rate		8.80%	Multiplier																							
D		Average MISO Energy Price	$/MWh		1.00	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																							
F		CO2 Credit Cost	$/ton																									
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		2.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.10	$ 0.43	$ 1.21	$ 4.28	$ 10.17	$ 12.82	$ 12.22	$ 11.64	$ 11.08	$ 10.53	$ 10.00	$ 9.48	$ 9.00	$ 8.54	$ 8.62	$ 8.32	$ 7.82	$ 7.32	$ 6.84	$ 6.38	$ 5.91	$ 5.50	$ 4.67
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			566	557	552	552	552	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
M		Operating Capacity	MW			514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									
Q		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.06	$ 0.21	$ 0.38	$ 2.58	$ 3.73	$ 3.78	$ 3.83	$ 3.88	$ 3.91	$ 3.96	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.48	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	8	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)				556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 13 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	219.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	47.1	1.00	
		Installed Capacity (ICAP) Increase	MW	16.4	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,881.4		included as a reference point only

				2013																							
		Discount Year		8.80%	Multiplier	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
		Discount Rate																									
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																					
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																						
F		CO2 Credit Cost	$/ton																								
G		NOx Credit Cost	$/ton																								
H		Capacity Market	$/kw-yr	-					$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.19	$ 0.43	$ 1.21	$ 4.26	$ 13.17	$ 12.82	$ 12.22	$ 11.64	$ 11.08	$ 10.53	$ 10.00	$ 9.48	$ 9.00	$ 8.54	$ 8.62	$ 8.37	$ 7.82	$ 7.32	$ 6.84	$ 6.38	$ 5.91	$ 5.50	$ 4.67
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
M		Operating Capacity	MW			514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									
Q		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.06	$ 0.21	$ 0.38	$ 2.58	$ 3.73	$ 3.78	$ 3.83	$ 3.88	$ 3.91	$ 3.96	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.48	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	506	506	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 14 Appendix B, Schedule 3 - Economic Modeling Input Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capability factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	219.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	47.1	1.00	
		Installed Capacity (ICAP) Increase	MW	15.4	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,891.4		included as a reference point only

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
	Common Unit and Market Assumptions	Discount Year		2013																								
		Discount Rate		8.80%	Multiplier																							
D		Average MISO Energy Price	$/MWh		1.25	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																							
F		CO2 Credit Cost	$/ton																									
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.10	$ 0.43	$ 1.21	$ 4.76	$ 13.17	$ 12.82	$ 12.22	$ 11.64	$ 11.08	$ 10.53	$ 10.00	$ 9.48	$ 9.00	$ 8.54	$ 8.62	$ 8.32	$ 7.80	$ 7.32	$ 6.84	$ 6.36	$ 5.91	$ 5.58	$ 4.67
K		Scheduled Maintenance	Weeks			5	7	5	3	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568
L		Unforced Capacity (UCAP)	MW			528	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
M		Operating Capacity	MW			514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									
Q		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.08	$ 0.21	$ 0.38	$ 2.58	$ 3.73	$ 3.76	$ 3.83	$ 3.88	$ 3.91	$ 3.96	$ 4.21	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.49	$ 5.27	$ 5.48	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)				556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			528	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 15 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lb/MMBtu	218.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	47.1	1.00	
		Installed Capacity (ICAP) Increase	MW	16.4	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,891.4		included as a reference point only

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
		Discount Year		2013																								
		Discount Rate		8.80%	Multiplier																							
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		0.75	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																							
F		CO2 Credit Cost	$/ton																									
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.10	$ 0.43	$ 1.21	$ 4.26	$ 13.17	$ 12.82	$ 12.22	$ 11.64	$ 11.08	$ 10.53	$ 10.00	$ 9.48	$ 9.00	$ 8.54	$ 8.62	$ 8.32	$ 7.82	$ 7.32	$ 6.84	$ 6.36	$ 5.91	$ 5.50	$ 4.67
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
M		Operating Capacity	MW			514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									
Q		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.08	$ 0.21	$ 0.38	$ 2.58	$ 3.73	$ 3.78	$ 3.83	$ 3.88	$ 3.91	$ 3.96	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.48	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)				556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 16 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	80%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	219.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	47.1	1.00	
		Installed Capacity (ICAP) Increase	MW	16.4	1.00	
		Heat Rate Improvement	Btu/kWh	641	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,891.4		included as a reference point only

		Discount Year		2013																							
		Discount Rate		8.80%	Multiplier	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																					
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.25																						
F		CO2 Credit Cost	$/ton																								
G		NOx Credit Cost	$/ton																								
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.10	$ 0.43	$ 1.21	$ 4.26	$ 13.17	$ 12.82	$ 12.22	$ 11.64	$ 11.08	$ 10.53	$ 10.00	$ 9.48	$ 9.00	$ 8.54	$ 8.62	$ 8.32	$ 7.82	$ 7.32	$ 6.84	$ 6.30	$ 5.91	$ 5.50	$ 4.67
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			555	557	552	552	552	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
M		Operating Capacity	MW			514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									
Q		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.06	$ 0.21	$ 0.38	$ 2.58	$ 3.73	$ 3.78	$ 3.83	$ 3.88	$ 3.91	$ 3.96	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.48	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	5	5	8	5	6	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)				556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 17 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	219.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	47.1	1.00	
		Installed Capacity (ICAP) Increase	MW	16.4	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,891.4		included as a reference point only

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
	Common Unit and Market Assumptions	Discount Year		2013																								
		Discount Rate		8.60%	Multiplier																							
D		Average MISO Energy Price	$/MWh		1.00	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		0.75																							
F		CO2 Credit Cost	$/ton																									
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.10	$ 0.43	$ 1.21	$ 4.26	$ 13.17	$ 12.82	$ 12.22	$ 11.64	$ 11.08	$ 10.53	$ 10.00	$ 9.48	$ 9.00	$ 8.54	$ 8.02	$ 8.32	$ 7.82	$ 7.32	$ 6.84	$ 6.36	$ 5.91	$ 5.50	$ 4.97
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
M		Operating Capacity	MW			514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									
Q		Heat Rate	Btu/kWh			10,656	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.06	$ 0.21	$ 0.38	$ 3.58	$ 3.73	$ 3.78	$ 3.83	$ 3.88	$ 3.91	$ 3.96	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.46	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)				556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,656	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 18 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	81%	0.90	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	219.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	42.19	0.90	
		Installed Capacity (ICAP) Increase	MW	14.8	0.00	
		Heat Rate Improvement	Btu/kWh	356.9	0.90	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,891.4		included as a reference point only

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
		Discount Year		2013																								
		Discount Rate		8.60%	Multiplier																							
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		0.75	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.25																							
F		CO2 Credit Cost	$/ton																									
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		-				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.10	$ 0.10	$ 0.43	$ 1.21	$ 4.26	$ 13.17	$ 12.82	$ 12.22	$ 11.64	$ 11.08	$ 10.53	$ 10.00	$ 9.48	$ 9.00	$ 8.54	$ 8.02	$ 8.32	$ 7.82	$ 7.32	$ 6.84	$ 6.36	$ 5.91	$ 5.50	$ 4.67
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	568	566	566	568	566	566	568	566	568	568	566	566	566	566	566	566	566	568
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	536	536	536	536	536	536	536	536	536	536	536	536	536	536	536	536	536	536
M		Operating Capacity	MW			514	508	508	508	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									
Q		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		0.90	$ 0.08	$ 0.21	$ 0.38	$ 2.58	$ 3.73	$ 3.78	$ 3.83	$ 3.88	$ 3.91	$ 3.95	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.48	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)				556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	553	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 19	Appendix B, Schedule 3 - Economic Modeling Input Tables Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	99%	1.10	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	219.52		
C		Emission Rate NOx	lb/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	57.81	1.10	
		Installed Capacity (ICAP) Increase	MW	18.0	1.10	
		Heat Rate Improvement	Btu/kWh	-485.1	1.10	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,691.8		included as a reference point only

	Common Unit and Market Assumptions	Discount Year		2013																									
		Discount Rate		8.60%	Multiplier	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
D		Average MISO Energy Price	$/MWh		1.25	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		0.75																							
F		CO2 Credit Cost	$/ton																									
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		2.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		0.90	$ 0.10	$ 0.43	$ 1.21	$ 4.26	$ 13.17	$ 12.82	$ 12.22	$ 11.64	$ 11.08	$ 10.53	$ 10.00	$ 9.48	$ 9.00	$ 8.54	$ 8.62	$ 8.32	$ 7.82	$ 7.32	$ 6.84	$ 6.38	$ 5.91	$ 5.50	$ 4.67
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	570	570	570	570	570	570	570	570	570	570	570	570	570	570	570	570	570	570
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	539	539	539	539	539	539	539	539	539	539	539	539	539	539	539	539	539	539
M		Operating Capacity	MW			514	508	508	508	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									
Q		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.10	$ 0.08	$ 0.21	$ 0.35	$ 2.56	$ 3.73	$ 3.76	$ 3.83	$ 3.88	$ 3.91	$ 3.96	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.48	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)				556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 20 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 1 Turbine and Mill Upgrade Assumptions

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	219.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	47.1	1.00	
		Installed Capacity (ICAP) Increase	MW	16.4	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,891.4		included as a reference point only

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
		Discount Year		2013																								
		Discount Rate		8.00%	Multiplier																							
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																							
F		CO2 Credit Cost	$/ton												$ 16.07	$ 17.37	$ 18.79	$ 20.31	$ 21.96	$ 23.74	$ 25.67	$ 27.75	$ 30.01	$ 32.44	$ 35.07	$ 37.92	$ 41.00	$ 44.33
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**	**5.4%**
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.16	$ 0.43	$ 1.21	$ 4.26	$ 13.17	$ 12.82	$ 12.22	$ 11.64	$ 11.06	$ 10.53	$ 10.00	$ 9.48	$ 9.00	$ 8.54	$ 8.62	$ 8.32	$ 7.82	$ 7.32	$ 6.84	$ 6.36	$ 5.91	$ 5.50	$ 4.67
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568
L		Unforced Capacity (UCAP)	MW			526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
M		Operating Capacity	MW			514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									
Q		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.06	$ 0.21	$ 0.35	$ 2.58	$ 3.73	$ 3.78	$ 3.83	$ 3.88	$ 3.91	$ 3.98	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.46	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)				556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 21 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	88%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	219.52		
C		Emission Rate NOx	lbs/MMBtu	0.149		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	47.1	1.00	
		Installed Capacity (ICAP) Increase	MW	16.4	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	0%		
		Emission LIMIT - NOx, Tons	tons	2,891.4		included as a reference point only

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
	Common Unit and Market Assumptions	Discount Year		2013																								
		Discount Rate		6.80%	Multiplier																							
D		Average MISO Energy Price	$/MWh		1.00	[redacted]																						
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																							
F		CO2 Credit Cost	$/ton												$ 16.07	$ 17.37	$ 18.79	$ 20.31	$ 21.96	$ 23.74	$ 25.67	$ 27.75	$ 30.01	$ 32.44	$ 35.07	$ 37.92	$ 41.00	$ 44.33
G		NOx Credit Cost	$/ton																									
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		**Forced Outage Rate**	%			5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.19	$ 0.43	$ 1.21	$ 4.26	$ 13.17	$ 12.82	$ 12.22	$ 11.64	$ 11.08	$ 10.53	$ 10.00	$ 9.48	$ 9.00	$ 8.54	$ 8.62	$ 8.32	$ 7.82	$ 7.32	$ 6.84	$ 6.38	$ 5.91	$ 5.50	$ 4.67
K		Scheduled Maintenance	Weeks			5	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			556	557	552	552	552	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568
L		Unforced Capacity (UCAP)	MW			528	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
M		Operating Capacity	MW			514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
N		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
O		Annual Variable O&M	$/MMBtu			[redacted]																						
P			$/MWh																									
Q		Heat Rate	Btu/kWh			10,656	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.08	$ 0.21	$ 0.38	$ 2.58	$ 3.73	$ 3.78	$ 3.83	$ 3.88	$ 3.91	$ 3.96	$ 4.31	$ 4.47	$ 4.47	$ 4.45	$ 4.44	$ 4.44	$ 4.45	$ 5.27	$ 5.48	$ 5.53	$ 5.67	$ 6.01	$ 6.43
S		Scheduled Maintenance	Weeks			5	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5
		Installed Capacity (ICAP)				556	557	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
T		Unforced Capacity (UCAP)	MW			528	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
U		Operating Capacity	MW			514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
V		Nox Emission Rate	lbs/MMBtu			0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
W		Annual Variable O&M	$/MMBtu			[redacted]																						
X			$/MWh																									
Y		Heat Rate	Btu/kWh			10,656	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644

Case 1 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information - Highlighted in Gray

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO2	lbs/MMBtu	208.78		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	48.17	1.00	
		Installed Capacity (ICAP) Increase	MW	9.70	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,704.8		not used in any calcs but rather included as a reference point

		Discount Year		2013																														
		Discount Rate		6.80%	Multiplier	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																									
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																										
F		CO2 Credit Cost	$/ton																												
G		NOx Credit Cost	$/ton																												
H		Capacity Market	$/kW-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.13	$ 0.71	$ 1.81	$ 10.39	$ 12.43	$ 11.93	$ 11.40	$ 10.88	$ 10.38	$ 9.89	$ 9.42	$ 8.96	$ 8.53	$ 8.54	$ 8.28	$ 7.84	$ 7.39	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 5.30	$ 5.20
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5
L		Installed Capacity (ICAP)	MW			557	559	553	553	563	563	563	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
M		Unforced Capacity (UCAP)	MW			538	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
N		Operating Capacity	MW			513	507	507	555	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
O		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
P		Annual Variable O&M	$/MMBtu			[redacted]																									
Q			$/MWh																												
R		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
S	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.11	$ 0.26	$ 2.49	$ 3.75	$ 3.79	$ 3.84	$ 3.88	$ 3.92	$ 3.95	$ 4.24	$ 4.19	$ 4.42	$ 4.40	$ 4.38	$ 4.35	$ 4.33	$ 4.86	$ 5.01	$ 4.98	$ 4.95	$ 4.95	$ 4.99	$ 5.09	$ 6.87	$ 7.42	$ 7.77
T		Scheduled Maintenance	Weeks			7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5
U		Installed Capacity (ICAP)	MW			557	559	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
V		Unforced Capacity (UCAP)	MW			538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
W		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
X		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
Y		Annual Variable O&M	$/MMBtu			[redacted]																									
			$/MWh																												
		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 2	Appendix B, Schedule 3 - Economic Modeling Input Tables Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	100%	1.00	Capacity factor when unit is available (aka operating factor)
B		Emission Rate CO2	lbs/MMBtu	208.76		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	45.12	1.00	
		Installed Capacity (ICAP) Increase	MW	9.70	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,704.8		not used in any calcs but rather included as a reference point

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
		Discount Year		2013																											
		Discount Rate		8.50%	Multiplier																										
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																									
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																										
F		CO2 Credit Cost	$/ton																												
G		NOx Credit Cost	$/ton																												
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$m/Bons.		1.10	$ 0.13	$ 0.71	$ 1.81	$ 10.36	$ 12.43	$ 11.83	$ 11.40	$ 10.88	$ 10.38	$ 9.89	$ 9.42	$ 8.96	$ 8.53	$ 8.54	$ 8.28	$ 7.84	$ 7.39	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 5.80	$ 5.20
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5
L		Installed Capacity (ICAP)	MW			557	550	553	553	563	563	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
M		Unforced Capacity (UCAP)	MW			538	540	534	534	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
N		Operating Capacity	MW			513	507	507	505	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
O		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
P		Annual Variable O&M	$/MMBtu			[redacted]																									
Q			$/MWh																												
R		Heat Rate	Btu/kWh			10,516	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
S	ALTERNATIVE Unit Assumptions WITHOUT Upgrades	Capital Rev Req Turbine & Mills	$m/Bons.		1.00	$ 0.11	$ 0.26	$ 2.49	$ 3.75	$ 2.79	$ 3.84	$ 3.88	$ 3.92	$ 3.95	$ 4.24	$ 4.38	$ 4.42	$ 4.40	$ 4.36	$ 4.35	$ 4.33	$ 4.66	$ 5.01	$ 4.98	$ 4.95	$ 4.65	$ 4.99	$ 5.09	$ 6.87	$ 7.42	$ 7.77
		Scheduled Maintenance	Weeks			7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	6	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)				557	550	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
T		Unforced Capacity (UCAP)	MW			538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
U		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
V		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
W		Annual Variable O&M	$/MMBtu			[redacted]																									
X			$/MWh																												
Y		Heat Rate	Btu/kWh			10,516	10,534	10,534	10,503	10,503	10,503	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 3 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	80%	1.00	Capacity factor when unit is available (aka operating factor)
B		Emission Rate CO	lbs/MMBtu	206.76		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	48.12	1.00	
		Installed Capacity (ICAP) Increase	MW	9.70	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,704.6		not used in any calcs but rather included as a reference point

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
		Discount Year		2013																											
		Discount Rate		8.60%	Multiplier																										
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																									
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																										
F		CO2 Credit Cost	$/ton																												
G		NOx Credit Cost	$/ton																												
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		0.90	$ 0.13	$ 0.71	$ 1.81	$ 10.39	$ 12.43	$ 11.93	$ 11.40	$ 10.86	$ 10.38	$ 9.89	$ 9.42	$ 8.96	$ 8.53	$ 8.54	$ 8.08	$ 7.84	$ 7.38	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 5.59	$ 5.20
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)	MW			557	559	553	553	563	563	563	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
L		Unforced Capacity (UCAP)	MW			538	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
M		Operating Capacity	MW			513	507	507	555	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
N		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
O		Annual Variable O&M	$/MMBtu			[redacted]																									
P			$/MWh																												
Q		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,661	10,661	10,661	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.11	$ 0.20	$ 2.49	$ 3.78	$ 3.79	$ 3.84	$ 3.88	$ 3.92	$ 3.95	$ 4.24	$ 4.39	$ 4.42	$ 4.40	$ 4.38	$ 4.35	$ 4.33	$ 4.86	$ 5.01	$ 4.88	$ 4.95	$ 4.95	$ 4.99	$ 5.09	$ 5.87	$ 7.42	$ 7.77
S		Scheduled Maintenance	Weeks			7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)				557	559	553	553	563	563	563	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
T		Unforced Capacity (UCAP)	MW			538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
U		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
V		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
W		Annual Variable O&M	$/MMBtu			[redacted]																									
X			$/MWh																												
Y		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 4 Appendix B, Schedule 3 - Economic Modeling Input Tables
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO	lbs/MMBtu	309.76		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	48.12	1.00	
		Installed Capacity (ICAP) Increase	MW	8.70	1.00	
		Heat Rate Improvement	Btu/kWh	-141	1.00	
		Emission Rate NOx Improvement	%	16%		
		Emission LIMIT - NOx, Tons	tons	2,704.6		Not used in any calcs but rather included as a reference point

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
		Discount Year		2013																											
		Discount Rate		8.80%	Multiplier																										
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																									
E		$-MMBtu Delivered Fuel Cost	$/MMBtu		1.00																										
F		CO2 Credit Cost	$/ton																												
G		NOx Credit Cost	$/ton																												
H		Capacity Market	$/kw/yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.13	$ 0.71	$ 1.81	$ 10.39	$ 12.43	$ 11.93	$ 11.49	$ 10.88	$ 10.38	$ 9.89	$ 9.42	$ 8.96	$ 8.53	$ 8.54	$ 8.26	$ 7.84	$ 7.39	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 5.90	$ 5.20
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)	MW			557	559	553	553	563	563	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
L		Unforced Capacity (UCAP)	MW			538	540	534	534	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
M		Operating Capacity	MW			513	507	507	555	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
N		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
O		Annual Variable O&M	$-MMBtu			[redacted]																									
P			$/MWh																												
Q		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,502	10,502	10,502	10,510	10,510	10,510	10,510	10,510	10,510	10,510	10,510	10,510	10,510	10,510	10,510	10,510	10,510	10,510	10,510	10,510	10,510	10,510	10,510
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.10	$ 0.11	$ 0.26	$ 2.49	$ 3.75	$ 3.79	$ 3.84	$ 3.88	$ 3.92	$ 3.95	$ 4.24	$ 4.30	$ 4.40	$ 4.40	$ 4.38	$ 4.35	$ 4.33	$ 4.86	$ 5.01	$ 4.98	$ 4.95	$ 4.95	$ 4.99	$ 5.09	$ 6.87	$ 7.42	$ 7.77
S		Scheduled Maintenance	Weeks			7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)	MW			557	559	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
T		Unforced Capacity (UCAP)	MW			536	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
U		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
V		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
W		Annual Variable O&M	$-MMBtu			[redacted]																									
X			$/MWh																												
Y		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,502	10,502	10,502	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500

Case 5 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	95%	1.00	Capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	208.78		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	48.12	1.00	
		Installed Capacity (ICAP) Increase	MW	2.70	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,704.6		not used in any calcs, but rather included as a reference point

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
		Discount Year		2013																											
		Discount Rate		8.80%	Multiplier																										
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																									
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																										
F		CO2 Credit Cost	$/ton																												
G		NOx Credit Cost	$/ton																												
H		Capacity Market	$/kW-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.13	$ 0.71	$ 1.81	$ 10.39	$ 12.43	$ 11.93	$ 11.40	$ 10.88	$ 10.38	$ 9.89	$ 9.42	$ 8.98	$ 8.53	$ 8.54	$ 8.28	$ 7.84	$ 7.39	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 5.90	$ 5.20
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)	MW			557	559	553	553	563	563	563	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
L		Unforced Capacity (UCAP)	MW			538	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
M		Operating Capacity	MW			513	507	507	505	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
N		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
O		Annual Variable O&M	$/MMBtu			[redacted]																									
P			$/MWh																												
Q		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,661	10,661	10,661	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		0.90	$ 0.11	$ 0.26	$ 2.48	$ 3.75	$ 3.79	$ 3.84	$ 3.88	$ 3.92	$ 3.95	$ 4.24	$ 4.39	$ 4.42	$ 4.40	$ 4.38	$ 4.35	$ 4.33	$ 4.86	$ 5.01	$ 4.98	$ 4.95	$ 4.92	$ 4.89	$ 5.09	$ 6.87	$ 7.42	$ 7.77
S		Scheduled Maintenance	Weeks			7	5	15	5	5	5	5	5	5	8	5	5	5	5	6	5	8	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)				557	559	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
T		Unforced Capacity (UCAP)	MW			538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
U		Operating Capacity	MW			513	507	507	501	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
V		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
W		Annual Variable O&M	$/MMBtu			[redacted]																									
X			$/MWh																												
Y		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 6 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	Capacity factor when unit is available (aka operating factor)
B		Emission Rate CO2	lbs/MMBtu	206.78		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	48.12	1.00	
		Installed Capacity (ICAP) Increase	MW	9.70	1.00	
		Heat Rate Improvement	Btu/kWh	485.1	1.10	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,704.6		not used in any calcs but rather included as a reference point

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
		Discount Year		2013																											
		Discount Rate		8.80%	Multiplier																										
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																									
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																										
F		CO2 Credit Cost	$/ton																												
G		NOx Credit Cost	$/ton																												
H		Capacity Market	$/kw-yr.		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.13	$ 0.71	$ 1.81	$ 10.39	$ 12.42	$ 11.93	$ 11.40	$ 10.88	$ 10.38	$ 9.89	$ 9.42	$ 8.96	$ 8.53	$ 8.54	$ 8.26	$ 7.84	$ 7.39	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 5.90	$ 5.20
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)	MW			557	558	553	553	563	563	563	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
L		Unforced Capacity (UCAP)	MW			538	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
M		Operating Capacity	MW			513	507	507	555	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
N		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.115	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
O		Annual Variable O&M	$/MMBtu			[redacted]																									
P			$/MWh																												
Q		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,017	10,017	10,017	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075
R	ALTERNATIVE Unit Assumptions WITHOUT Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.11	$ 0.26	$ 2.49	$ 3.75	$ 3.79	$ 3.64	$ 3.68	$ 3.92	$ 3.95	$ 4.24	$ 4.39	$ 4.42	$ 4.49	$ 4.38	$ 4.35	$ 4.33	$ 4.88	$ 5.01	$ 4.88	$ 4.95	$ 4.95	$ 4.99	$ 5.09	$ 6.87	$ 7.42	$ 7.77
S		Scheduled Maintenance	Weeks			7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)				557	559	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
T		Unforced Capacity (UCAP)	MW			538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
U		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
V		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
W		Annual Variable O&M	$/MMBtu			[redacted]																									
X			$/MWh																												
Y		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 7 | Appendix B, Schedule 3 - Economic Modeling Input Tables
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	(capacity factor when unit is available (aka, operating factor)
B		Emission Rate CO_2	lbs/MMBtu	208.76		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	48.12	1.00	
		Installed Capacity (ICAP) Increase	MW	9.79	1.00	
		Heat Rate Improvement	Btu/kWh	300.9	0.90	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,704.6		but used in any calcs, but rather included as a reference point

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
		Discount Year		2013																											
		Discount Rate		8.60%	Multiplier																										
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																									
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																										
F		CO2 Credit Cost	$/ton																												
G		NOx Credit Cost	$/ton																												
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.13	$ 0.71	$ 1.81	$ 10.39	$ 12.43	$ 11.93	$ 11.40	$ 10.88	$ 10.38	$ 9.88	$ 9.42	$ 8.98	$ 8.53	$ 8.54	$ 8.28	$ 7.84	$ 7.39	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.22	$ 4.82	$ 6.07	$ 5.90	$ 5.20
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)	MW			557	559	553	553	563	563	563	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
L		Unforced Capacity (UCAP)	MW			538	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
M		Operating Capacity	MW			513	507	507	555	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
N		New Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
O		Annual Variable O&M	$/MMBtu			[redacted]																									
P			$/MWh																												
Q		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,105	10,105	10,105	10,103	10,103	10,103	10,103	10,103	10,103	10,103	10,103	10,103	10,103	10,103	10,103	10,103	10,103	10,103	10,103	10,103	10,103	10,103	10,103
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.11	$ 0.26	$ 2.49	$ 3.75	$ 3.79	$ 3.84	$ 3.88	$ 3.92	$ 3.96	$ 4.24	$ 4.39	$ 4.42	$ 4.40	$ 4.38	$ 4.35	$ 4.33	$ 4.86	$ 5.01	$ 4.98	$ 4.95	$ 4.95	$ 4.99	$ 5.08	$ 6.87	$ 7.42	$ 7.77
S		Scheduled Maintenance	Weeks			7	5	15	8	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)	MW			557	559	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
T		Unforced Capacity (UCAP)	MW			538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
U		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
V		New Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
W		Annual Variable O&M	$/MMBtu			[redacted]																									
X			$/MWh																												
Y		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 8	Appendix B, Schedule 3 - Economic Modeling Input Tables Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	208.76		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	52.84	1.10	
		Installed Capacity (ICAP) Increase	MW	10.67	1.10	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,704.6		not used in any case, but rather included as a reference point

SOURCE ID					Multiplier	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
	Common Unit and Market Assumptions	Discount Year		2013																											
		Discount Rate		6.80%	Multiplier																										
D		Average MISO Energy Price	$/MWh		1.00	[redacted]																									
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																										
F		CO2 Credit Cost	$/ton																												
G		NOx Credit Cost	$/ton																												
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.13	$ 0.71	$ 1.81	$ 10.39	$ 12.43	$ 11.93	$ 11.40	$ 10.88	$ 10.38	$ 9.89	$ 9.42	$ 8.96	$ 8.53	$ 8.54	$ 8.28	$ 7.84	$ 7.39	$ 6.95	$ 6.51	$ 6.06	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 3.90	$ 5.20
K		Scheduled Maintenance	Weeks			7	5	5	5	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	5	5	5
		Installed Capacity (ICAP)	MW			557	559	553	553	564	564	564	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561
L		Unforced Capacity (UCAP)	MW			538	540	534	534	545	545	545	542	542	542	542	542	542	542	542	542	542	542	542	542	542	542	542	542	542	542
M		Operating Capacity	MW			513	507	507	560	560	560	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557
N		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
O		Annual Variable O&M	$/MMBtu			[redacted]																									
P			$/MWh																												
Q		Heat Rate	Btu/kWh			10,516	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.11	$ 0.26	$ 2.49	$ 3.75	$ 3.79	$ 3.84	$ 3.88	$ 3.92	$ 3.95	$ 4.24	$ 4.39	$ 4.42	$ 4.40	$ 4.38	$ 4.35	$ 4.33	$ 4.88	$ 5.01	$ 4.88	$ 4.95	$ 4.95	$ 4.99	$ 5.09	$ 6.87	$ 7.42	$ 7.77
S		Scheduled Maintenance	Weeks			7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)				557	559	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
T		Unforced Capacity (UCAP)	MW			538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
U		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
V		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
W		Annual Variable O&M	$/MMBtu			[redacted]																									
X			$/MWh																												
Y		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 9 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	208.76		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	43.31	0.80	
		Installed Capacity (ICAP) Increase	MW	8.73	0.80	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	16%		
		Emission LIMIT - NOx, Tons	tons	2,204.8		not used in any calcs but rather included as a reference point

				2013																													
		Discount Year				2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
		Discount Rate		8.00%	Multiplier																										
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																									
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																										
F		CO2 Credit Cost	$/ton																												
G		NOx Credit Cost	$/ton																												
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.13	$ 0.71	$ 1.81	$ 10.20	$ 12.43	$ 11.93	$ 11.40	$ 10.88	$ 10.38	$ 9.89	$ 9.47	$ 8.96	$ 8.53	$ 8.54	$ 8.28	$ 7.84	$ 7.39	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 5.60	$ 5.20
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)	MW			557	559	553	553	562	562	562	559	559	559	559	559	559	559	559	559	559	559	559	559	558	559	559	559	559	559
L		Unforced Capacity (UCAP)	MW			538	540	534	534	543	543	543	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540
M		Operating Capacity	MW			513	507	507	550	550	550	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547
N		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
O		Annual Variable O&M	$/MMBtu			[redacted]																									
P			$/MWh																												
Q		Heat Rate	Btu/kWh			10,516	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
R	ALTERNATIVE Unit Assumptions WITHOUT Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.11	$ 0.20	$ 2.49	$ 3.75	$ 3.79	$ 3.84	$ 3.88	$ 3.92	$ 3.95	$ 4.24	$ 4.30	$ 4.42	$ 4.40	$ 4.38	$ 4.35	$ 4.33	$ 4.86	$ 5.01	$ 4.98	$ 4.93	$ 4.95	$ 4.99	$ 5.09	$ 6.87	$ 7.42	$ 7.77
S		Scheduled Maintenance	Weeks			7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)	MW			557	559	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
T		Unforced Capacity (UCAP)	MW			538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
U		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
V		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
W		Annual Variable O&M	$/MMBtu			[redacted]																									
X			$/MWh																												
Y		Heat Rate	Btu/kWh			10,516	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 10 | Appendix B, Schedule 3 - Economic Modeling Input Tables
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	99%	1.10	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	208.76		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	48.12	1.00	
		Installed Capacity (ICAP) Increase	MW	9.70	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NO_x, Tons	tons	2,704.6		not used in any calcs but rather included as a reference point

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
		Discount Year		2013																											
		Discount Rate		8.60%	Multiplier																										
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																									
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																										
F		CO2 Credit Cost	$/ton																												
G		NOx Credit Cost	$/ton																												
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.13	$ 0.71	$ 1.81	$ 10.39	$ 12.43	$ 11.93	$ 11.40	$ 10.88	$ 10.38	$ 9.89	$ 9.42	$ 8.96	$ 8.53	$ 8.54	$ 8.28	$ 7.84	$ 7.39	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 5.90	$ 5.20
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	8	8	5
		Installed Capacity (ICAP)	MW			557	559	553	553	553	553	553	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550
L		Unforced Capacity (UCAP)	MW			536	540	534	534	534	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
M		Operating Capacity	MW			513	507	507	555	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
N		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
O		Annual Variable O&M	$/MMBtu			[redacted]																									
P			$/MWh																												
Q		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.11	$ 0.26	$ 2.49	$ 3.75	$ 3.79	$ 3.84	$ 3.88	$ 3.92	$ 3.95	$ 4.24	$ 4.39	$ 4.42	$ 4.40	$ 4.38	$ 4.35	$ 4.33	$ 4.86	$ 5.01	$ 4.98	$ 4.95	$ 4.95	$ 4.99	$ 5.09	$ 6.87	$ 7.42	$ 7.77
S		Scheduled Maintenance	Weeks			7	5	16	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)				557	559	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
T		Unforced Capacity (UCAP)	MW			536	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
U		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
V		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
W		Annual Variable O&M	$/MMBtu			[redacted]																									
X			$/MWh																												
Y		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 11 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	81%	0.90	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO2	lbs/MMBtu	208.79		
C		Emission Rate NOx	lbs/MMBtu	0.177		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	46.12	1.00	
		Installed Capacity (ICAP) Increase	MW	9.76	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,704.8		not used in any calcs but rather included as a reference point

				2013																											
		Discount Rate		6.60%	Multiplier	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																									
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																										
F		CO2 Credit Cost	$/ton																												
G		NOx Credit Cost	$/ton																												
H		Capacity Market	$/kw-yr		1.00				$ 48.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.13	$ 0.71	$ 1.81	$ 10.38	$ 12.43	$ 11.93	$ 11.40	$ 10.88	$ 10.38	$ 9.89	$ 9.42	$ 8.96	$ 8.53	$ 8.54	$ 8.28	$ 7.84	$ 7.39	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 5.60	$ 5.20
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5
L		Installed Capacity (ICAP)	MW			557	559	553	553	563	563	563	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
M		Unforced Capacity (UCAP)	MW			538	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
N		Operating Capacity	MW			513	507	507	555	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
O		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
P		Annual Variable O&M	$/MMBtu			[redacted]																									
Q			$/MWh																												
R		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
S	ALTERNATIVE Unit Assumptions WITHOUT Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.11	$ 0.26	$ 2.49	$ 3.75	$ 3.76	$ 3.84	$ 3.88	$ 3.92	$ 3.96	$ 4.24	$ 4.39	$ 4.42	$ 4.40	$ 4.38	$ 4.35	$ 4.33	$ 4.86	$ 5.01	$ 4.98	$ 4.95	$ 4.95	$ 4.99	$ 5.00	$ 6.87	$ 7.42	$ 7.77
		Scheduled Maintenance	Weeks			7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)				557	559	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
T		Unforced Capacity (UCAP)	MW			538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
U		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
V		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
W		Annual Variable O&M	$/MMBtu			[redacted]																									
K			$/MWh																												
Y		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 12 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	Capacity factor when unit is available (aka operating factor)
B		Emission Rate CO2	lbs/MMBtu	208.76		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	48.12	1.00	
		Installed Capacity (ICAP) Increase	MW	9.70	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,704.8		not used in any calcs but rather included as a reference point

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
		Discount Year		2013																											
		Discount Rate		8.80%	Multiplier																										
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																									
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																										
F		CO2 Credit Cost	$/ton																												
G		NOx Credit Cost	$/ton																												
H		Capacity Market	$/kw-yr		2.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 8.13	$ 8.71	$ 1.81	$ 10.39	$ 12.43	$ 11.93	$ 11.40	$ 10.86	$ 10.38	$ 9.89	$ 9.42	$ 8.96	$ 8.53	$ 8.54	$ 8.28	$ 7.84	$ 7.39	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 5.90	$ 5.20
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)	MW			557	559	553	553	563	563	563	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
L		Unforced Capacity (UCAP)	MW			538	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
M		Operating Capacity	MW			513	507	507	555	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
N		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.080	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
O		Annual Variable O&M	$/MMBtu			[redacted]																									
P			$/MWh																												
Q		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
R	ALTERNATIVE Unit Assumptions WITHOUT Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.11	$ 0.26	$ 2.49	$ 3.75	$ 3.79	$ 3.84	$ 3.88	$ 3.92	$ 3.90	$ 4.24	$ 4.38	$ 4.42	$ 4.40	$ 4.38	$ 4.35	$ 4.33	$ 4.86	$ 5.01	$ 4.98	$ 4.95	$ 4.95	$ 4.99	$ 5.09	$ 6.87	$ 7.42	$ 7.77
S		Scheduled Maintenance	Weeks			7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)	MW			557	559	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
T		Unforced Capacity (UCAP)	MW			538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
U		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
V		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.127	0.127	0.080	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
W		Annual Variable O&M	$/MMBtu			[redacted]																									
X			$/MWh																												
Y		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 13 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	208.70		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	48.12	1.00	
		Installed Capacity (ICAP) Increase	MW	9.75	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,704.8		not used in any calcs but rather included as a reference point

				2013																												
		Discount Year		2013																												
		Discount Rate		8.00%	Multiplier	2012	2014	2016	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																										
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																											
F		CO2 Credit Cost	$/ton																													
G		NOx Credit Cost	$/ton																													
H		Capacity Market	$/kw/yr		-				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.13	$ 0.71	$ 1.61	$ 10.39	$ 12.43	$ 11.93	$ 11.40	$ 10.88	$ 10.36	$ 9.83	$ 9.47	$ 8.96	$ 8.53	$ 8.54	$ 8.26	$ 7.84	$ 7.50	$ 6.85	$ 6.51	$ 6.06	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 5.60	$ 5.20
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)	MW			557	559	553	553	563	563	563	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
L		Unforced Capacity (UCAP)	MW			538	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
M		Operating Capacity	MW			513	507	507	555	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
N		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
O		Annual Variable O&M	$/MMBtu			[redacted]																										
P			$/MWh																													
Q		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.11	$ 0.26	$ 2.49	$ 3.75	$ 3.79	$ 3.84	$ 3.88	$ 3.92	$ 3.95	$ 4.24	$ 4.39	$ 4.42	$ 4.40	$ 4.36	$ 4.35	$ 4.33	$ 4.86	$ 5.01	$ 4.98	$ 4.95	$ 4.95	$ 4.99	$ 5.89	$ 6.87	$ 7.42	$ 7.77
S		Scheduled Maintenance	Weeks			7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)				557	558	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
T		Unforced Capacity (UCAP)	MW			538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
U		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
V		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
W		Annual Variable O&M	$/MMBtu			[redacted]																										
X			$/MWh																													
Y		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 14 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	Capacity factor when unit is available (aka operating factor)
B		Emission Rate CO2	lbs/MMBtu	208.76		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	48.12	1.00	
		Installed Capacity (ICAP) Increase	MW	8.70	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,704.8		not used in any calcs but rather included as a reference point

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
	Common Unit and Market Assumptions	Discount Year		2013																											
		Discount Rate		8.80%	Multiplier																										
D		Average MISO Energy Price	$/MWh		1.35	[redacted]																									
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																										
F		CO2 Credit Cost	$/ton																												
G		NOx Credit Cost	$/ton																												
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 9.13	$ 9.71	$ 1.81	$ 10.39	$ 12.43	$ 11.93	$ 11.40	$ 10.88	$ 10.38	$ 9.88	$ 9.42	$ 8.96	$ 8.53	$ 8.54	$ 8.28	$ 7.84	$ 7.39	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 5.90	$ 5.80
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5
L		Installed Capacity (ICAP)	MW			557	559	553	553	563	563	563	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
M		Unforced Capacity (UCAP)	MW			536	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
N		Operating Capacity	MW			513	507	507	555	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
O		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
P		Annual Variable O&M	$/MMBtu			[redacted]																									
Q			$/MWh																												
R		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,081	10,081	10,081	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
S	ALTERNATIVE Unit Assumptions WITHOUT Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.11	$ 0.20	$ 2.49	$ 3.76	$ 3.79	$ 3.84	$ 3.88	$ 3.92	$ 3.95	$ 4.24	$ 4.39	$ 4.42	$ 4.40	$ 4.36	$ 4.35	$ 4.33	$ 4.86	$ 5.01	$ 4.98	$ 4.96	$ 4.95	$ 4.99	$ 5.09	$ 6.87	$ 7.42	$ 7.77
T		Scheduled Maintenance	Weeks			7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5
U		Installed Capacity (ICAP)				557	559	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
V		Unforced Capacity (UCAP)	MW			535	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
W		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
X		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
Y		Annual Variable O&M	$/MMBtu			[redacted]																									
			$/MWh																												
		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 15 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	86%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO2	lbs/MMBtu	208.76		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	48.12	1.00	
		Installed Capacity (ICAP) Increase	MW	9.70	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,704.8		not used in any calcs, but rather included as a reference point

SOURCE ID					Multiplier	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
		Discount Year		2013																											
		Discount Rate		8.80%																											
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		0.75	[redacted]																									
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																										
F		CO2 Credit Cost	$/ton																												
G		NOx Credit Cost	$/ton																												
H		Capacity Market	$/kW-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.13	$ 0.71	$ 1.87	$ 10.39	$ 12.43	$ 11.93	$ 11.40	$ 10.85	$ 10.38	$ 9.89	$ 9.42	$ 8.86	$ 8.53	$ 8.54	$ 8.28	$ 7.84	$ 7.39	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 5.98	$ 5.20
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)	MW			557	559	553	553	563	563	563	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
L		Unforced Capacity (UCAP)	MW			538	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
M		Operating Capacity	MW			513	507	507	555	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
N		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
O		Annual Variable O&M	$/MMBtu			[redacted]																									
P			$/MWh																												
Q		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.11	$ 0.26	$ 2.48	$ 3.75	$ 3.79	$ 3.84	$ 3.88	$ 3.92	$ 3.90	$ 4.24	$ 4.39	$ 4.42	$ 4.40	$ 4.38	$ 4.35	$ 4.33	$ 4.36	$ 5.01	$ 4.08	$ 4.86	$ 4.95	$ 4.99	$ 5.09	$ 6.27	$ 7.42	$ 7.72
S		Scheduled Maintenance	Weeks			7	5	15	5	5	5	5	5	5	8	5	5	5	8	5	5	5	8	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)	MW			557	559	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
T		Unforced Capacity (UCAP)	MW			538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
U		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
V		Nox Emission Rate	lbs/MMBtu			[redacted]																									
W		Annual Variable O&M	$/MMBtu																												
X			$/MWh																												
Y		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 16 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	Capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	208.76		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	48.12	1.00	
		Installed Capacity (ICAP) Increase	MW	9.70	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,704.8		Not used in any calcs but rather included as a reference point

	Common Unit and Market Assumptions	Discount Year		2013																													
		Discount Rate		8.92%	Multiplier	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
D		Average MISO Energy Price	$/MWh		1.00	[redacted]																											
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.25																												
F		CO2 Credit Cost	$/ton																														
G		NOx Credit Cost	$/ton																														
H		Capacity Market	$/kw/yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.13	$ 0.71	$ 1.61	$ 10.39	$ 12.43	$ 11.93	$ 11.40	$ 10.88	$ 10.38	$ 9.89	$ 9.42	$ 8.96	$ 8.53	$ 8.54	$ 8.29	$ 7.84	$ 7.39	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 5.90	$ 5.20
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5
L		Installed Capacity (ICAP)	MW			557	559	553	553	563	563	563	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
M		Unforced Capacity (UCAP)	MW			538	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
N		Operating Capacity	MW			513	507	507	555	555	555	552	552	552	552	552	552	552	553	552	553	552	552	552	552	552	552	552	552	552	552
O		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
P		Annual Variable O&M	$/MMBtu			[redacted]																									
Q			$/MWh																														
		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,081	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.17	$ 0.26	$ 2.49	$ 3.75	$ 3.76	$ 3.84	$ 3.88	$ 3.92	$ 3.95	$ 4.24	$ 4.39	$ 4.42	$ 4.40	$ 4.38	$ 4.35	$ 4.33	$ 4.80	$ 5.01	$ 4.68	$ 4.95	$ 4.95	$ 4.99	$ 5.09	$ 6.87	$ 7.42	$ 7.72
S		Scheduled Maintenance	Weeks			7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5
T		Installed Capacity (ICAP)	MW			557	559	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
U		Unforced Capacity (UCAP)	MW			538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
V		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
W		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
X		Annual Variable O&M	$/MMBtu			[redacted]																									
Y			$/MWh																												
		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 17 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	208.76		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	48.12	1.00	
		Installed Capacity (ICAP) Increase	MW	9.70	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NO_x, Tons	tons	2,704.8		not used in any calcs but rather included as a reference point

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
		Discount Year		2013																											
		Discount Rate		8.80%	Multiplier																										
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																									
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		0.35																										
F		CO2 Credit Cost	$/ton																												
G		NOx Credit Cost	$/ton																												
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$/Millions		1.00	$ 0.13	$ 0.71	$ 1.81	$ 10.39	$ 12.43	$ 11.93	$ 11.40	$ 10.88	$ 10.38	$ 9.80	$ 9.42	$ 8.86	$ 8.53	$ 8.54	$ 8.28	$ 7.94	$ 7.39	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 5.90	$ 5.20
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)	MW			557	558	553	553	563	563	563	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
L		Unforced Capacity (UCAP)	MW			538	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
M		Operating Capacity	MW			513	507	507	555	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
N		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
O		Annual Variable O&M	$/MMBtu			[redacted]																									
P			$/MWh																												
Q		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
R	ALTERNATIVE Unit Assumptions WITHOUT Upgrades	Capital Rev Req Turbine & Mills	$/millions		1.00	$ 0.11	$ 0.26	$ 2.49	$ 3.75	$ 3.79	$ 3.84	$ 3.88	$ 3.92	$ 3.95	$ 4.24	$ 4.39	$ 4.42	$ 4.40	$ 4.38	$ 4.35	$ 4.33	$ 4.88	$ 5.01	$ 4.98	$ 4.95	$ 4.85	$ 4.99	$ 5.09	$ 6.87	$ 7.42	$ 7.77
S		Scheduled Maintenance	Weeks			7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)				557	558	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
T		Unforced Capacity (UCAP)	MW			538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
U		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
V		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
W		Annual Variable O&M	$/MMBtu			[redacted]																									
X			$/MWh																												
Y		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 18 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	81%	0.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	208.78		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	43.31	0.00	
		Installed Capacity (ICAP) Increase	MW	8.73	0.00	
		Heat Rate Improvement	Btu/kWh	399.9	0.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,704.6		not used in any calcs but rather included as a reference point

SOURCE ID					Multiplier	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
	Common Unit and Market Assumptions	Discount Year		2013																											
		Discount Rate		8.80%	Multiplier																										
D		Average MISO Energy Price	$/MWh		0.75	[redacted]																									
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.25																										
F		CO2 Credit Cost	$/ton																												
G		NOx Credit Cost	$/ton																												
H		Capacity Market	$/kw-yr							$ -49.19	$ 49.19	$ -49.19	$ -49.19	$ -49.19	$ -49.19	$ -49.19	$ -49.19	$ -49.19	$ -49.19	$ -49.19	$ -49.19	$ -49.19	$ -49.19	$ -49.19	$ -49.19	$ -49.19	$ -49.19	$ -49.19	$ -49.19	$ -49.19	$ -49.19	$ -49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.10	$ 6.13	$ 0.71	$ 1.81	$ 10.39	$ 12.43	$ 11.93	$ 11.40	$ 10.88	$ 10.38	$ 9.89	$ 9.42	$ 8.96	$ 8.53	$ 8.54	$ 8.28	$ 7.84	$ 7.39	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 5.80	$ 5.50
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)	MW			557	559	562	553	562	562	562	559	559	559	559	559	559	559	559	558	559	559	559	559	559	559	559	559	559	559
L		Unforced Capacity (UCAP)	MW			536	540	534	534	543	543	543	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540
M		Operating Capacity	MW			513	507	507	550	550	550	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547
N		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
O		Annual Variable O&M	$/MMBtu			[redacted]																									
P			$/MWh																												
Q		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,105	10,105	10,105	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163
R	ALTERNATIVE Unit Assumptions WITHOUT Upgrades	Capital Rev Req Turbine & Mills	$millions		0.00	$ 0.11	$ 0.26	$ 2.49	$ 3.75	$ 3.79	$ 3.64	$ 3.68	$ 3.92	$ 3.95	$ 4.24	$ 4.39	$ 4.42	$ 4.40	$ 4.38	$ 4.35	$ 4.33	$ 4.88	$ 5.01	$ 4.98	$ 4.95	$ 4.95	$ 4.89	$ 5.08	$ 6.87	$ 7.42	$ 7.77
S		Scheduled Maintenance	Weeks			7	5	15	5	5	5	5	5	5	8	5	5	5	8	5	5	8	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)				557	559	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
T		Unforced Capacity (UCAP)	MW			538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
U		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
V		Nox Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
W		Annual Variable O&M	$/MMBtu			[redacted]																									
X			$/MWh																												
Y		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 19 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	89%	1.10	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO_2	lbs/MMBtu	208.76		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	52.94	1.10	
		Installed Capacity (ICAP) Increase	MW	10.67	1.10	
		Heat Rate Improvement	Btu/kWh	465.1	1.10	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,704.6		not used in any calcs but rather included as a reference point

				2013																											
		Discount Year		2013																											
		Discount Rate		8.80%	Multiplier	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/kWh		1.35	[redacted]																									
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		0.75																										
F		CO_2 Credit Cost	$/ton																												
G		NOx Credit Cost	$/ton																												
H		Capacity Market	$/kW-yr		2.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		0.90	$ 0.13	$ 0.71	$ 1.81	$ 10.38	$ 12.43	$ 11.93	$ 11.40	$ 10.88	$ 10.38	$ 9.89	$ 9.42	$ 8.96	$ 8.53	$ 8.14	$ 8.28	$ 7.89	$ 7.38	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.23	$ 4.82	$ 8.02	$ 5.60	$ 5.20
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	6	5	5	5	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)	MW			557	559	553	552	564	564	564	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561
L		Unforced Capacity (UCAP)	MW			538	540	534	534	545	545	545	542	542	542	542	542	542	542	542	542	542	542	542	542	542	542	542	542	542	542
M		Operating Capacity	MW			513	507	507	560	560	560	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557
N		Nox Emissions Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
O		Annual Variable O&M	$/MMBtu			[redacted]																									
P			$/MWh																												
Q		Heat Rate	Btu/kWh			10,516	10,534	10,534	10,017	10,017	10,017	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.10	$ 0.11	$ 0.26	$ 2.49	$ 3.75	$ 3.79	$ 3.64	$ 3.48	$ 3.32	$ 3.16	$ 3.24	$ 4.29	$ 4.42	$ 4.40	$ 4.38	$ 4.35	$ 4.33	$ 4.86	$ 5.01	$ 4.98	$ 4.95	$ 4.95	$ 4.99	$ 5.09	$ 6.67	$ 7.42	$ 7.77
S		Scheduled Maintenance	Weeks			7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)				557	559	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
T		Unforced Capacity (UCAP)	MW			538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
U		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
V		Nox Emission Rate	lbs/MMBtu			[redacted]																									
W		Annual Variable O&M	$/MMBtu																												
X			$/MWh																												
Y		Heat Rate	Btu/kWh			10,516	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 20 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO2	lbs/MMBtu	208.76		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	48.12	1.00	
		Installed Capacity (ICAP) Increase	MW	9.70	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,704.8		not used in any calcs but rather included as a reference point

				2013	
		Discount Year			
		Discount Rate		6.60%	Multiplier
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00
F		CO2 Credit Cost	$/ton		
G		NOx Credit Cost	$/ton		
H		Capacity Market	$/kw-yr		1.00
I		Forced Outage Rate	%		
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00
K		Scheduled Maintenance	Weeks		
		Installed Capacity (ICAP)	MW		
L		Unforced Capacity (UCAP)	MW		
M		Operating Capacity	MW		
N		Nox Emission Rate	lbs/MMBtu		
O		Annual Variable O&M	$/MMBtu		
P			$/MWh		
Q		Heat Rate	Btu/kWh		
R	ALTERNATIVE Unit Assumptions WITHOUT upgrades	Capital Rev Req Turbine & Mills	$millions		1.00
S		Scheduled Maintenance	Weeks		
		Installed Capacity (ICAP)			
T		Unforced Capacity (UCAP)	MW		
U		Operating Capacity	MW		
V		Nox Emission Rate	lbs/MMBtu		
W		Annual Variable O&M	$/MMBtu		
X			$/MWh		
Y		Heat Rate	Btu/kWh		

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
D	[redacted]																									
E	[redacted]																									
F										$ 16.07	$ 17.37	$ 18.78	$ 20.31	$ 21.96	$ 23.74	$ 25.67	$ 27.75	$ 30.01	$ 32.44	$ 35.07	$ 37.92	$ 41.00	$ 44.33	$ 47.93	$ 51.83	$ 56.03
G																										
H				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	$ 0.13	$ 0.71	$ 1.81	$ 10.30	$ 12.43	$ 11.93	$ 11.40	$ 10.88	$ 10.38	$ 9.89	$ 8.42	$ 8.06	$ 8.53	$ 8.54	$ 8.28	$ 7.84	$ 7.39	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 5.00	$ 5.20
K	7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	3	5	5	5	5	8	5	5
	557	559	553	552	563	563	563	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
L	536	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
M	513	507	507	595	595	555	552	552	552	552	552	552	552	552	552	552	552	553	552	552	552	552	552	552	552	552
N	0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
O	[redacted]																									
P																										
Q	10,518	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
R	$ 0.11	$ 0.26	$ 2.49	$ 3.75	$ 3.79	$ 3.84	$ 3.88	$ 3.92	$ 3.99	$ 4.24	$ 4.39	$ 4.42	$ 4.40	$ 4.38	$ 4.35	$ 4.33	$ 4.66	$ 5.61	$ 4.98	$ 4.85	$ 4.95	$ 4.99	$ 5.09	$ 6.87	$ 7.42	$ 2.72
S	7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	8	5	5	8	5	5
	557	559	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
T	536	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
U	513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
V	0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
W	[redacted]																									
X																										
Y	10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 21 **Appendix B, Schedule 3 - Economic Modeling Input Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

SOURCE ID			Units		Multiplier	
A	Unit Assumptions	Unit Operating Factor	%	90%	1.00	capacity factor when unit is available (aka operating factor)
B		Emission Rate CO	lbs/MMBtu	208.76		
C		Emission Rate NOx	lbs/MMBtu	0.127		
	Unit Improvement Assumptions	Operating Capacity Increase	MW	48.12	1.00	
		Installed Capacity (ICAP) Increase	MW	9.70	1.00	
		Heat Rate Improvement	Btu/kWh	441	1.00	
		Emission Rate NOx Improvement	%	10%		
		Emission LIMIT - NOx, Tons	tons	2,704.6		not used in any calcs but rather included as a reference point

						2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
		Discount Year		2013																											
		Discount Rate		8.20%	Multiplier																										
D	Common Unit and Market Assumptions	Average MISO Energy Price	$/MWh		1.00	[redacted]																									
E		$/MMBtu Delivered Fuel Cost	$/MMBtu		1.00																										
F		CO2 Credit Cost	$/ton												$ 16.07	$ 17.37	$ 18.79	$ 20.31	$ 21.96	$ 23.74	$ 25.67	$ 27.75	$ 30.01	$ 32.44	$ 35.07	$ 37.92	$ 41.00	$ 44.33	$ 47.93	$ 51.82	$ 56.03
G		NOx Credit Cost	$/ton																												
H		Capacity Market	$/kw-yr		1.00				$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19	$ 49.19
I		Forced Outage Rate	%			3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
J	PROJECT Unit Assumptions WITH Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.13	$ 0.71	$ 1.81	$ 10.39	$ 12.43	$ 11.93	$ 11.40	$ 10.88	$ 10.38	$ 8.89	$ 8.42	$ 8.00	$ 8.53	$ 8.54	$ 8.28	$ 7.84	$ 7.39	$ 6.95	$ 6.51	$ 6.08	$ 5.65	$ 5.23	$ 4.82	$ 6.02	$ 5.60	$ 5.20
K		Scheduled Maintenance	Weeks			7	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)	MW			557	558	553	553	563	563	563	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
L		Unforced Capacity (UCAP)	MW			538	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
M		Operating Capacity	MW			513	507	507	555	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
N		New Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
O		Annual Variable O&M	$/MMBtu			[redacted]																									
P			$/MWh																												
Q		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
R	ALTERNATIVE Unit Assumptions WITHOUT Upgrades	Capital Rev Req Turbine & Mills	$millions		1.00	$ 0.11	$ 0.20	$ 2.49	$ 3.78	$ 3.70	$ 3.64	$ 3.58	$ 3.92	$ 3.65	$ 4.24	$ 4.38	$ 4.42	$ 4.40	$ 4.38	$ 4.35	$ 4.33	$ 4.86	$ 5.01	$ 4.98	$ 4.95	$ 4.95	$ 4.99	$ 5.08	$ 6.87	$ 7.42	$ 7.77
S		Scheduled Maintenance	Weeks			7	5	15	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	5
		Installed Capacity (ICAP)				557	559	553	553	553	553	553	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551	551
T		Unforced Capacity (UCAP)	MW			538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
U		Operating Capacity	MW			513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
V		New Emission Rate	lbs/MMBtu			0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
W		Annual Variable O&M	$/MMBtu			[redacted]																									
X			$/MWh																												
Y		Heat Rate	Btu/kWh			10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560

Case 1 — Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information Is Highlighted in Gray

			Source on Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
		Capacity Factor	A, I, K	%		77%	73%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,259	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,799)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (298)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,259	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Full Load Heat Rate	Q	Btu/kWh		10,698	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	34.7	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,250**																							
		$/MMBtu VO&M Cost	O	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 81**																							
		NOx Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,586	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	218.52	219.52	219.52	219.52	219.52	219.52	219.52	218.52	219.52	218.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.81	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds / Revenue Requirements	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 8.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.6	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.6	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.6
		Capital Rev Req Turbine & Mills		$million/yr		$ 0.1	$ 0.4	$ 1.2	$ 4.3	$ 13.2	$ 12.8	$ 12.2	$ 11.6	$ 11.1	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5	$ 8.6	$ 8.3	$ 7.8	$ 7.3	$ 6.8	$ 6.4	$ 5.9	$ 5.5	$ 4.7
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.5	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 717.4**	**$ 28.6**	**$ 76.9**	**$ 77.7**	**$ 79.8**	**$ 85.4**	**$ 82.9**	**$ 80.3**	**$ 77.9**	**$ 75.1**	**$ 72.8**	**$ 70.3**	**$ 68.0**	**$ 65.7**	**$ 63.5**	**$ 62.0**	**$ 60.1**	**$ 58.1**	**$ 56.2**	**$ 54.6**	**$ 62.7**	**$ 60.2**	**$ 47.1**	**$ 38.1**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 154.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 2

Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Source on Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
		Capacity Factor	A, I, K	%		77%	73%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Average MISO Energy Price	D	$/MWhr		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,799)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		528	527	529	527	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (206)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	2,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Full Load Heat Rate	Q	Btu/kWh		10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	34.7	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,250**																							
		$/MMBtu VO&M Cost	D	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 81**																							
		NOx Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,586	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.81	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds / Revenue Requirements / Fixed O&M	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
		Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.5	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.5	$ 1.3	$ 4.7	$ 14.5	$ 14.1	$ 13.4	$ 12.8	$ 12.2	$ 11.6	$ 11.0	$ 10.4	$ 9.8	$ 9.4	$ 9.5	$ 9.1	$ 8.6	$ 8.1	$ 7.5	$ 7.0	$ 6.5	$ 6.0	$ 5.1
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.6	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 725.0**	**$ 28.6**	**$ 76.9**	**$ 77.8**	**$ 79.2**	**$ 86.8**	**$ 84.2**	**$ 81.4**	**$ 78.7**	**$ 76.2**	**$ 73.7**	**$ 71.3**	**$ 68.9**	**$ 66.6**	**$ 64.4**	**$ 62.8**	**$ 60.9**	**$ 59.9**	**$ 57.0**	**$ 55.3**	**$ 53.3**	**$ 50.7**	**$ 47.7**	**$ 38.8**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.9
		Fixed O&M adder CAMP Study and CA Development		$million/yr		0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 154.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.9**

Case 3 — Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Contidential information is Highlighted in Gray

			Source on input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
		Capacity Factor	A, J, K	%		77%	73%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%	77%	77%	77%	77%	77%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,799)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (200)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (26.7)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Full Load Heat Rate	Q	Btu/kWh		10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	34.7	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,250**																							
		$/MMBtu VO&M Cost	D	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 81**																							
		NOx Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,589	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.81	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.8	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.4	$ 1.1	$ 3.8	$ 11.9	$ 11.5	$ 11.0	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5	$ 8.1	$ 7.7	$ 7.8	$ 7.5	$ 7.0	$ 6.6	$ 6.2	$ 5.7	$ 5.3	$ 4.9	$ 4.2
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.6	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 709.9**	**$ 28.6**	**$ 76.8**	**$ 77.5**	**$ 78.3**	**$ 84.1**	**$ 81.6**	**$ 79.0**	**$ 76.4**	**$ 74.0**	**$ 71.6**	**$ 69.2**	**$ 67.0**	**$ 64.8**	**$ 62.7**	**$ 61.1**	**$ 59.2**	**$ 57.3**	**$ 55.5**	**$ 53.9**	**$ 52.0**	**$ 49.6**	**$ 46.6**	**$ 37.5**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 154.0**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 4 **Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Additional information is highlighted in Grey

			Source on Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
		Capacity Factor	A, J, K	%		77%	73%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,799)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		526	537	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (208)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Full Load Heat Rate	G	Btu/kWh		10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
		MMBtu Fuel Burn	calc	Million MMBtu		[redacted]																						
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu																								
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,250**																							
		$/MMBtu VO&M Cost	D	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 81**																							
		NOx Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,586	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.81	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds / Revenue Requirements / Fixed O&M	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 8.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 4.4	$ 4.5	$ 2.4	$ 0.3
		Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.9	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.2	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills		$million/yr		$ 0.1	$ 0.4	$ 1.2	$ 4.3	$ 13.2	$ 12.8	$ 12.2	$ 11.6	$ 11.1	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5	$ 8.6	$ 8.3	$ 7.8	$ 7.3	$ 6.8	$ 6.4	$ 5.9	$ 5.5	$ 4.7
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.6	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 717.4**	**$ 28.6**	**$ 76.9**	**$ 77.7**	**$ 78.8**	**$ 85.4**	**$ 82.9**	**$ 80.2**	**$ 77.6**	**$ 75.1**	**$ 72.5**	**$ 70.3**	**$ 68.0**	**$ 65.7**	**$ 63.5**	**$ 62.0**	**$ 60.1**	**$ 59.1**	**$ 56.2**	**$ 54.8**	**$ 52.7**	**$ 50.2**	**$ 47.1**	**$ 38.1**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 20.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 164.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 20.5**

Case 5 Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Source on input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
		Capacity Factor	A, J, K	%		77%	73%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,799)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (209)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Full Load Heat Rate	O	Btu/kWh		10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	34.7	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,250**																							
		$/MMBtu VO&M Cost	O	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 81**																							
		NOx Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,586	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.81	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 8.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
	Fixed O&M	Capital Rev Req SunK/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.9	$ 8.0	$ 8.8	$ 9.5	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.2	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.4	$ 1.2	$ 4.3	$ 13.2	$ 12.8	$ 12.2	$ 11.6	$ 11.1	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5	$ 8.0	$ 8.3	$ 7.8	$ 7.3	$ 6.8	$ 6.4	$ 5.9	$ 5.5	$ 4.7
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.5	$ 56.9	$ 54.3	$ 51.6	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 717.4**	**$ 28.6**	**$ 76.9**	**$ 77.7**	**$ 78.8**	**$ 85.4**	**$ 82.9**	**$ 80.2**	**$ 77.0**	**$ 75.1**	**$ 72.6**	**$ 70.3**	**$ 68.0**	**$ 65.7**	**$ 63.5**	**$ 62.0**	**$ 60.1**	**$ 58.1**	**$ 56.2**	**$ 54.6**	**$ 52.7**	**$ 50.3**	**$ 47.1**	**$ 38.1**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 23.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 154.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 23.5**

Case 6 Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Source on input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	508	555	555	555	559	559	555	555	555	555	555	555	555	555	555	555	559	559	555	555
		Capacity Factor	A, J, K	%		77%	73%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Average MSO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,799)**																							
	CAPACITY MARKET VALUE	Resource Capacity	L	MW		526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (206)**	**$ -**	**$ -**	**$ -**	**$ (26.7)**	**$ (26.7)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Full Load Heat Rate	G	Btu/kWh		10,658	10,676	10,676	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	34.6	35.2	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	35.2	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,246**																							
		$/MMBtu VO&M Cost	D	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 80**																							
		NOx Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,575	2,360	2,532	2,532	2,532	2,532	2,532	2,532	2,532	2,532	2,532	2,360	2,532	2,532	2,532	2,532	2,532	2,532	2,532	2,532
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.07	3.81	3.99	3.80	3.87	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	3.87	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 8.3	$ 6.1	$ 6.2	$ 8.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 8.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.5	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 8.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.4	$ 1.2	$ 4.3	$ 13.2	$ 12.8	$ 12.2	$ 11.6	$ 11.1	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5	$ 8.6	$ 8.3	$ 7.8	$ 7.3	$ 6.8	$ 6.4	$ 5.9	$ 5.5	$ 4.7
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 717.4**	**$ 29.6**	**$ 76.9**	**$ 77.7**	**$ 78.8**	**$ 85.4**	**$ 82.9**	**$ 80.2**	**$ 77.6**	**$ 75.1**	**$ 72.6**	**$ 70.3**	**$ 68.0**	**$ 65.7**	**$ 63.5**	**$ 63.0**	**$ 60.1**	**$ 58.1**	**$ 56.2**	**$ 54.0**	**$ 52.7**	**$ 50.3**	**$ 47.1**	**$ 38.1**
		Fixed O&M		$million/yr		$ 8.8	$ 17.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 154.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.3**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 7	Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology) Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Source on Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
		Capacity Factor	A 1 K	%		77%	73%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,799)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		526	507	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (206)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Full Load Heat Rate	Q	Btu/kWh		10,658	10,576	10,676	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	34.9	35.5	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	35.5	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,255**																							
		$/MMBtu VO&M Cost	O	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 81**																							
		NOx Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,597	2,381	2,554	2,554	2,554	2,554	2,554	2,554	2,554	2,554	2,554	2,381	2,554	2,554	2,554	2,554	2,554	2,554	2,554	2,554
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.83	3.90	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	3.90	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds Revenue Requirements Fixed O&M	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 3.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.6	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
		Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.6	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.6	$ 18.5
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.4	$ 1.2	$ 4.3	$ 13.2	$ 12.8	$ 12.2	$ 11.6	$ 11.1	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5	$ 8.6	$ 8.3	$ 7.8	$ 7.3	$ 6.8	$ 6.4	$ 5.9	$ 5.5	$ 4.7
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 717.4**	**$ 28.6**	**$ 78.3**	**$ 77.7**	**$ 78.8**	**$ 85.4**	**$ 82.9**	**$ 80.2**	**$ 77.6**	**$ 75.1**	**$ 72.6**	**$ 70.3**	**$ 68.0**	**$ 65.7**	**$ 63.5**	**$ 62.0**	**$ 60.1**	**$ 58.1**	**$ 56.2**	**$ 54.6**	**$ 52.7**	**$ 50.2**	**$ 47.1**	**$ 38.1**
		Fixed O&M		$million/yr		$ 6.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 154.9**	**$ 6.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.8**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 8 Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Source on input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	508	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
		Capacity Factor	A, J, K	%		77%	73%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	72%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,496	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,496	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,811)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		526	527	522	522	522	539	539	539	539	539	539	539	539	539	539	539	539	539	539	539	539	539	539
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (209)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (26.5)**	**$ (26.5)**	**$ (26.5)**	**$ (26.5)**	**$ (26.5)**	**$ (26.5)**	**$ (26.5)**	**$ (26.5)**	**$ (26.5)**	**$ (26.5)**	**$ (26.5)**	**$ (26.5)**	**$ (26.5)**	**$ (26.5)**	**$ (26.5)**	**$ (26.5)**	**$ (26.5)**	**$ (26.5)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,496	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,496	3,751	3,751	3,751	3,751	3,751	3,751	3,751	3,751
		Full Load Heat Rate	Q	Btu/kWh		10,635	10,675	10,675	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	34.7	35.7	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	35.7	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,259**																							
		$/MMBtu VO&M Cost	O	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 81**																							
		NOx Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,586	2,391	2,565	2,565	2,565	2,565	2,565	2,565	2,565	2,565	2,565	2,391	2,565	2,565	2,565	2,565	2,565	2,565	2,565	2,565
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.81	3.92	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	3.92	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds / Revenue Requirements / Fixed O&M	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 8.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
		Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.2	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.4	$ 1.2	$ 4.3	$ 13.2	$ 12.8	$ 12.2	$ 11.6	$ 11.1	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5	$ 8.6	$ 8.3	$ 7.8	$ 7.3	$ 6.8	$ 6.4	$ 5.9	$ 5.5	$ 4.7
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.8	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 717.4**	**$ 28.6**	**$ 76.9**	**$ 77.7**	**$ 78.8**	**$ 85.4**	**$ 82.9**	**$ 80.2**	**$ 77.6**	**$ 75.1**	**$ 72.6**	**$ 70.3**	**$ 68.0**	**$ 65.7**	**$ 63.6**	**$ 62.0**	**$ 60.1**	**$ 59.1**	**$ 56.2**	**$ 54.6**	**$ 52.7**	**$ 50.2**	**$ 47.1**	**$ 38.1**
		Fixed O&M		$million/yr		$ 6.8	$ 12.0	$ 11.9	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 164.9**	**$ 6.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 9 Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Source on Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	568	568	568	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550
		Capacity Factor	A, J, K	%		77%	73%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,437	3,688	3,688	3,688	3,688	3,688	3,688	3,688	3,688	3,688	3,437	3,688	3,688	3,688	3,688	3,688	3,688	3,688	3,688
		Average MISO Energy Price	O	$/MWhr																								
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,785)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		526	527	522	522	522	536	536	536	536	536	539	536	536	539	535	536	535	536	536	536	536	536	536
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (205)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (26.7)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,437	3,688	3,688	3,688	3,688	3,688	3,688	3,688	3,688	3,688	3,437	3,688	3,688	3,688	3,688	3,688	3,688	3,688	3,688
		Full Load Heat Rate	Q	Btu/kWh		10,656	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
		MMBtu Fuel Burn	calc	Mbpo MMBtu		36,7	34,7	36,3	34,7	35,1	37,6	37,6	37,6	37,6	37,6	37,6	37,6	37,6	37,6	35,1	37,6	37,6	37,6	37,6	37,6	37,6	37,6	37,6
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu																								
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,242**																							
		$/MMBtu VO&M Cost	D	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 80**																							
		NOx Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,586	2,350	2,521	2,521	2,521	2,521	2,521	2,521	2,521	2,521	2,521	2,350	2,521	2,521	2,521	2,521	2,521	2,521	2,521	2,521
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	210.52	210.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.81	3.85	4.13	4.13	4.13	4.13	4.13	4.13	4.13	4.13	4.13	3.85	4.13	4.13	4.13	4.13	4.13	4.13	4.13	4.13
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 17.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.9	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.8	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.4	$ 1.2	$ 4.3	$ 13.2	$ 12.9	$ 12.2	$ 11.6	$ 11.1	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5	$ 8.6	$ 8.3	$ 7.8	$ 7.3	$ 6.8	$ 6.4	$ 5.9	$ 5.5	$ 4.7
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.6	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 717.4**	**$ 28.6**	**$ 76.9**	**$ 77.7**	**$ 78.8**	**$ 85.4**	**$ 82.9**	**$ 80.2**	**$ 77.5**	**$ 75.1**	**$ 72.4**	**$ 70.3**	**$ 68.0**	**$ 65.7**	**$ 63.5**	**$ 62.0**	**$ 60.1**	**$ 58.1**	**$ 56.2**	**$ 54.5**	**$ 52.7**	**$ 50.2**	**$ 47.1**	**$ 38.1**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 184.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 10 Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Source on Input Page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	568	568	568	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
		Capacity Factor	A, J, K	%		84%	80%	84%	84%	78%	84%	84%	84%	84%	84%	84%	84%	84%	84%	78%	84%	84%	84%	84%	84%	84%	84%	84%
		Energy Production	calc	GWh		3,785	3,575	3,744	3,744	3,814	4,091	4,091	4,091	4,091	4,091	4,091	4,091	4,091	4,091	3,814	4,091	4,091	4,091	4,091	4,091	4,091	4,091	4,091
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,979)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (209)**	**$ -**	**$ -**	**$ -**	**$ (26.7)**	**$ (26.7)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**
	PRODUCTION COST	Energy Production	calc	GWh		3,785	3,575	3,744	3,744	3,814	4,091	4,091	4,091	4,091	4,091	4,091	4,091	4,091	4,091	3,814	4,091	4,091	4,091	4,091	4,091	4,091	4,091	4,091
		Full Load Heat Rate	Q	Btu/kWh		10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
		MMBtu Fuel Burn	calc	Million MMBtu		40.1	38.2	40.0	38.2	38.9	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	38.9	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,375**																							
		$/MMBtu VO&M Cost	O	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 88**																							
		NO_x Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NO_x emissions	calc	tons/yr		3,001	2,842	2,970	2,844	2,607	2,797	2,797	2,797	2,797	2,797	2,797	2,797	2,797	2,797	2,607	2,797	2,797	2,797	2,797	2,797	2,797	2,797	2,797
		NO_x Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NO_x Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO_2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	210.52	219.52	219.52	219.52	219.52	219.52	219.52	218.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO_2 emissions	calc	million tons/yr		4.43	4.18	4.39	4.19	4.27	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.27	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58
		CO_2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO_2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OSC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.5	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.1	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 6.3	$ 4.5	$ 2.4	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.8	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.4	$ 1.2	$ 4.3	$ 13.2	$ 12.8	$ 12.2	$ 11.6	$ 11.1	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5	$ 8.0	$ 8.3	$ 7.8	$ 7.3	$ 6.8	$ 6.4	$ 5.9	$ 5.5	$ 4.7
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.6	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 717.4**	**$ 28.6**	**$ 76.9**	**$ 77.7**	**$ 78.8**	**$ 85.4**	**$ 82.9**	**$ 80.2**	**$ 77.6**	**$ 75.1**	**$ 72.5**	**$ 70.1**	**$ 68.0**	**$ 65.7**	**$ 63.5**	**$ 62.0**	**$ 60.1**	**$ 58.1**	**$ 56.2**	**$ 54.6**	**$ 52.7**	**$ 50.2**	**$ 47.1**	**$ 38.1**
		Fixed O&M		$million/yr		$ 8.6	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 154.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 11 Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Source on input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
		Capacity Factor	A, J, K	%		69%	66%	69%	69%	64%	69%	69%	69%	69%	69%	69%	69%	69%	69%	64%	69%	69%	69%	69%	69%	69%	69%	69%
		Energy Production	calc	GWh		3,097	2,925	3,063	3,063	3,120	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,120	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,347
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,620)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (208)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**
	PRODUCTION COST	Energy Production	calc	GWh		3,097	2,925	3,063	3,063	3,120	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,120	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,347
		Full Load Heat Rate	Q	Btu/kWh		10,656	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
		MMBtu Fuel Burn	calc	Million MMBtu		33.0	31.2	31.2	31.3	31.8	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	31.8	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,125**																							
		$/MMBtu VO&M Cost	O	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 73**																							
		NOx Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,458	2,325	2,435	2,327	2,133	2,289	2,289	2,289	2,289	2,289	2,289	2,289	2,289	2,289	2,133	2,289	2,289	2,289	2,289	2,289	2,289	2,289	2,289
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		3.62	3.43	3.59	3.43	3.49	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.49	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 6.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.4	$ 1.2	$ 4.3	$ 13.2	$ 12.8	$ 12.2	$ 11.6	$ 11.1	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5	$ 8.0	$ 8.3	$ 7.8	$ 7.3	$ 6.8	$ 6.4	$ 5.9	$ 5.5	$ 4.7
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.6	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 717.4**	**$ 28.6**	**$ 76.9**	**$ 77.7**	**$ 78.8**	**$ 85.4**	**$ 82.9**	**$ 80.2**	**$ 77.6**	**$ 75.1**	**$ 72.6**	**$ 70.3**	**$ 68.0**	**$ 65.7**	**$ 63.5**	**$ 62.0**	**$ 60.1**	**$ 58.1**	**$ 56.2**	**$ 54.6**	**$ 52.7**	**$ 50.2**	**$ 47.1**	**$ 38.1**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 164.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 12 — Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Commercial Information is Highlighted in Gray

			Source on input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
		Capacity Factor	A, J, K	%		77%	79%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,799)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		526	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
		Capacity Value	H	$/MW-yr					98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380
		Annual Capacity Value	**calc**	**$million/yr**	**$ (411)**	**$ -**	**$ -**	**$ -**	**$ (51.7)**	**$ (51.7)**	**$ (52.9)**	**$ (52.9)**	**$ (52.9)**	**$ (52.9)**	**$ (52.9)**	**$ (52.9)**	**$ (52.9)**	**$ (52.9)**	**$ (52.9)**	**$ (52.9)**	**$ (52.9)**	**$ (52.9)**	**$ (52.9)**	**$ (52.9)**	**$ (52.9)**	**$ (52.9)**	**$ (52.9)**	**$ (52.9)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Full Load Heat Rate	O	Btu/kWh		10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	34.7	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,250**																							
		$/MMBtu VO&M Cost	O	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 81**																							
		NOx Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,586	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.81	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds / Revenue Requirements / Fixed O&M	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 8.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
		Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.4	$ 1.2	$ 4.3	$ 13.2	$ 12.8	$ 12.2	$ 11.6	$ 11.1	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5	$ 8.6	$ 8.3	$ 7.8	$ 7.3	$ 6.8	$ 6.4	$ 5.8	$ 5.5	$ 4.7
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.8	$ 15.6	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 717.4**	**$ 28.9**	**$ 76.9**	**$ 77.7**	**$ 78.8**	**$ 85.4**	**$ 82.9**	**$ 80.2**	**$ 77.8**	**$ 75.1**	**$ 72.4**	**$ 70.3**	**$ 68.0**	**$ 65.7**	**$ 63.5**	**$ 62.0**	**$ 60.1**	**$ 58.1**	**$ 56.2**	**$ 54.6**	**$ 52.7**	**$ 50.2**	**$ 47.1**	**$ 38.1**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 154.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 13 Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

			Source on Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
		Capacity Factor	A J K	%		77%	73%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,799)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
		Capacity Value	H	$/MW-yr		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Annual Capacity Value	**calc**	**$million/yr**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Full Load Heat Rate	Q	Btu/kWh		10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	34.7	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,250**																							
		$/MMBtu VO&M Cost	Q	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 81**																							
		NOx Emission Rate	N	lb/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,586	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lb/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	218.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.81	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 8.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.6	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.4	$ 1.2	$ 4.3	$ 13.2	$ 12.8	$ 12.2	$ 11.6	$ 11.1	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5	$ 8.6	$ 8.3	$ 7.8	$ 7.3	$ 6.8	$ 6.4	$ 5.9	$ 5.5	$ 4.7
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.5	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.1	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.6	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 717.4**	**$ 28.5**	**$ 76.9**	**$ 77.7**	**$ 79.8**	**$ 85.4**	**$ 82.9**	**$ 80.2**	**$ 77.6**	**$ 75.1**	**$ 72.6**	**$ 70.3**	**$ 68.0**	**$ 65.7**	**$ 63.5**	**$ 62.0**	**$ 60.1**	**$ 58.1**	**$ 56.2**	**$ 54.6**	**$ 52.7**	**$ 50.2**	**$ 47.1**	**$ 38.1**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 154.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 14 Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

			Source on input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
		Capacity Factor	A, I, K	%		77%	73%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (2,249)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (206)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Full Load Heat Rate	Q	Btu/kWh		10,655	10,676	10,676	10,293	10,293	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	34.7	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,250**																							
		$/MMBtu VO&M Cost	O	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 81**																							
		NOx Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,731	2,583	2,700	2,586	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.81	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 8.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 29.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
	Revenue Requirements	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 8.6	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.4	$ 1.2	$ 4.3	$ 13.2	$ 12.8	$ 12.2	$ 11.8	$ 11.1	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5	$ 8.6	$ 8.3	$ 7.8	$ 7.3	$ 6.8	$ 6.4	$ 5.9	$ 5.5	$ 4.7
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 51.0	$ 59.6	$ 58.8	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 717.4**	**$ 26.6**	**$ 76.9**	**$ 77.7**	**$ 78.8**	**$ 85.4**	**$ 82.8**	**$ 80.2**	**$ 77.6**	**$ 75.1**	**$ 72.5**	**$ 70.3**	**$ 68.0**	**$ 65.7**	**$ 63.5**	**$ 62.0**	**$ 60.1**	**$ 58.1**	**$ 56.2**	**$ 54.6**	**$ 52.7**	**$ 50.2**	**$ 47.1**	**$ 38.1**
	Fixed O&M	Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.8	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 154.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 15 Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

			Source on Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
		Capacity Factor	A, J, K	%		77%	73%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Average MSO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,350)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (208)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Full Load Heat Rate	Q	Btu/kWh		10,658	10,678	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	34.7	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,250**																							
		$/MMBtu VO&M Cost	O	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 81**																							
		NOx Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,556	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.81	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds / Revenue Requirements / Fixed O&M	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 19.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
		Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.5	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.4	$ 1.2	$ 4.3	$ 13.2	$ 12.8	$ 12.2	$ 11.6	$ 11.1	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5	$ 8.6	$ 8.3	$ 7.8	$ 7.3	$ 6.8	$ 6.4	$ 5.9	$ 5.5	$ 4.7
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 717.4**	**$ 28.6**	**$ 76.9**	**$ 77.7**	**$ 79.8**	**$ 85.4**	**$ 82.9**	**$ 80.2**	**$ 77.0**	**$ 75.1**	**$ 72.6**	**$ 70.3**	**$ 68.0**	**$ 65.7**	**$ 63.3**	**$ 62.0**	**$ 60.1**	**$ 58.1**	**$ 56.2**	**$ 54.6**	**$ 52.7**	**$ 50.2**	**$ 47.1**	**$ 38.1**
		Fixed O&M		$million/yr		$ 8.8	$ 12.9	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 154.9**	**$ 8.9**	**$ 16.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 16 Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

			Source on input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
		Capacity Factor	R, T, R	%		77%	73%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,799)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (206)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Full Load Heat Rate	Q	Btu/kWh		10,658	10,676	10,676	10,293	10,293	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	34.7	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,563**																							
		$/MMBtu VO&M Cost	Q	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 81**																							
		NOx Emission Rate	N	lb/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,731	2,563	2,706	2,566	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lb/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.81	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 8.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 150.6	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
	Revenue Requirements	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 18.5
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.4	$ 1.2	$ 4.3	$ 13.2	$ 12.8	$ 12.2	$ 11.6	$ 11.1	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5	$ 8.5	$ 8.3	$ 7.8	$ 7.3	$ 6.8	$ 6.4	$ 5.9	$ 5.5	$ 4.7
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 58.6	$ 56.6	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.6	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 717.4**	**$ 28.8**	**$ 76.9**	**$ 77.7**	**$ 78.3**	**$ 85.4**	**$ 82.9**	**$ 80.2**	**$ 77.6**	**$ 75.1**	**$ 72.6**	**$ 70.2**	**$ 68.0**	**$ 65.7**	**$ 63.5**	**$ 62.0**	**$ 60.1**	**$ 58.1**	**$ 56.2**	**$ 54.5**	**$ 52.7**	**$ 50.2**	**$ 47.1**	**$ 38.1**
	Fixed O&M	Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.6
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 154.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.6**

Case 17 **Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Source on Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
		Capacity Factor	A, J, K	%		77%	73%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Average MSO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,799)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		520	537	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (206)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Full Load Heat Rate	Q	Btu/kWh		10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
		MMBtu Fuel Burn	calc	Milion MMBtu		36.7	34.7	36.3	34.7	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 938**																							
		$/MMBtu VO&M Cost	G	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 81**																							
		NOx Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,589	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.81	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 8.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.1	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.4	$ 1.2	$ 4.3	$ 13.2	$ 12.8	$ 12.3	$ 11.6	$ 11.1	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5	$ 8.6	$ 8.3	$ 7.8	$ 7.3	$ 6.8	$ 6.4	$ 5.9	$ 5.5	$ 4.7
		Capital Rev Req CACP		$million/yr		$ 13.8	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.2	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 717.4**	**$ 28.6**	**$ 76.9**	**$ 77.7**	**$ 78.8**	**$ 85.4**	**$ 82.9**	**$ 80.2**	**$ 77.6**	**$ 75.1**	**$ 72.6**	**$ 70.2**	**$ 68.0**	**$ 65.7**	**$ 63.5**	**$ 62.0**	**$ 60.1**	**$ 58.1**	**$ 56.2**	**$ 54.6**	**$ 52.7**	**$ 50.2**	**$ 47.1**	**$ 38.1**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.9	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 154.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 18 — Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Contractual Information is Highlighted in Gray

			Source on Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	508	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550
		Capacity Factor	A, J, K	%		69%	66%	69%	69%	64%	69%	69%	69%	69%	69%	69%	69%	69%	69%	64%	69%	69%	69%	69%	69%	69%	69%	69%
		Energy Production	calc	GWh		3,097	2,925	3,063	3,063	3,094	3,319	3,319	3,319	3,319	3,319	3,319	3,319	3,319	3,319	3,094	3,319	3,319	3,319	3,319	3,319	3,319	3,319	3,319
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,207)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW	-	526	527	522	522	572	536	536	536	536	536	536	536	536	536	536	536	536	536	536	536	536	536	536
		Capacity Value	H	$/MW-yr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Annual Capacity Value	**calc**	**$million/yr**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	PRODUCTION COST	Energy Production	calc	GWh		3,097	2,925	3,063	3,063	3,094	3,319	3,319	3,319	3,319	3,319	3,319	3,319	3,319	3,319	3,094	3,319	3,319	3,319	3,319	3,319	3,319	3,319	3,319
		Full Load Heat Rate	Q	Btu/kWh		10,658	10,679	10,678	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247	10,247
		MMBtu Fuel Burn	calc	Million MMBtu		33.0	31.2	32.7	31.4	31.7	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	31.7	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,402**																							
		$/MMBtu VO&M Cost	D	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 72**																							
		NOx Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,458	2,325	2,430	2,337	2,124	2,279	2,279	2,279	2,279	2,279	2,279	2,279	2,279	2,279	2,124	2,279	2,279	2,279	2,279	2,279	2,279	2,279	2,279
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		3.62	3.43	3.59	3.45	3.48	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.48	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 8.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 8.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.9
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.1	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.5	$ 1.3	$ 4.7	$ 14.5	$ 14.1	$ 13.4	$ 12.8	$ 12.2	$ 11.6	$ 11.0	$ 10.4	$ 9.8	$ 9.4	$ 9.5	$ 9.1	$ 8.6	$ 8.1	$ 7.5	$ 7.0	$ 6.5	$ 6.0	$ 5.1
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 725.0**	**$ 28.6**	**$ 76.9**	**$ 77.8**	**$ 79.2**	**$ 86.8**	**$ 84.2**	**$ 81.4**	**$ 78.7**	**$ 76.2**	**$ 73.7**	**$ 71.1**	**$ 68.9**	**$ 66.0**	**$ 64.4**	**$ 62.3**	**$ 60.9**	**$ 59.9**	**$ 57.0**	**$ 55.3**	**$ 53.3**	**$ 50.7**	**$ 47.7**	**$ 38.6**
		Fixed O&M		$million/yr		$ 6.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 154.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 19

Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

UNIT 1 PROJECT

Group	Item	Source on Input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	508	560	560	560	560	560	560	560	560
	Capacity Factor	A, I, K	%		84%	80%	84%	84%	78%	84%	84%	84%	84%	84%	84%	84%
	Energy Production	calc	GWh		[redacted]											
	Average MISO Energy Price	D	$/MWh		[redacted]											
	Annual Energy Revenue	calc	$million/yr	$ (2,490)	[redacted]											
CAPACITY MARKET VALUE	Reserve Capacity	L	MW		[redacted]											
	Capacity Value	H	$/MW-yr		-	-	-	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380
	Annual Capacity Value	calc	$million/yr	$ (412)	$ -	$ -	$ -	$ (51.3)	$ (51.3)	$ (53.0)	$ (53.0)	$ (53.0)	$ (53.0)	$ (53.0)	$ (53.0)	$ (53.0)
PRODUCTION COST	Energy Production	calc	GWh		3,785	3,575	3,744	3,744	3,846	4,126	4,126	4,126	4,126	4,126	4,126	4,126
	Full Load Heat Rate	O	Btu/kWh		10,658	10,676	10,676	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159
	MMBtu Fuel Burn	calc	Million MMBtu		[redacted]											
	$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]											
	Annual Fuel Cost	calc	$Million/yr	$ 1,035	[redacted]											
	$/MMBtu VO&M Cost	O	$/MMBtu		[redacted]											
	Annual VO&M Cost	calc		$ 89	[redacted]											
	NOx Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
	NOx emissions	calc	tons/yr		3,004	2,942	2,970	2,832	2,618	2,809	2,809	2,809	2,809	2,809	2,809	2,809
	NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
	CO2 emissions	calc	million tons/yr		4.43	4.19	4.39	4.17	4.29	4.60	4.60	4.60	4.60	4.60	4.60	4.60
	CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds / Revenue Requirements / Fixed O&M	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9
	Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9
	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0
	Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4
	Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.4	$ 1.1	$ 3.8	$ 11.9	$ 11.5	$ 11.0	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5
	Capital Rev Req CACP		$million/yr		$ 13.0	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0
	Capital Rev Req Total		$million/yr	$ 709.9	$ 28.6	$ 76.8	$ 77.5	$ 78.3	$ 84.1	$ 81.6	$ 79.0	$ 76.4	$ 74.0	$ 71.6	$ 69.3	$ 67.0
	Fixed O&M		$million/yr		$ 6.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5
	Fixed O&M adder CAMP Study and CA Development		$million/yr		0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	TOTAL Fixed O&M		$million/yr	$ 164.9	$ 6.9	$ 15.3	$ 11.9	$ 12.2	$ 13.0	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5

Group	Item	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
ENERGY REVENUE	Rated Capacity	560	560	560	560	560	560	560	560	560	560	560
	Capacity Factor	84%	84%	78%	84%	84%	84%	84%	84%	84%	84%	84%
	Energy Production	[redacted]										
	Average MISO Energy Price	[redacted]										
	Annual Energy Revenue	[redacted]										
CAPACITY MARKET VALUE	Reserve Capacity	[redacted]										
	Capacity Value	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380
	Annual Capacity Value	$ (53.0)	$ (53.0)	$ (53.0)	$ (53.0)	$ (53.0)	$ (53.0)	$ (53.0)	$ (53.0)	$ (53.0)	$ (53.0)	$ (53.0)
PRODUCTION COST	Energy Production	4,126	4,126	3,846	4,126	4,126	4,126	4,126	4,126	4,126	4,126	4,126
	Full Load Heat Rate	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159	10,159
	MMBtu Fuel Burn	[redacted]										
	$/MMBtu Delivered Fuel Cost	[redacted]										
	Annual Fuel Cost	[redacted]										
	$/MMBtu VO&M Cost	[redacted]										
	Annual VO&M Cost	[redacted]										
	NOx Emission Rate	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
	NOx emissions	2,809	2,809	2,618	2,809	2,809	2,809	2,809	2,809	2,809	2,809	2,809
	NOx Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual NOx Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	CO2 Emission Rate	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
	CO2 emissions	4.60	4.60	4.29	4.60	4.60	4.60	4.60	4.60	4.60	4.60	4.60
	CO2 Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual CO2 Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds / Revenue Requirements / Fixed O&M	Ongoing Capital Adds (OGC)	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
	Cap adder Turbine Upgrades	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Turbine Maintenance	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Maintenance	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
	Cap adder Clean Air Compliance Programs (CACP)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total Capital Adds	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
	Capital Rev Req Sunk/Decom	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
	Capital Rev Req Ongoing	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 18.5
	Capital Rev Req Turbine & Mills	$ 8.1	$ 7.7	$ 7.8	$ 7.5	$ 7.0	$ 6.6	$ 6.2	$ 5.7	$ 5.3	$ 4.8	$ 4.2
	Capital Rev Req CACP	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.6	$ 12.6
	Capital Rev Req Total	$ 64.8	$ 62.7	$ 61.1	$ 59.3	$ 57.3	$ 55.5	$ 53.9	$ 52.0	$ 49.6	$ 46.6	$ 37.6
	Fixed O&M	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
	Fixed O&M adder CAMP Study and CA Development	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Fixed O&M adder Turbine Maintenance	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	TOTAL Fixed O&M	$ 16.0	$ 16.5	$ 24.2	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.3	$ 20.8	$ 25.5

Case 20 — Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is highlighted in Grey

			Source on input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	508	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
		Capacity Factor	A, I, K	%		77%	73%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (2,100)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (206)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,718	3,719	3,719	3,719	3,719	3,467	3,719	3,719	3,719	3,719	3,719	3,719	3,719	3,719
		Full Load Heat Rate	Q	Btu/kWh		10,658	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	34.7	35.4	37.9	37.9	37.9	37.9	37.8	37.9	37.9	37.9	37.9	35.4	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,186**																							
		$/MMBtu VO&M Cost	D	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 81**																							
		NOx Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,586	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,370	2,543	2,543	2,543	2,543	2,543	2,543	2,543	2,543
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.81	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	3.88	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16	$ 17	$ 19	$ 20	$ 22	$ 24	$ 26	$ 28	$ 30	$ 32	$ 35	$ 38	$ 41	$ 44
		Annual CO2 Cost	**calc**	**$ Millions**	**$ 419**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 66.9**	**$ 72.3**	**$ 78.3**	**$ 84.6**	**$ 91.5**	**$ 92.2**	**$ 106.9**	**$ 115.6**	**$ 126.0**	**$ 135.1**	**$ 146.1**	**$ 157.9**	**$ 170.8**	**$ 184.6**
	Capital Adds Revenue Requirements Fixed O&M	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 8.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.7	$ 43.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
		Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.4	$ 1.2	$ 4.3	$ 13.2	$ 12.8	$ 12.2	$ 11.6	$ 11.1	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5	$ 8.6	$ 8.3	$ 7.8	$ 7.3	$ 6.8	$ 6.4	$ 5.9	$ 5.5	$ 4.7
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 58.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 717.4**	**$ 28.6**	**$ 76.9**	**$ 77.7**	**$ 78.8**	**$ 85.4**	**$ 82.9**	**$ 80.2**	**$ 77.6**	**$ 75.1**	**$ 72.6**	**$ 70.3**	**$ 68.0**	**$ 65.7**	**$ 63.5**	**$ 62.0**	**$ 60.1**	**$ 58.1**	**$ 56.2**	**$ 54.6**	**$ 52.7**	**$ 50.2**	**$ 47.1**	**$ 38.1**
		Fixed O&M		$million/yr		$ 8.6	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 134.3**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 21	Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology) Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Source on Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		514	508	508	506	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
		Capacity Factor	A, J, K	%		77%	73%	77%	77%	71%	77%	77%	77%	77%	69%	69%	69%	69%	69%	64%	69%	69%	69%	69%	69%	69%	69%	69%
		Energy Production	calc	GWh		[redacted]																						
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,951)**	[redacted]																						
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		526	527	522	522	522	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537	537
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (208)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**	**$ (26.4)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	3,404	3,467	3,719	3,719	3,719	3,719	3,347	3,347	3,347	3,347	3,347	3,120	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,347
		Full Load Heat Rate	O	Btu/kWh		10,638	10,676	10,676	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203	10,203
		MMBtu Fuel Burn	calc	Million MMBtu		36.6	34.7	36.3	34.7	35.4	37.9	37.9	37.9	37.9	34.2	34.2	34.2	34.2	34.2	31.8	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,186**	[redacted]																						
		$/MMBtu VO&M Cost	D	$/MMBtu		[redacted]																						
		Annual VO&M Cost	**calc**		**$ 77**	[redacted]																						
		NOx Emission Rate	N	lbs/MMBtu		0.149	0.149	0.149	0.149	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
		NOx emissions	calc	tons/yr		2,731	2,593	2,706	2,586	2,370	2,543	2,543	2,543	2,543	2,289	2,289	2,289	2,289	2,289	2,133	2,289	2,289	2,289	2,289	2,289	2,289	2,289	2,289
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.81	3.88	4.17	4.17	4.17	4.17	3.75	3.75	3.75	3.75	3.75	3.49	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 18	$ 17	$ 19	$ 20	$ 22	$ 24	$ 26	$ 28	$ 30	$ 32	$ 35	$ 38	$ 41	$ 44
		Annual CO2 Cost	**calc**	**$ Millions**	**$ 377**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 60.2**	**$ 65.1**	**$ 70.4**	**$ 76.1**	**$ 82.3**	**$ 83.0**	**$ 95.2**	**$ 104.0**	**$ 112.5**	**$ 121.8**	**$ 131.5**	**$ 142.1**	**$ 153.7**	**$ 166.2**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 8.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ -	$ 7.3	$ 10.0	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.6	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ -	$ 0.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		**$million/yr**		$ 158.7	$ 40.4	$ 27.2	$ 26.7	$ 29.2	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.3	$ 7.4	$ 10.4	$ 7.8	$ 7.9	$ 8.1	$ 8.3	$ 6.4	$ 4.5	$ 2.4	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.4	$ 1.2	$ 4.3	$ 13.2	$ 12.8	$ 12.2	$ 11.6	$ 11.1	$ 10.5	$ 10.0	$ 9.5	$ 9.0	$ 8.5	$ 8.0	$ 8.3	$ 7.8	$ 7.3	$ 6.8	$ 6.4	$ 5.9	$ 5.5	$ 4.7
		Capital Rev Req CACP		$million/yr		$ 43.9	$ 61.0	$ 58.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.6	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 717.4**	**$ 28.6**	**$ 76.9**	**$ 77.7**	**$ 78.8**	**$ 85.4**	**$ 82.9**	**$ 80.2**	**$ 77.8**	**$ 75.1**	**$ 72.6**	**$ 70.3**	**$ 68.0**	**$ 65.7**	**$ 63.5**	**$ 62.0**	**$ 60.1**	**$ 58.1**	**$ 56.2**	**$ 54.6**	**$ 52.7**	**$ 50.2**	**$ 47.1**	**$ 38.1**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ -	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 154.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 24.2**	**$ 17.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 1 | Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

Section	Item	Source on Input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
UNIT 2 PROJECT – ENERGY REVENUE	Rated Capacity	M	MW		513	507	507	555	555	555	552	552	552	552	552	552	552
	Capacity Factor	A, I, K	%		75%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%
	Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,804	3,804	3,785	3,785	3,785	3,785	3,785	3,785	3,785
	Average MISO Energy Price	D	$/MWh		[redacted]												
	Annual Energy Revenue	calc	$million/yr	$ (1,378)													
CAPACITY MARKET VALUE	Reserve Capacity	L	MW		536	540	534	534	544	544	544	541	541	541	541	541	541
	Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
	Annual Capacity Value	calc	$million/yr	$ (219)	$ -	$ -	$ -	$ (26.3)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,804	3,804	3,785	3,785	3,785	3,785	3,785	3,785	3,785
	Full Load Heat Rate	C	Btu/kWh		10,518	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119
	MMBtu Fuel Burn	calc	Million MMBtu		35.3	36.6	36.6	35.7	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3
	$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]												
	Annual Fuel Cost	calc	$Million/yr	$ 1,360													
	$/MMBtu VOAM Cost	O	$/MMBtu														
	Annual VOAM Cost	calc		$ 100													
	NOx Emission Rate	N	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060
	NOx emissions	calc	tons/yr		2,244	2,326	2,326	2,271	2,189	2,189	1,149	1,149	1,149	1,149	1,149	1,149	1,149
	NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
	CO2 emissions	calc	million tons/yr		3.69	3.82	3.82	3.73	3.99	3.99	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds Revenue Requirements	Ongoing Capital Adds (OCC)		$million/yr		$ 17.3	$ 24.8	$ 0.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3
	Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ 7.1	$ 9.7	$ 18.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 9.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2
	Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total Capital Adds		$million/yr		$ 172.5	$ 64.3	$ 28.6	$ 83.4	$ 94.1	$ 116.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.5
Fixed O&M	Capital Rev Req Exist/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.3	$ 6.7	$ 6.1	$ 5.6
	Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 17.0	$ 13.8	$ 14.6	$ 15.1	$ 15.6	$ 16.6	$ 17.6	$ 19.2	$ 20.6	$ 21.9
	Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.7	$ 1.8	$ 10.4	$ 12.4	$ 11.9	$ 11.4	$ 10.9	$ 10.4	$ 9.9	$ 9.4	$ 9.0	$ 8.5
	Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.0	$ 46.0	$ 45.6	$ 43.7	$ 41.8	$ 39.6	$ 37.7	$ 35.8
	Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.6	$ 39.7	$ 37.6	$ 35.6
	Capital Rev Req Total		$million/yr	$ 1,020.6	$ 31.5	$ 80.1	$ 81.5	$ 99.8	$ 94.4	$ 99.1	$ 130.6	$ 126.6	$ 122.3	$ 118.4	$ 114.7	$ 111.0	$ 107.4
	Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4
	Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5
	Fixed O&M adder Turbine Maintenance		$million/yr		3.2	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	TOTAL Fixed O&M		$million/yr	$ 171.4	$ 12.5	$ 12.2	$ 12.2	$ 12.8	$ 13.0	$ 13.5	$ 14.2	$ 14.6	$ 15.1	$ 15.6	$ 16.0	$ 16.5	$ 17.0

Item	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Rated Capacity	552	552	552	552	552	552	552	552	552	552	552	552	552
Capacity Factor	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%
Energy Production	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
Average MISO Energy Price	[redacted]												
Annual Energy Revenue													
Reserve Capacity	541	541	541	541	541	541	541	541	541	541	541	541	541
Capacity Value	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
Annual Capacity Value	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
Energy Production	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
Full Load Heat Rate	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
MMBtu Fuel Burn	35.8	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	35.8	38.3	38.3
$/MMBtu Delivered Fuel Cost	[redacted]												
Annual Fuel Cost													
$/MMBtu VOAM Cost													
Annual VOAM Cost													
NOx Emission Rate	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
NOx emissions	1,073	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149
NOx Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual NOx Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
CO2 Emission Rate	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
CO2 emissions	3.73	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00
CO2 Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual CO2 Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ongoing Capital Adds (OCC)	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
Cap adder Turbine Upgrades	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Turbine Maintenance	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
Cap adder Mill Maintenance	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
Capital adder SCR	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Clean Air Compliance Programs (CACP)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Adds	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.8	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.8	$ 10.9	$ 3.9	$ 0.3
Capital Rev Req Exist/Decom	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
Capital Rev Req Ongoing	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
Capital Rev Req Turbine & Mills	$ 8.5	$ 8.3	$ 7.8	$ 7.4	$ 7.0	$ 6.5	$ 6.1	$ 5.6	$ 5.2	$ 4.8	$ 6.0	$ 5.9	$ 5.2
Capital Rev Req SCR	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
Capital Rev Req CACP	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
Capital Rev Req Total	$ 104.6	$ 101.3	$ 97.8	$ 94.7	$ 91.6	$ 88.6	$ 85.7	$ 83.1	$ 81.2	$ 79.2	$ 76.0	$ 74.2	$ 69.8
Fixed O&M	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
Fixed O&M adder CAMP Study and CA Development	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Fixed O&M adder SCR	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
Fixed O&M adder Turbine Maintenance	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
TOTAL Fixed O&M	$ 24.5	$ 18.0	$ 18.6	$ 19.1	$ 19.7	$ 20.3	$ 20.8	$ 21.5	$ 22.1	$ 22.8	$ 32.9	$ 24.2	$ 29.8

Case 2 | Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Continuation of Information in Highlighted in Map

			Source on Input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		512	507	507	555	555	555	552	552	552	552	552	552	552
		Capacity Factor	A, I, K	%		75%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,604	3,604	3,765	3,765	3,765	3,765	3,765	3,765	3,765
		Average MISO Energy Price	D	$/MWh														
		Annual Energy Revenue	calc	$million/yr	$ (1,978)													
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		538	540	534	534	544	544	544	541	541	541	541	541	541
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$million/yr	$ (215)	$ -	$ -	$ -	$ (26.5)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,604	3,604	3,765	3,765	3,765	3,765	3,765	3,765	3,765
		Full Load Heat Rate	G	Btu/kWh		10,518	10,514	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119
		MMBtu Fuel Burn	calc	Million MMBtu		35.3	36.6	36.6	35.7	36.3	36.3	38.1	38.1	38.1	38.1	38.1	38.1	38.1
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu														
		Annual Fuel Cost	calc	$Millions/yr	$ 1,360													
		$/MMBtu VO&M Cost	O	$/MMBtu														
		Annual VO&M Cost	calc		$ 100													
		NOx Emission Rate	N	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	2,326	2,271	2,169	2,169	1,149	1,149	1,149	1,149	1,149	1,149	1,149
		NOx Credit Cost	O	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	**$ Millions**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	N	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.69	3.82	3.82	3.73	3.99	3.99	4.00	4.00	4.00	4.00	4.00	4.00	4.00
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	**$ Millions**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 8.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ 7.1	$ 9.7	$ 19.9	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 3.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.8	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.5	$ 84.3	$ 28.8	$ 83.4	$ 94.1	$ 116.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.5
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 8.6	$ 8.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.8	$ 16.6	$ 17.9	$ 18.2	$ 20.8	$ 21.9
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.8	$ 2.0	$ 11.4	$ 13.7	$ 13.1	$ 13.5	$ 12.0	$ 11.4	$ 10.9	$ 10.4	$ 9.9	$ 9.4
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 48.0	$ 45.8	$ 43.7	$ 41.8	$ 39.8	$ 37.7	$ 35.8
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 46.1	$ 48.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6
		Capital Rev Req Total		**$million/yr**	**$ 1,028.6**	**$ 31.6**	**$ 80.2**	**$ 81.7**	**$ 90.9**	**$ 95.6**	**$ 98.3**	**$ 121.8**	**$ 127.8**	**$ 123.3**	**$ 119.4**	**$ 115.6**	**$ 111.6**	**$ 108.3**
		Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder EGR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5
		Fixed O&M adder Turbine Maintenance		$million/yr		$ 3.2	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 173.4**	**$ 13.5**	**$ 12.2**	**$ 12.2**	**$ 13.0**	**$ 13.0**	**$ 13.6**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.4**	**$ 17.0**

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Rated Capacity	552	552	552	552	552	552	552	552	552	552	552	552	552
Capacity Factor	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%
Energy Production	3,533	3,765	3,765	3,765	3,765	3,765	3,765	3,765	3,765	3,765	3,533	3,765	3,765
Average MISO Energy Price													
Annual Energy Revenue													
Reserve Capacity	541	541	541	541	541	541	541	541	541	541	541	541	541
Capacity Value	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
Annual Capacity Value	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
Energy Production	3,533	3,765	3,765	3,765	3,765	3,765	3,765	3,765	3,765	3,765	3,533	3,765	3,765
Full Load Heat Rate	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
MMBtu Fuel Burn	35.8	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	35.8	38.1	38.1
$/MMBtu Delivered Fuel Cost													
Annual Fuel Cost													
$/MMBtu VO&M Cost													
Annual VO&M Cost													
NOx Emission Rate	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
NOx emissions	1,023	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149
NOx Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual NOx Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
CO2 Emission Rate	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
CO2 emissions	3.73	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00
CO2 Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual CO2 Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ongoing Capital Adds (OGC)	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
Cap adder Turbine Upgrades	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Turbine Maintenance	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
Cap adder Mill Maintenance	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
Capital adder SCR	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Clean Air Compliance Programs (CACP)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Adds	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.8	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.8	$ 10.9	$ 3.9	$ 0.3
Capital Rev Req Sunk/Decom	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
Capital Rev Req Ongoing	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.5	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
Capital Rev Req Turbine & Mills	$ 9.4	$ 8.1	$ 8.6	$ 8.1	$ 7.6	$ 7.2	$ 6.7	$ 6.2	$ 5.8	$ 5.3	$ 6.8	$ 6.5	$ 5.7
Capital Rev Req SCR	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
Capital Rev Req CACP	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
Capital Rev Req Total	**$ 105.3**	**$ 102.1**	**$ 99.7**	**$ 95.4**	**$ 92.2**	**$ 88.1**	**$ 86.3**	**$ 83.7**	**$ 81.8**	**$ 79.7**	**$ 78.6**	**$ 74.7**	**$ 62.3**
Fixed O&M	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
Fixed O&M adder CAMP Study and CA Development	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Fixed O&M adder EGR	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
Fixed O&M adder Turbine Maintenance	$ -	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
TOTAL Fixed O&M	**$ 17.4**	**$ 24.9**	**$ 18.6**	**$ 19.1**	**$ 19.7**	**$ 20.3**	**$ 20.9**	**$ 21.6**	**$ 22.1**	**$ 22.8**	**$ 32.8**	**$ 24.2**	**$ 29.8**

Case 3	Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
	Columbia Unit 2 Turbine and Mill Upgrade Analysis

			Source on Input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		513	507	507	555	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
		Capacity Factor	A, J, K	%		75%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,804	3,804	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
		Average MISO Energy Price	D	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	$million/yr	$ (1,879)																										
	CAPACITY MARKET VALUE	Reserve Capacity	I	MW		538	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$million/yr	$ (219)	$ -	$ -	$ -	$ (26.3)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,804	3,804	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
		Full Load Heat Rate	O	Btu/kWh		10,518	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
		MMBtu Fuel Burn	calc	Million MMBtu		[redacted]																									
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu																											
		Annual Fuel Cost	calc	$Millions/yr	$ 1,360																										
		$/MMBtu VO&M Cost	D	$/MMBtu																											
		Annual VO&M Cost	calc		$ 109																										
		NOx Emission Rate	N	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	2,326	2,271	2,169	2,169	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.49	3.52	3.62	3.73	3.99	3.99	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.6	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ 7.1	$ 9.7	$ 19.9	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.7	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.2	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Requirements	Total Capital Adds		$million/yr		$ 172.5	$ 54.3	$ 28.6	$ 83.4	$ 94.1	$ 116.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.5	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.8	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.8	$ 10.9	$ 3.9	$ 0.3
		Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.8	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.3	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
	Fixed O&M	Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.6	$ 17.9	$ 19.2	$ 20.6	$ 21.9	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.8	$ 34.8	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 9.6	$ 1.6	$ 9.4	$ 11.2	$ 10.7	$ 10.3	$ 9.8	$ 9.3	$ 8.9	$ 8.3	$ 8.1	$ 7.7	$ 7.7	$ 7.5	$ 7.1	$ 6.7	$ 6.3	$ 5.9	$ 5.5	$ 5.1	$ 4.7	$ 4.3	$ 5.4	$ 5.3	$ 4.7
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 46.8	$ 45.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.3	$ 30.5	$ 28.7	$ 26.8	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.9	$ 41.8	$ 39.7	$ 37.8	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$million/yr	$ 1,012.7	$ 31.6	$ 80.0	$ 81.4	$ 89.9	$ 93.1	$ 96.9	$ 128.3	$ 125.6	$ 121.2	$ 117.4	$ 113.7	$ 110.1	$ 106.6	$ 103.9	$ 100.4	$ 97.1	$ 93.3	$ 90.8	$ 87.9	$ 85.1	$ 82.6	$ 80.7	$ 78.7	$ 77.4	$ 73.6	$ 69.3
		Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$million/yr		$ 3.2	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8.4	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 175.4	$ 12.5	$ 12.2	$ 12.2	$ 12.8	$ 13.0	$ 13.5	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 24.5	$ 18.0	$ 18.6	$ 19.1	$ 19.7	$ 20.3	$ 20.9	$ 21.6	$ 22.1	$ 22.8	$ 32.8	$ 24.2	$ 29.8

Case 4 | Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is highlighted in Grey

			Source on input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
	ENERGY REVENUE	Rated Capacity	M	MW		513	507	507	555	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
		Capacity Factor	A, I, R	%		75%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,604	3,604	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
		Average MISO Energy Price	D	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	$million/yr	$ (1,978)	[redacted]																									
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		538	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$million/yr	$ (215)	$ -	$ -	$ -	$ (26.3)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,604	3,604	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
		Full Load Heat Rate	Q	Btu/kWh		10,518	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,118	10,118	10,118	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
		Million MMBtu Fuel Burn	calc	Million MMBtu		35.3	36.6	36.6	35.7	36.3	36.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	35.8	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	35.8	38.3	38.3
		$/MMBtu Delivered Fuel Cost	F	$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	$Million/yr	$ 1,360	[redacted]																									
		$/MMBtu VO&M Cost	O	$/MMBtu		[redacted]																									
		Annual VO&M Cost	calc		$ 109	[redacted]																									
		NOx Emission Rate	N	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	2,326	2,271	2,189	2,189	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149
		NOx Credit Cost	O	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76	206.76
		CO2 emissions	calc	million tons/yr		3.69	3.82	3.82	3.73	3.99	3.99	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
UNIT 2 PROJECT	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 32.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.1	$ 7.1	$ 9.7	$ 19.9	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.9	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.5	$ 64.3	$ 28.8	$ 83.4	$ 94.1	$ 116.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.5	$ 14.5	$ 12.0	$ 12.3	$ 12.5	$ 12.8	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.8	$ 10.8	$ 3.9	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.8	$ 14.9	$ 15.1	$ 15.6	$ 16.6	$ 17.9	$ 19.2	$ 20.8	$ 21.9	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 53.2
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.2	$ 1.6	$ 10.4	$ 12.4	$ 11.9	$ 11.4	$ 10.9	$ 10.4	$ 9.9	$ 9.4	$ 9.0	$ 8.5	$ 8.5	$ 8.3	$ 7.8	$ 7.4	$ 7.0	$ 6.5	$ 6.1	$ 5.6	$ 5.2	$ 4.6	$ 6.0	$ 5.8	$ 5.2
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 46.9	$ 45.8	$ 43.7	$ 41.6	$ 39.5	$ 37.7	$ 35.8	$ 34.0	$ 32.7	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 17.3
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 58.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.1	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$million/yr	$ 1,020.6	$ 31.5	$ 80.1	$ 81.6	$ 89.8	$ 94.4	$ 98.1	$ 130.4	$ 126.6	$ 122.3	$ 118.4	$ 114.7	$ 111.0	$ 107.4	$ 104.5	$ 101.3	$ 97.9	$ 94.7	$ 91.6	$ 88.6	$ 85.7	$ 83.1	$ 81.2	$ 78.2	$ 79.0	$ 74.2	$ 83.8
		Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 28.0
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$million/yr		$ 3.3	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 172.4	$ 12.5	$ 12.2	$ 12.2	$ 13.0	$ 13.0	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.6	$ 16.0	$ 16.5	$ 17.0	$ 24.5	$ 18.0	$ 19.0	$ 19.1	$ 19.7	$ 20.3	$ 20.9	$ 21.5	$ 22.1	$ 22.8	$ 32.8	$ 24.2	$ 29.0

Case 5 | Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

			Source on Input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		513	507	507	555	555	555	552	552	552	552	552	552
		Capacity Factor	A, I, K	%		75%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,804	3,804	3,785	3,785	3,785	3,785	3,785	3,785
		Average MISO Energy Price	D	$/MWh		[redacted]											
		Annual Energy Revenue	calc	$million/yr	$ (1,978)												
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		538	540	534	534	544	544	541	541	541	541	541	541
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$million/yr	$ (215)	$ -	$ -	$ -	$ (26.3)	$ (26.7)	$ (26.7)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,804	3,804	3,785	3,785	3,785	3,785	3,785	3,785
		Full Load Heat Rate	G	Btu/kWh		10,516	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119
		MMBtu Fuel Burn	calc	Million MMBtu		35.3	36.6	36.6	35.7	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]											
		Annual Fuel Cost	calc	$Million/yr	$ 1,360												
		$/MWBtu VO&M Cost	D	$/MMBtu													
		Annual VO&M Cost	calc		$ 109												
		NOx Emission Rate	N	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	2,326	2,271	2,189	2,189	1,149	1,149	1,149	1,149	1,149	1,149
		NOx Credit Cost	O	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		205.78	205.78	205.78	205.78	205.78	205.78	205.78	205.78	205.78	205.78	205.78	205.78
		CO2 emissions	calc	million tons/yr		3.69	3.82	3.82	3.73	3.91	3.91	4.00	4.00	4.00	4.00	4.00	4.00
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 8.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ 2.7	$ 0.7	$ 10.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.5	$ 64.3	$ 28.6	$ 83.4	$ 94.1	$ 116.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1
	Fixed O&M	Capital Rev Req Built/Obsolete		$million/yr		$ 12.0	$ 12.5	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.6	$ 17.9	$ 18.2	$ 20.6
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.7	$ 1.8	$ 10.4	$ 12.4	$ 11.9	$ 11.4	$ 10.9	$ 10.4	$ 9.9	$ 9.4	$ 9.0
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.9	$ 48.8	$ 45.8	$ 43.7	$ 41.8	$ 39.8	$ 37.7
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6
		Capital Rev Req Total		$million/yr	$ 1,020.6	$ 31.6	$ 80.1	$ 81.5	$ 89.8	$ 94.4	$ 98.1	$ 132.4	$ 126.6	$ 122.3	$ 118.4	$ 114.7	$ 111.0
		Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5
		Fixed O&M adder Turbine Maintenance		$million/yr		$ 3.2	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 173.4	$ 12.6	$ 12.2	$ 12.2	$ 12.9	$ 13.0	$ 13.6	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5

		2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 PROJECT	ENERGY REVENUE	552	552	552	552	552	552	552	552	552	552	552	552	552	552
		78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%
		3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
		[redacted]													
	CAPACITY MARKET VALUE	541	541	541	541	541	541	541	541	541	541	541	541	541	541
		49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
	PRODUCTION COST	3,785	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
		10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
		38.3	35.8	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	35.6	38.3	38.3
		[redacted]													
		0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		1,149	1,073	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		205.78	205.78	205.78	205.78	205.78	205.78	205.78	205.78	205.78	205.78	205.78	205.78	205.78	205.78
		4.00	3.73	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		$ 11.5	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.8	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.8	$ 10.9	$ 3.9	$ 0.3
	Fixed O&M	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		$ 21.9	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
		$ 8.5	$ 8.5	$ 8.3	$ 7.8	$ 7.4	$ 7.0	$ 6.5	$ 6.1	$ 5.6	$ 5.2	$ 4.6	$ 6.0	$ 5.9	$ 5.2
		$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		$ 36.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
		$ 107.4	$ 104.6	$ 101.3	$ 97.9	$ 94.7	$ 91.5	$ 88.5	$ 85.7	$ 83.1	$ 81.2	$ 79.2	$ 78.0	$ 74.2	$ 58.8
		$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.8	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		$ -	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.4	$ -	$ -
		$ 17.0	$ 24.5	$ 18.0	$ 18.6	$ 19.1	$ 19.7	$ 20.3	$ 20.9	$ 21.8	$ 22.1	$ 22.8	$ 23.8	$ 24.2	$ 29.8

Case 6 — Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Proprietary Information is Highlighted in Gray

			Source on front page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		541	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557
		Capacity Factor	A, I, R	%		75%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,804	3,804	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
		Average MISO Energy Price	O	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	$millions/yr	$ (1,978)	[redacted]																									
	CAPACITY MARKET VALUE	Rated Capacity	L	MW		538	540	538	534	546	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
		Capacity Value	H	$/MW/yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$millions/yr	$ (218)	$ -	$ -	$ -	$ (26.3)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,804	3,804	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
		Full Load Heat Rate	O	Btu/kWh		10,518	10,534	10,534	10,017	10,017	10,017	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075
		MMBtu Fuel Burn	calc	Million MMBtu		35.3	36.6	36.6	35.6	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	35.6	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	35.6	38.1	38.1
		$/MMBtu Delivered Fuel Cost	$	$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	$Millions/yr	$ 1,355	[redacted]																									
		$/MMBtu VO&M Cost	O	$/MMBtu		[redacted]																									
		Annual VO&M Cost	calc		$ [redacted]	[redacted]																									
		NOx Emission Rate	N	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	2,326	2,261	2,178	2,178	1,144	1,144	1,144	1,144	1,144	1,144	1,144	1,088	1,144	1,144	1,144	1,144	1,144	1,144	1,144	1,144	1,144	1,088	1,144	1,144
		NOx Credit Cost	O	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.69	3.82	3.82	3.71	3.99	3.99	3.98	3.98	3.98	3.98	3.98	3.98	3.98	3.72	3.98	3.98	3.98	3.98	3.98	3.98	3.98	3.98	3.98	3.72	3.98	3.98
		CO2 Credit Cost	T	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)		$millions/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$millions/yr		$ 0.3	$ 7.1	$ 8.7	$ 19.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$millions/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$millions/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$millions/yr		$ 0.0	$ 1.1	$ 1.6	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$millions/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$millions/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$millions/yr		$ 0.0	$ 1.1	$ -	$ 3.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$millions/yr		$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$millions/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
		Capital adder SCR		$millions/yr		$ -	$ -	$ 12	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$millions/yr		$ 153.8	$ 29.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$millions/yr		$ 172.5	$ 64.3	$ 26.6	$ 83.4	$ 94.1	$ 116.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.5	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.9	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.8	$ 10.9	$ 3.9	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$millions/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$millions/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.8	$ 14.6	$ 15.1	$ 15.6	$ 16.6	$ 17.8	$ 19.2	$ 20.6	$ 21.9	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 38.3	$ 40.3	$ 40.1	$ 31.2
		Capital Rev Req Turbine & Mills	J	$millions/yr		$ 0.1	$ 0.7	$ 1.6	$ 10.4	$ 12.4	$ 11.9	$ 11.4	$ 10.9	$ 10.4	$ 9.9	$ 9.4	$ 9.0	$ 8.5	$ 8.5	$ 8.3	$ 7.9	$ 7.4	$ 7.0	$ 6.5	$ 6.1	$ 5.6	$ 5.2	$ 4.8	$ 4.0	$ 5.9	$ 5.2
		Capital Rev Req SCR		$millions/yr		$ -	$ -	$ 0.9	$ 1.4	$ 5.2	$ 11.8	$ 46.9	$ 45.8	$ 43.7	$ 41.8	$ 39.6	$ 37.7	$ 35.6	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$millions/yr		$ 14.0	$ 58.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$millions/yr	$ 1,020.6	$ 31.5	$ 80.1	$ 81.6	$ 89.9	$ 94.4	$ 98.1	$ 130.4	$ 126.5	$ 122.3	$ 118.4	$ 114.7	$ 111.0	$ 107.4	$ 104.5	$ 101.3	$ 97.9	$ 94.7	$ 91.5	$ 88.5	$ 85.7	$ 83.1	$ 81.2	$ 78.2	$ 78.0	$ 74.2	$ 69.8
		Fixed O&M		$millions/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.8	$ 15.6	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 19.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
		Fixed O&M adder CAMP Study and CA Development		$millions/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.6
		Fixed O&M adder Turbine Maintenance		$millions/yr		$ 3.3	$ -	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8.4	$ -	$ -
		TOTAL Fixed O&M		$millions/yr	$ 173.4	$ 12.6	$ 12.2	$ 12.2	$ 12.8	$ 13.0	$ 13.6	$ 14.2	$ 14.8	$ 15.1	$ 15.6	$ 16.0	$ 16.5	$ 17.0	$ 24.6	$ 18.0	$ 18.6	$ 19.1	$ 19.7	$ 20.3	$ 20.8	$ 21.5	$ 22.1	$ 22.8	$ 32.5	$ 24.3	$ 29.6

Case 7 | Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information Highlighted in Gray

			Source on input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		513	507	507	535	555	555	552	552	552	552	552	552	552
		Capacity Factor	A, I, K	%		75%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,604	3,604	3,785	3,785	3,785	3,785	3,785	3,785	3,785
		Average MISO Energy Price	D	$/MWh		[redacted]												
		Annual Energy Revenue	calc	**$million/yr**														
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		538	540	534	534	544	544	544	541	541	541	541	541	541
		Capacity Value	H	$/MW/yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	**$million/yr**	$ (219)	$ -	$ -	$ -	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,604	3,604	3,785	3,785	3,785	3,785	3,785	3,785	3,785
		Full Load Heat Rate	Q	Btu/kWh		10,518	10,534	10,534	10,105	10,105	10,105	10,163	10,163	10,163	10,163	10,163	10,163	10,163
		MMBtu Fuel Burn	calc	Million MMBtu		35.3	36.6	36.6	35.9	36.4	36.4	38.5	38.5	38.5	38.5	38.5	38.5	38.5
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]												
		Annual Fuel Cost	calc	**$Million/yr**	$ 1,365													
		$/MMBtu VO&M Cost	O	$/MMBtu														
		Annual VO&M Cost	calc		$ 100													
		NOx Emission Rate	N	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	2,326	2,261	2,198	2,198	1,154	1,154	1,154	1,154	1,154	1,154	1,154
		NOx Credit Cost	C	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	**$ Millions**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.69	3.82	3.82	3.75	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	**$ Millions**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ 7.1	$ 9.7	$ 19.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.5	$ 64.3	$ 28.8	$ 83.4	$ 94.1	$ 116.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.5
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 8.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.8	$ 17.9	$ 19.2	$ 20.6	$ 21.9
		Capital Rev Req Turbine & Mills	d	$million/yr		$ 0.1	$ 0.7	$ 1.8	$ 10.4	$ 12.4	$ 11.8	$ 11.4	$ 10.9	$ 10.4	$ 9.9	$ 9.4	$ 9.0	$ 8.5
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.8	$ 46.9	$ 45.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 50.0	$ 57.3	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.8	$ 35.8
		Capital Rev Req Total		**$million/yr**	**$ 1,020.6**	**$ 31.5**	**$ 90.1**	**$ 81.9**	**$ 89.8**	**$ 94.4**	**$ 98.1**	**$ 130.4**	**$ 126.5**	**$ 122.3**	**$ 118.4**	**$ 114.7**	**$ 111.0**	**$ 107.4**
		Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5
		Fixed O&M adder Turbine Maintenance		$million/yr		$ 3.3	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 173.4**	**$ 12.6**	**$ 12.2**	**$ 12.3**	**$ 12.8**	**$ 13.0**	**$ 13.6**	**$ 14.2**	**$ 14.8**	**$ 15.1**	**$ 15.6**	**$ 16.0**	**$ 16.5**	**$ 17.0**

			2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	552	552	553	552	552	552	552	552	552	552	552	552	552
		Capacity Factor	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%
		Energy Production	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
		Average MISO Energy Price	[redacted]												
		Annual Energy Revenue													
	CAPACITY MARKET VALUE	Reserve Capacity	541	541	541	541	541	541	541	541	541	541	541	541	541
		Capacity Value	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
	PRODUCTION COST	Energy Production	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
		Full Load Heat Rate	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163
		MMBtu Fuel Burn	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.9	38.5	38.5
		$/MMBtu Delivered Fuel Cost	[redacted]												
		Annual Fuel Cost													
		$/MMBtu VO&M Cost													
		Annual VO&M Cost													
		NOx Emission Rate	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	1,077	1,154	1,154	1,154	1,154	1,154	1,154	1,154	1,154	1,154	1,077	1,154	1,154
		NOx Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	3.75	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	3.75	4.01	4.01
		CO2 Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
		Capital adder SCR	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.8	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.8	$ 10.8	$ 3.8	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.6	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills	$ 8.5	$ 8.3	$ 7.8	$ 7.4	$ 7.0	$ 6.5	$ 6.1	$ 5.6	$ 5.2	$ 4.8	$ 4.0	$ 5.9	$ 3.2
		Capital Rev Req SCR	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 18.2	$ 14.4	$ 11.3
		Capital Rev Req CACP	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.2	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total	**$ 104.5**	**$ 101.3**	**$ 97.9**	**$ 94.7**	**$ 91.6**	**$ 88.5**	**$ 85.7**	**$ 83.1**	**$ 81.2**	**$ 79.2**	**$ 78.0**	**$ 74.2**	**$ 59.8**
		Fixed O&M	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.6	$ 28.0
		Fixed O&M adder CAMP Study and CA Development	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M	**$ 18.5**	**$ 18.1**	**$ 18.7**	**$ 20.2**	**$ 20.9**	**$ 21.8**	**$ 22.1**	**$ 22.8**	**$ 22.8**	**$ 23.8**	**$ 34.2**	**$ 24.4**	**$ 29.8**

Case 8 | Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

			Source on input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	K	MW		513	507	507	580	580	580	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557
		Capacity Factor	A, I, K	%		75%	78%	78%	72%	78%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	3,474	3,582	3,837	3,837	3,818	3,818	3,818	3,818	3,818	3,818	3,818	3,564	3,818	3,818	3,818	3,818	3,818	3,818	3,818	3,818	3,818	3,564	3,818	3,818
		Average MISO Energy Price	D	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	$millions/yr	$ (1,233)																										
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		538	540	534	534	545	545	545	542	542	542	542	543	547	547	541	542	547	547	542	542	542	542	542	542	542	543
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$millions/yr	$ (219)	$ -	$ -	$ -	$ (26.3)	$ (28.0)	$ (26.8)	$ (26.8)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.7)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	3,474	3,582	3,837	3,837	3,818	3,818	3,818	3,818	3,818	3,818	3,818	3,564	3,818	3,818	3,818	3,818	3,818	3,818	3,818	3,818	3,818	3,564	3,818	3,818
		Full Load Heat Rate	Q	Btu/kWh		10,518	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
		MMBtu Fuel Burn	calc	Mbtu/h MMBtu		35.3	36.6	36.6	36.0	38.6	38.6	38.6	38.6	38.6	38.6	38.6	38.6	38.6	36.1	38.6	38.6	38.6	38.6	38.6	38.6	38.6	38.6	38.6	36.1	38.6	38.6
		$/MMBtu Different Fuel Cost	T	$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	$Millions/yr	$ 1,370																										
		$/MMBtu VO&M Cost	O	$/MMBtu																											
		Annual VO&M Cost	calc		$ 189																										
		NOx Emission Rate	N	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,328	2,328	2,291	2,208	2,208	1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,092	1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,092	1,159	1,159
		NOx Credit Cost	Q	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78
		CO2 emissions	calc	million tons/yr		3.69	3.82	3.82	3.76	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	3.76	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	3.76	4.03	4.03
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)		$millions/yr		$ 17.3	$ 24.8	$ 8.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$millions/yr		$ 0.3	$ 7.1	$ 3.7	$ 19.9	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$millions/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$millions/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$millions/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$millions/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$millions/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$millions/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$millions/yr		$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$millions/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
		Capital adder SCR		$millions/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$millions/yr		$ 153.8	$ 25.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$millions/yr		$ 172.5	$ 64.3	$ 28.0	$ 83.4	$ 94.1	$ 116.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.5	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.8	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.8	$ 10.9	$ 3.9	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$millions/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 8.9	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$millions/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.9	$ 15.1	$ 15.8	$ 16.6	$ 17.9	$ 19.2	$ 20.6	$ 21.9	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.1	$ 40.1	$ 33.3
		Capital Rev Req Turbine & Mills	2	$millions/yr		$ 0.1	$ 0.7	$ 1.8	$ 10.4	$ 12.4	$ 11.9	$ 11.4	$ 10.9	$ 10.4	$ 9.9	$ 9.4	$ 9.0	$ 8.5	$ 8.5	$ 8.3	$ 7.8	$ 7.4	$ 7.0	$ 6.5	$ 6.1	$ 5.8	$ 5.2	$ 4.8	$ 6.0	$ 5.9	$ 5.3
		Capital Rev Req SCR		$millions/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.2	$ 11.6	$ 46.9	$ 45.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$millions/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.2	$ 13.4	$ 13.2	$ 10.2
		Capital Rev Req Total		$millions/yr	$ 1,020.6	$ 31.5	$ 80.1	$ 81.8	$ 89.8	$ 94.4	$ 98.1	$ 130.4	$ 128.8	$ 122.2	$ 119.4	$ 114.7	$ 111.0	$ 107.4	$ 104.5	$ 101.3	$ 97.8	$ 94.7	$ 91.8	$ 88.8	$ 85.7	$ 83.1	$ 81.2	$ 78.2	$ 76.0	$ 74.2	$ 59.8
		Fixed O&M		$millions/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.8	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 20.0
		Fixed O&M adder CAMP Study and CA Development		$millions/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$millions/yr		$ 3.2	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M		$millions/yr	$ 173.4	$ 12.6	$ 12.2	$ 12.2	$ 12.9	$ 13.0	$ 13.6	$ 14.3	$ 14.6	$ 15.1	$ 15.6	$ 16.0	$ 16.5	$ 17.0	$ 24.3	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.3	$ 20.9	$ 21.6	$ 22.1	$ 22.8	$ 32.9	$ 23.3	$ 20.8

Case 9 | **Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

			Source on Input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		513	507	507	550	550	550	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547
		Capacity Factor	A, I, K	%		75%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%
		Energy Production	calc	GWh		[redacted]																									
		Average MISO Energy Price	O	$/MWh																											
		Annual Energy Revenue	calc	$million/yr	$ (1,984																										
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		538	540	534	534	543	543	543	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$million/yr	$ (219)	$ -	$ -	$ -	$ (26.3)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	3,474	3,520	3,771	3,771	3,752	3,752	3,752	3,752	3,752	3,752	3,752	3,503	3,752	3,752	3,752	3,752	3,752	3,752	3,752	3,752	3,752	3,503	3,752	3,752
		Full Load Heat Rate	Q	Btu/kWh		10,518	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
		MMBtu Fuel Burn	calc	Million MMBtu		[redacted]																									
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu																											
		Annual Fuel Cost	calc	$Million/yr	$ 1,360																										
		$/MMBtu VO&M Cost	O	$/MMBtu																											
		Annual VO&M Cost	calc		$ [redacted]																										
		NOx Emission Rate	N	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	2,326	2,251	2,170	2,170	1,139	1,139	1,139	1,139	1,139	1,139	1,139	1,063	1,139	1,139	1,139	1,139	1,139	1,139	1,139	1,139	1,139	1,063	1,139	1,139
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.69	3.87	3.82	3.70	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.70	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.70	3.96	3.96
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.5	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ 7.1	$ 9.7	$ 10.9	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.5	$ 64.3	$ 28.6	$ 83.4	$ 94.1	$ 116.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.5	$ 14.6	$ 12.0	$ 12.3	$ 12.6	$ 12.8	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.8	$ 10.9	$ 4.0	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.6	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.6	$ 17.9	$ 19.2	$ 20.6	$ 21.9	$ 23.7	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.6	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.7
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.7	$ 1.8	$ 10.4	$ 12.4	$ 11.9	$ 11.4	$ 10.9	$ 10.4	$ 9.9	$ 9.4	$ 9.0	$ 8.5	$ 8.5	$ 8.3	$ 7.8	$ 7.4	$ 7.0	$ 6.5	$ 6.1	$ 5.6	$ 5.2	$ 4.8	$ 6.0	$ 5.8	$ 5.2
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 46.9	$ 45.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.6	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 58.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$million/yr	$ 1,020.6	$ 31.6	$ 80.1	$ 81.6	$ 88.8	$ 94.4	$ 98.1	$ 130.4	$ 126.3	$ 122.5	$ 118.4	$ 114.7	$ 111.0	$ 107.4	$ 104.9	$ 101.3	$ 97.9	$ 94.7	$ 91.6	$ 88.5	$ 85.7	$ 83.1	$ 81.2	$ 79.2	$ 79.0	$ 74.2	$ 69.8
		Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$million/yr		3.2	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8.4	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 172.4	$ 12.5	$ 12.2	$ 12.2	$ 12.9	$ 13.0	$ 13.5	$ 14.2	$ 14.8	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 24.8	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.3	$ 20.8	$ 21.5	$ 22.1	$ 22.8	$ 32.9	$ 24.2	$ 29.9

Case 10 | Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

			Source on Input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
	ENERGY REVENUE	Rated Capacity	M	MW		513	507	507	555	555	558	552	552	552	552	552	553	552
		Capacity Factor	A / K	%		82%	86%	86%	80%	88%	88%	88%	88%	88%	88%	88%	88%	88%
		Energy Production	calc	GWh		3,693	3,821	3,821	3,806	4,184	4,184	4,163	4,163	4,163	4,163	4,163	4,163	4,163
		Average MISO Energy Price	D	$/MWh		[redacted]												
		Annual Energy Revenue	calc	$million/yr	$ (2,176)													
	CAPACITY MARKET VALUE	Rated Capacity	L	MW		538	540	534	534	544	544	544	541	541	541	541	541	541
		Capacity Value	H	$/MW/yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$million/yr	$ (319)	$ -	$ -	$ -	$ (26.3)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
	PRODUCTION COST	Energy Production	calc	GWh		3,693	3,821	3,821	3,806	4,184	4,184	4,163	4,163	4,163	4,163	4,163	4,163	4,163
		Full Load Heat Rate	G	Btu/kWh		10,518	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119
		MMBtu Fuel Burn	calc	Million MMBtu		38.8	40.3	40.3	38.3	42.1	42.1	42.1	42.1	42.1	42.3	42.1	42.1	42.1
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]												
		Annual Fuel Cost	calc	$Million/yr	$ 1,496													
		$/MWh VO&M Cost	O	$/MWh														
		Annual VO&M Cost	calc	$million/yr	$ 116													
		NOx Emission Rate	N	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,469	2,558	2,558	2,468	2,408	2,408	1,264	1,264	1,264	1,264	1,264	1,264	1,264
		NOx Credit Cost	G	$/ton		-	-	-	-	-	-	-	-	-	-	-	-	-
		Annual NOx Cost	calc	**$ Millions**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		4.05	4.20	4.20	4.10	4.38	4.38	4.40	4.40	4.40	4.40	4.40	4.40	4.40
		CO2 Credit Cost	F	$/ton		-	-	-	-	-	-	-	-	-	-	-	-	-
UNIT #		**Annual CO2 Cost**	calc	**$ Millions**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
PROJECT	Capital Adds	Ongoing Capital Adds (ICDC)		$million/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 32.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ 7.1	$ 9.7	$ 19.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.9	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.5	$ 84.3	$ 29.6	$ 83.4	$ 94.1	$ 116.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.5
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.8	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.6	$ 7.3	$ 6.7	$ 6.1	$ 5.8
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.6	$ 17.9	$ 19.2	$ 20.6	$ 21.9
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.7	$ 1.6	$ 10.4	$ 12.4	$ 11.9	$ 11.4	$ 10.9	$ 10.4	$ 9.9	$ 9.4	$ 9.0	$ 8.5
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 46.0	$ 43.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.8	$ 35.8
		Capital Rev Req Total		$million/yr	$ 1,028.6	$ 31.5	$ 80.1	$ 81.5	$ 89.8	$ 94.4	$ 98.1	$ 130.4	$ 125.5	$ 122.3	$ 119.4	$ 114.7	$ 111.0	$ 107.4
		Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 13.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5
		Fixed O&M adder Turbine Maintenance		$million/yr		$ 3.2	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 171.4	$ 12.5	$ 12.2	$ 13.2	$ 12.8	$ 13.0	$ 13.5	$ 14.2	$ 14.8	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0

			2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
	ENERGY REVENUE	Rated Capacity	552	552	553	553	553	553	552	552	552	552	552	552	553
		Capacity Factor	80%	80%	86%	86%	86%	86%	86%	86%	86%	86%	80%	80%	86%
		Energy Production	3,687	4,163	4,163	4,163	4,163	4,163	4,163	4,163	4,163	4,163	3,687	4,163	4,163
		Average MISO Energy Price	[redacted]												
		Annual Energy Revenue													
	CAPACITY MARKET VALUE	Rated Capacity	541	541	541	541	541	541	541	541	541	541	541	541	541
		Capacity Value	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
	PRODUCTION COST	Energy Production	4,163	4,163	4,163	4,163	4,163	4,163	4,163	4,163	4,163	4,163	3,687	4,163	4,163
		Full Load Heat Rate	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
		MMBtu Fuel Burn	42.1	42.1	42.1	42.1	42.1	42.1	42.1	42.1	42.1	42.1	38.3	42.1	42.1
		$/MMBtu Delivered Fuel Cost	[redacted]												
		Annual Fuel Cost													
		$/MWh VO&M Cost													
		Annual VO&M Cost													
		NOx Emission Rate	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	1,180	1,264	1,264	1,264	1,264	1,264	1,264	1,264	1,264	1,264	1,180	1,264	1,264
		NOx Credit Cost	-	-	-	-	-	-	-	-	-	-	-	-	-
		Annual NOx Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	4.11	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.11	4.40	4.40
		CO2 Credit Cost	-	-	-	-	-	-	-	-	-	-	-	-	-
UNIT #		**Annual CO2 Cost**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
PROJECT	Capital Adds	Ongoing Capital Adds (ICDC)	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.8	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
	Capital Adds	Cap adder Mill Maintenance	$ 0.3	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
		Capital adder SCR	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.8	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.8	$ 10.9	$ 3.9	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.6	$ 32.6	$ 34.6	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills	$ 8.5	$ 8.3	$ 7.8	$ 7.4	$ 7.0	$ 6.5	$ 6.1	$ 5.6	$ 5.2	$ 4.8	$ 6.0	$ 5.8	$ 5.2
		Capital Rev Req SCR	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP	$ 33.9	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.1	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total	$ 104.5	$ 101.3	$ 97.8	$ 94.7	$ 91.5	$ 88.5	$ 85.7	$ 83.1	$ 81.2	$ 79.2	$ 78.0	$ 74.5	$ 59.8
		Fixed O&M	$ 16.8	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.8	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 24.0
		Fixed O&M adder CAMP Study and CA Development	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8.4	$ -	$ -
		TOTAL Fixed O&M	$ 24.6	$ 18.0	$ 19.2	$ 19.1	$ 19.7	$ 20.3	$ 20.8	$ 21.5	$ 22.1	$ 22.8	$ 32.0	$ 24.2	$ 24.8

Case 11 — Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

			Source on input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		513	507	507	555	555	555	552	552	552	552	552	552
		Capacity Factor	A, I, K	%		67%	70%	70%	66%	70%	70%	70%	70%	70%	70%	70%	70%
		Energy Production	calc	GWh		3,021	3,127	3,127	3,196	3,423	3,423	3,406	3,406	3,406	3,406	3,406	3,406
		Average MISO Energy Price	D	$/MWh		[redacted]											
		Annual Energy Revenue	calc	**$millions/yr**	**$ (1,793)**												
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		538	540	534	534	544	544	544	541	541	541	541	541
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	**$millions/yr**	**$ (219)**	$ -	$ -	$ -	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
	PRODUCTION COST	Energy Production	calc	GWh		3,021	3,127	3,127	3,196	3,423	3,423	3,406	3,406	3,406	3,406	3,406	3,406
		Full Load Heat Rate	Q	Btu/kWh		10,519	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119
		MMBtu Fuel Burn	calc	Million MMBtu		31.8	32.9	32.9	32.2	34.4	34.4	34.5	34.5	34.5	34.5	34.5	34.5
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]											
		Annual Fuel Cost	calc	**$Millions/yr**	**$ 1,224**												
		$/MMBtu VO&M Cost	O	$/MMBtu													
		Annual VO&M Cost	calc		**$ 80**												
		NOx Emission Rate	N	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,020	2,065	2,065	2,044	1,970	1,970	1,034	1,034	1,034	1,034	1,034	1,034
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	**$ Millions**	**$ -**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.32	3.44	3.44	3.36	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	**$ Millions**	**$ -**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ 7.1	$ 9.7	$ 19.9	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.5	$ 64.3	$ 28.8	$ 83.4	$ 94.1	$ 116.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 8.0	$ 8.3	$ 7.8	$ 7.3	$ 6.7	$ 6.1
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.8	$ 17.8	$ 18.2	$ 20.6
		Capital Rev Req Turbine & Mill		$million/yr		$ 0.1	$ 0.7	$ 1.8	$ 10.4	$ 12.4	$ 11.8	$ 11.4	$ 10.9	$ 10.4	$ 9.9	$ 9.4	$ 9.0
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.8	$ 46.8	$ 45.8	$ 43.7	$ 41.8	$ 39.8	$ 37.7
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.8	$ 57.7	$ 59.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6
		Capital Rev Req Total		**$million/yr**	**$ 1,020.6**	$ 31.5	$ 80.1	$ 81.5	$ 89.8	$ 94.4	$ 98.1	$ 130.4	$ 126.5	$ 122.3	$ 118.4	$ 114.7	$ 111.0
		Fixed O&M		$million/yr		$ 8.2	$ 12.2	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5
		Fixed O&M adder Turbine Maintenance		$million/yr		$ 3.2	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 171.4**	$ 12.6	$ 12.2	$ 12.2	$ 12.9	$ 13.0	$ 13.6	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.6

			2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	552	552	552	552	552	552	552	552	552	552	552	552	552	552
		Capacity Factor	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%
		Energy Production	3,406	3,180	3,406	3,406	3,406	3,406	3,406	3,406	3,406	3,406	3,406	3,180	3,406	3,406
		Average MISO Energy Price	[redacted]													
		Annual Energy Revenue														
	CAPACITY MARKET VALUE	Reserve Capacity	541	541	541	541	541	541	541	541	541	541	541	541	541	541
		Capacity Value	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
	PRODUCTION COST	Energy Production	3,406	3,180	3,406	3,406	3,406	3,406	3,406	3,406	3,406	3,406	3,406	3,180	3,406	3,406
		Full Load Heat Rate	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
		MMBtu Fuel Burn	34.5	32.2	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	32.2	34.5	34.5
		$/MMBtu Delivered Fuel Cost	[redacted]													
		Annual Fuel Cost														
		$/MMBtu VO&M Cost														
		Annual VO&M Cost														
		NOx Emission Rate	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	1,034	965	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	965	1,034	1,034
		NOx Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	3.60	3.36	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.36	3.60	3.60
		CO2 Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Upgrades - Set 6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
		Capital adder SCR	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds	$ 11.5	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.8	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.8	$ 10.9	$ 3.9	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.6	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing	$ 21.9	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mill	$ 8.5	$ 8.5	$ 8.3	$ 7.8	$ 7.4	$ 7.0	$ 6.5	$ 6.1	$ 5.6	$ 5.2	$ 4.8	$ 6.0	$ 5.8	$ 5.2
		Capital Rev Req SCR	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total	$ 107.4	$ 104.5	$ 101.3	$ 97.9	$ 94.7	$ 91.6	$ 88.6	$ 85.7	$ 83.1	$ 81.2	$ 78.2	$ 76.0	$ 74.2	$ 59.8
		Fixed O&M	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 16.5	$ 16.1	$ 19.8	$ 20.2	$ 20.6	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
		Fixed O&M adder CAMP Study and CA Development	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance	$ -	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M	$ 17.0	$ 24.5	$ 18.0	$ 18.6	$ 18.1	$ 18.7	$ 20.3	$ 20.8	$ 21.6	$ 22.1	$ 22.8	$ 32.8	$ 24.2	$ 29.8

Case 12 | Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

			Source on input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		513	507	507	555	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
		Capacity Factor	A, E, K	%		75%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	73%	78%	78%	78%	73%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,804	3,804	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
		Average MISO Energy Price	D	$/MWh																											
		Annual Energy Revenue	calc	$million/yr	$ (1,970)																										
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		530	540	554	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
		Capacity Value	H	$/MW-yr		-	-	-	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380
		Annual Capacity Value	calc	$million/yr	$ (417)	$ -	$ -	$ -	$ (52.5)	$ (53.5)	$ (53.5)	$ (53.5)	$ (53.2)	$ (53.2)	$ (53.2)	$ (53.2)	$ (53.2)	$ (53.2)	$ (53.2)	$ (53.2)	$ (53.2)	$ (53.2)	$ (53.2)	$ (53.2)	$ (53.2)	$ (53.2)	$ (53.2)	$ (53.2)	$ (53.2)	$ (53.2)	$ (53.2)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,804	3,804	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
		Full Load Heat Rate	G	Btu/kWh		10,518	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,118	10,118	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
		MMBtu Fuel Burn	calc	Million MMBtu		35.3	36.6	36.6	35.7	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	35.8	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	35.8	38.3	38.3
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu																											
		Annual Fuel Cost	calc	$Millions/yr	$ 1,360																										
		$/MMBtu VO&M Cost	Q	$/MMBtu																											
		Annual VO&M Cost	calc		$ 100																										
		NOx Emission Rate	N	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	2,326	2,271	2,189	2,189	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.68	3.82	3.82	3.73	3.90	3.90	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00	4.00	3.73	4.00	4.00
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 8.1	$ 6.2	$ 8.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ 7.1	$ 8.7	$ 19.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.2	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.5	$ 64.3	$ 28.8	$ 83.4	$ 94.1	$ 116.1	$ 6.2	$ 8.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.5	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.8	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.8	$ 10.9	$ 3.9	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.8	$ 14.8	$ 15.1	$ 15.6	$ 16.6	$ 17.9	$ 19.2	$ 20.6	$ 21.9	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.5	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills		$million/yr		$ 0.1	$ 0.7	$ 1.8	$ 10.4	$ 12.4	$ 11.8	$ 11.4	$ 10.9	$ 10.4	$ 9.9	$ 9.4	$ 9.0	$ 8.5	$ 8.5	$ 8.3	$ 7.8	$ 7.4	$ 7.0	$ 6.5	$ 6.1	$ 5.6	$ 5.2	$ 4.8	$ 9.0	$ 5.9	$ 5.2
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 46.8	$ 45.8	$ 43.7	$ 41.8	$ 39.8	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.1
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.1	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$million/yr	$ 1,020.6	$ 31.5	$ 80.1	$ 81.5	$ 89.8	$ 94.4	$ 98.1	$ 130.4	$ 126.5	$ 122.3	$ 119.4	$ 114.7	$ 111.0	$ 107.4	$ 104.6	$ 101.1	$ 97.5	$ 94.7	$ 91.6	$ 88.5	$ 85.7	$ 83.1	$ 81.2	$ 78.2	$ 78.0	$ 74.2	$ 69.8
		Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$million/yr		$ 3.2	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 173.4	$ 12.5	$ 12.3	$ 12.2	$ 12.6	$ 13.0	$ 13.5	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 24.4	$ 18.0	$ 18.6	$ 19.1	$ 19.7	$ 20.3	$ 20.9	$ 21.5	$ 22.1	$ 22.9	$ 32.8	$ 24.2	$ 29.8

Case 12 | Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information as Highlighted in Blue

			Source on Input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		513	507	507	555	555	555	552	552	552	552	552	552	552
		Capacity Factor	A / B	%		78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,604	3,504	3,785	3,785	3,785	3,785	3,785	3,785	3,785
		Average MISO Energy Price	D	$/MWh		[redacted]												
		Annual Energy Revenue	calc	**$million/yr**	**$ (1,978)**													
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		530	540	534	534	544	544	548	541	541	541	541	541	541
		Capacity Value	H	$/MW-yr		-	-	-	-	-	-	-	-	-	-	-	-	-
		Annual Capacity Value	calc	**$million/yr**	**$ -**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,604	3,504	3,785	3,785	3,785	3,785	3,785	3,785	3,785
		Full Load Heat Rate	G	Btu/kWh		10,519	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119
		MMBtu Fuel Burn	calc	Million MMBtu		35.3	36.6	36.6	35.7	36.3	35.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]												
		Annual Fuel Cost	calc	**$Million/yr**	**$ 1,360**													
		$/MMBtu VO&M Cost	O	$/MMBtu														
		Annual VO&M Cost	calc		**$ 120**													
		NOx Emission Rate	N	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	2,326	2,271	2,160	2,160	1,149	1,149	1,149	1,149	1,149	1,149	1,149
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	**$ Millions**	**$ -**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.68	3.82	3.82	3.73	3.96	3.96	4.00	4.00	4.00	4.00	4.00	4.00	4.00
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	**$ Millions**	**$ -**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.6	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ 7.1	$ 8.7	$ 19.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 3.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2
	Revenue Requirements	Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.8	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.5	$ 64.5	$ 26.6	$ 63.4	$ 94.1	$ 116.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.5
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.6	$ 7.2	$ 6.7	$ 6.1	$ 5.6
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.9	$ 17.9	$ 19.2	$ 20.6	$ 21.9
		Capital Rev Req Turbine & Mills		$million/yr		$ 0.1	$ 0.7	$ 7.8	$ 10.4	$ 12.4	$ 11.9	$ 11.4	$ 10.9	$ 10.4	$ 9.9	$ 9.4	$ 9.0	$ 8.5
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 48.3	$ 45.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 45.9	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6
		Capital Rev Req Total		**$million/yr**	**$ 1,020.6**	**$ 31.6**	**$ 80.1**	**$ 91.5**	**$ 89.9**	**$ 94.4**	**$ 98.1**	**$ 130.4**	**$ 126.5**	**$ 122.3**	**$ 118.4**	**$ 114.7**	**$ 111.0**	**$ 107.6**
		Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.9	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder KER		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5
		Fixed O&M adder Turbine Maintenance		$million/yr		3.2	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 173.4**	**$ 12.5**	**$ 12.2**	**$ 12.2**	**$ 12.9**	**$ 13.0**	**$ 13.4**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.6**	**$ 16.0**	**$ 16.5**	**$ 17.0**

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Rated Capacity	552	552	552	552	552	552	552	552	552	552	552	552	552
Capacity Factor	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%
Energy Production	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
Average MISO Energy Price	[redacted]												
Annual Energy Revenue													
Reserve Capacity	541	541	541	541	541	541	541	541	541	541	541	541	541
Capacity Value	-	-	-	-	-	-	-	-	-	-	-	-	-
Annual Capacity Value	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Energy Production	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
Full Load Heat Rate	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
MMBtu Fuel Burn	35.8	38.3	38.3	38.3	38.3	38.3	35.8	38.3	38.3	38.3	35.8	38.3	38.3
$/MMBtu Delivered Fuel Cost	[redacted]												
Annual Fuel Cost													
$/MMBtu VO&M Cost													
Annual VO&M Cost													
NOx Emission Rate	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
NOx emissions	1,073	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149
NOx Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual NOx Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
CO2 Emission Rate	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
CO2 emissions	3.73	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00
CO2 Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual CO2 Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ongoing Capital Adds (OGC)	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
Cap adder Turbine Upgrades	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Turbine Maintenance	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
Cap adder Mill Maintenance	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
Capital adder SCR	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Clean Air Compliance Programs (CACP)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Adds	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.9	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.8	$ 10.9	$ 3.9	$ 0.3
Capital Rev Req Sunk/Decom	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
Capital Rev Req Ongoing	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.5	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
Capital Rev Req Turbine & Mills	$ 8.5	$ 8.3	$ 7.8	$ 7.4	$ 7.0	$ 6.5	$ 6.1	$ 5.8	$ 5.2	$ 4.8	$ 4.0	$ 5.9	$ 9.2
Capital Rev Req SCR	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.2	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
Capital Rev Req CACP	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.2	$ 13.4	$ 13.2	$ 10.3
Capital Rev Req Total	**$ 104.5**	**$ 101.3**	**$ 97.9**	**$ 94.7**	**$ 91.5**	**$ 88.5**	**$ 85.7**	**$ 82.1**	**$ 81.2**	**$ 78.2**	**$ 76.0**	**$ 74.3**	**$ 59.8**
Fixed O&M	$ 16.8	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.8	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 38.0
Fixed O&M adder CAMP Study and CA Development	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Fixed O&M adder KER	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
Fixed O&M adder Turbine Maintenance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
TOTAL Fixed O&M	**$ 24.5**	**$ 18.0**	**$ 18.5**	**$ 19.1**	**$ 19.7**	**$ 20.3**	**$ 20.9**	**$ 21.5**	**$ 22.1**	**$ 22.8**	**$ 32.9**	**$ 24.2**	**$ 39.8**

Case 14 **Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

			Source on Input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
	ENERGY REVENUE	Rated Capacity	M	MW		513	507	507	555	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
		Capacity Factor	a, J, K	%		75%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,604	3,604	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
		Average MISO Energy Price	O	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	$millions/yr	$ (2,473)																										
	CAPACITY MARKET VALUE	Rated Capacity	L	MW		538	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$millions/yr	$ (219)	$ -	$ -	$ -	$ (26.3)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,604	3,604	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
		Full Load Heat Rate	Q	Btu/kWh		10,519	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
		MMBtu Fuel Burn	calc	Million MMBtu		35.3	36.6	36.6	35.7	36.3	36.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	35.8	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	35.7	38.3	38.3
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	$Millions/yr	$ 1,360																										
		$/MMBtu VO&M Cost	D	$/MMBtu																											
		Annual VO&M Cost	calc		$ 160																										
		NOx Emission Rate	N	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	2,326	2,271	2,188	2,189	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.68	3.82	3.82	3.73	3.89	3.89	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
UNIT 2		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
PROJECT	Capital Adds Revenue Requirements Fixed O&M	Ongoing Capital Adds (OGC)		$millions/yr		$ 17.3	$ 24.6	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 16.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$millions/yr		$ 0.3	$ 7.1	$ 3.7	$ 19.9	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$millions/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$millions/yr		$ 0.0	$ 1.1	$ 1.6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$millions/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$millions/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$millions/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$millions/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$millions/yr		$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$millions/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.7	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
		Capital adder SCR		$millions/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Clean Air Compliance Programs (CACP)		$millions/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$millions/yr		$ 172.5	$ 64.3	$ 28.5	$ 83.4	$ 94.1	$ 116.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.5	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.8	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 16.8	$ 10.9	$ 3.9	$ 0.3
		Capital Rev Req Sunk/Decom		$millions/yr		$ 12.0	$ 12.3	$ 11.0	$ 10.8	$ 10.7	$ 9.6	$ 8.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$millions/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.0	$ 15.1	$ 15.8	$ 16.6	$ 17.8	$ 18.2	$ 20.6	$ 21.9	$ 23.3	$ 24.6	$ 28.0	$ 27.5	$ 28.1	$ 30.8	$ 33.9	$ 34.8	$ 37.3	$ 39.7	$ 40.3	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills	J	$millions/yr		$ 0.1	$ 0.7	$ 1.6	$ 10.4	$ 12.4	$ 11.9	$ 11.4	$ 10.9	$ 10.4	$ 9.8	$ 9.4	$ 8.9	$ 8.5	$ 8.5	$ 8.3	$ 7.8	$ 7.4	$ 7.0	$ 6.5	$ 6.1	$ 5.6	$ 5.2	$ 4.8	$ 4.0	$ 3.9	$ 5.2
		Capital Rev Req SCR		$millions/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 46.9	$ 45.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.3	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$millions/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.1	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$millions/yr	$ 1,020.6	$ 31.5	$ 80.1	$ 81.0	$ 89.8	$ 94.4	$ 98.1	$ 130.4	$ 126.8	$ 122.3	$ 118.4	$ 114.7	$ 111.0	$ 107.4	$ 104.5	$ 101.3	$ 97.8	$ 94.7	$ 91.8	$ 88.6	$ 85.7	$ 83.1	$ 81.2	$ 78.2	$ 76.0	$ 74.2	$ 69.8
		Fixed O&M		$millions/yr		$ 9.2	$ 12.3	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.8	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 24.0
		Fixed O&M adder CAMP Study and CA Development		$millions/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$millions/yr		$ 3.3	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M		$millions/yr	$ 171.4	$ 12.6	$ 12.3	$ 12.2	$ 12.8	$ 13.0	$ 13.6	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 24.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.3	$ 20.9	$ 21.5	$ 22.1	$ 22.8	$ 32.8	$ 24.2	$ 24.8

Case 15 — Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

			Source on input page	Units	PV Discounted to yrs of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		513	507	507	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
		Capacity Factor	A, J, K	%		79%	76%	78%	73%	76%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	73%	73%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,804	3,804	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,533	3,785	3,785
		Average MISO Energy Price	D	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	$millions/yr	$ (1,464)																										
	CAPACITY MARKET VALUE	Reserve Capacity	I	MW		538	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$millions/yr	$ (219)	$ -	$ -	$ -	$ (26.3)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,804	3,804	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,533	3,785	3,785
		Full Load Heat Rate	G	Btu/kWh		10,518	10,534	10,534	10,661	10,081	10,081	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
		MMBtu Fuel Burn	calc	Million MMBtu		35,3	36,6	36,6	37,8	38,3	38,3	38,3	38,3	38,3	38,3	38,3	38,3	38,3	35,8	38,3	38,3	38,3	38,3	38,3	38,3	38,3	38,3	35,8	35,8	38,3	38,3
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	$Millions/yr	$ 1,360																										
		$/MMBtu VO&M Cost	O	$/MMBtu																											
		Annual VO&M Cost	calc	$millions/yr	$ 199																										
		NOx Emission Rate	N	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,344	2,326	2,326	2,271	2,168	2,168	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,073	1,149	1,149
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	**$ Millions**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.83	3.82	3.82	3.73	3.99	3.99	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	3.73	4.00	4.00
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	**$ Millions**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.8	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 6.3	$ 7.1	$ 9.7	$ 18.9	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 2.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 2.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.9	$ 40.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.5	$ 64.3	$ 28.8	$ 83.4	$ 54.1	$ 118.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.5	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.8	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.8	$ 10.0	$ 3.9	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 13.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.4	$ 14.8	$ 15.1	$ 16.8	$ 18.5	$ 17.8	$ 19.2	$ 20.6	$ 21.8	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.2	$ 39.3	$ 40.3	$ 40.1	$ 37.7
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.7	$ 1.8	$ 10.4	$ 12.4	$ 11.9	$ 11.4	$ 10.9	$ 10.4	$ 9.9	$ 9.4	$ 9.0	$ 8.5	$ 8.5	$ 8.3	$ 7.8	$ 7.4	$ 7.0	$ 6.5	$ 6.1	$ 5.6	$ 5.2	$ 4.8	$ 4.0	$ 3.9	$ 3.2
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.8	$ 48.0	$ 45.9	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 59.2	$ 57.7	$ 56.4	$ 48.1	$ 45.0	$ 43.9	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		**$million/yr**	**$ 1,020.6**	**$ 31.5**	**$ 80.1**	**$ 81.8**	**$ 88.8**	**$ 94.4**	**$ 99.1**	**$ 130.4**	**$ 126.5**	**$ 122.2**	**$ 118.4**	**$ 114.7**	**$ 111.0**	**$ 107.4**	**$ 104.6**	**$ 101.2**	**$ 97.9**	**$ 94.7**	**$ 91.6**	**$ 88.5**	**$ 85.7**	**$ 83.1**	**$ 81.2**	**$ 78.2**	**$ 76.0**	**$ 74.3**	**$ 69.8**
		Fixed O&M		$million/yr		$ 9.3	$ 12.2	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.6
		Fixed O&M adder Turbine Maintenance		$million/yr		$ 3.2	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 173.4**	**$ 12.5**	**$ 12.2**	**$ 12.2**	**$ 12.8**	**$ 13.0**	**$ 13.5**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 17.0**	**$ 24.8**	**$ 18.0**	**$ 18.6**	**$ 19.1**	**$ 19.7**	**$ 20.3**	**$ 20.9**	**$ 21.5**	**$ 22.1**	**$ 22.8**	**$ 32.5**	**$ 24.2**	**$ 29.6**

Case 16 Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Commercial information is highlighted in gray

			Source or input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		513	507	507	555	555	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
		Capacity Factor	A / B	%		75%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,804	3,804	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
		Average MISO Energy Price	D	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	$millions/yr	$ (1,875)	[redacted]																									
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		538	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
		Capacity Value	R	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$millions/yr	$ (219)	$ -	$ -	$ -	$ (26.3)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,804	3,804	3,785	3,785	3,785	3,765	3,785	3,785	3,785	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
		Full Load Heat Rate	Q	Btu/kWh		10,516	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,116
		MMBtu Fuel Burn	calc	Million MMBtu		[redacted]																									
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	$millions/yr	$ 1,700	[redacted]																									
		$/MMBtu VO&M Cost	O	$/MMBtu		[redacted]																									
		Annual VO&M Cost	calc		$ 100	[redacted]																									
		NOx Emission Rate	N	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	2,326	2,271	2,169	2,169	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149
		NOx Credit Cost	O	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.69	3.82	3.82	3.73	3.99	3.99	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)		$millions/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.9	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$millions/yr		$ 0.3	$ 7.1	$ 8.7	$ 19.9	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$millions/yr		$ 0.0	$ 1.1	$ 2.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$millions/yr		$ 0.0	$ 1.1	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$millions/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$millions/yr		$ 0.0	$ 1.1	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$millions/yr		$ 0.0	$ 1.1	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$millions/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$millions/yr		$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$millions/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
		Capital adder SCR		$millions/yr		$ -	$ -	$ 1.3	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$millions/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$millions/yr		$ 172.5	$ 64.1	$ 28.8	$ 83.4	$ 94.1	$ 115.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.5	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.8	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.8	$ 10.9	$ 3.9	$ 0.3
	Fixed O&M	Capital Rev Req Sum/Discom		$millions/yr		$ 13.9	$ 12.3	$ 11.6	$ 10.8	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.3	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$millions/yr		$ 4.4	$ 6.1	$ 10.4	$ 12.0	$ 13.6	$ 14.9	$ 15.1	$ 15.6	$ 16.6	$ 17.9	$ 19.2	$ 20.6	$ 21.9	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.8	$ 34.8	$ 37.3	$ 39.3	$ 40.5	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills	J	$millions/yr		$ 0.1	$ 0.7	$ 1.8	$ 10.4	$ 12.4	$ 11.9	$ 11.4	$ 10.9	$ 10.4	$ 9.9	$ 9.4	$ 8.0	$ 8.5	$ 8.5	$ 8.3	$ 7.8	$ 7.4	$ 7.0	$ 6.5	$ 6.1	$ 5.6	$ 5.2	$ 4.8	$ 4.0	$ 5.9	$ 5.2
		Capital Rev Req SCR		$millions/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 46.9	$ 43.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.5
		Capital Rev Req CACP		$millions/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.1	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$millions/yr	$ 1,020.6	$ 31.5	$ 80.1	$ 81.8	$ 89.8	$ 94.4	$ 98.1	$ 130.4	$ 126.5	$ 122.5	$ 118.4	$ 114.7	$ 111.0	$ 107.4	$ 104.0	$ 101.3	$ 97.9	$ 94.7	$ 91.8	$ 89.5	$ 86.7	$ 83.1	$ 81.2	$ 78.2	$ 76.0	$ 74.2	$ 69.8
		Fixed O&M		$millions/yr		$ 9.7	$ 12.2	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 28.0
		Fixed O&M adder CAMP Study and CA Development		$millions/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$millions/yr		$ 3.2	$ -	$ -	$ 0.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -	$ -
		TOTAL Fixed O&M		$millions/yr	$ 173.4	$ 12.5	$ 12.2	$ 12.2	$ 12.9	$ 13.0	$ 13.5	$ 14.2	$ 14.8	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 24.4	$ 18.0	$ 18.6	$ 19.1	$ 19.7	$ 20.3	$ 20.8	$ 21.5	$ 22.1	$ 22.8	$ 22.6	$ 24.2	$ 28.8

Case 17 | Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

			Source on Sized page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		513	507	507	505	505	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
		Capacity Factor	A, J, K	%		78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,804	3,804	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
		Average MIDO Energy Price	D	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	**$millions/yr**	**$ (1,878)**																										
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		538	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	**$millions/yr**	**$ (219)**	**$ -**	**$ -**	**$ -**	**$ (26.5)**	**$ (26.7)**	**$ (26.7)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**	**$ (26.6)**
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,804	3,804	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,785	3,533	3,785	3,785
		Full Load Heat Rate	D	Btu/kWh		10,518	10,534	10,534	10,061	10,081	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
		MMBtu Fuel Burn	calc	Million MMBtu		35.3	36.6	36.6	35.7	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	35.6	38.3	38.3
		$/MMBtu Delivered Fuel Cost		$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	**$Millions/yr**	**$ 1,020**																										
		$/MMBtu VO&M Cost	O	$/MMBtu																											
		Annual VO&M Cost	calc		**$ 166**																										
		NOx Emission Rate	N	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	2,326	2,271	2,169	2,169	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.69	3.82	3.82	3.73	3.99	3.99	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$millions/yr		$ 17.3	$ 24.8	$ 8.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$millions/yr		$ 0.3	$ 7.1	$ 9.7	$ 19.9	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$millions/yr		$ 0.0	$ 1.1	$ 3.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$millions/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$millions/yr		$ 0.0	$ 1.1	$ 1.9	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$millions/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$millions/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$millions/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$millions/yr		$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$millions/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
		Capital adder SCR		$millions/yr		$ -	$ -	$ 12	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$millions/yr		$ 15.28	$ 25.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$millions/yr		$ 172.5	$ 64.3	$ 28.6	$ 83.4	$ 94.1	$ 116.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.5	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.9	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.6	$ 10.9	$ 3.9	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$millions/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$millions/yr		$ 4.4	$ 8.1	$ 10.4	$ 17.0	$ 13.6	$ 14.9	$ 15.1	$ 15.6	$ 16.6	$ 17.8	$ 19.2	$ 20.8	$ 21.9	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills		$millions/yr		$ 0.1	$ 0.7	$ 1.8	$ 10.4	$ 12.4	$ 11.9	$ 11.4	$ 10.9	$ 10.4	$ 9.9	$ 9.4	$ 9.0	$ 8.5	$ 8.5	$ 8.3	$ 8.8	$ 7.4	$ 7.0	$ 6.5	$ 6.1	$ 5.6	$ 5.2	$ 4.8	$ 6.0	$ 5.9	$ 5.2
		Capital Rev Req SCR		$millions/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 46.9	$ 45.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$millions/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 57.7	$ 50.4	$ 46.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		**$millions/yr**	**$ 1,020.6**	**$ 31.6**	**$ 80.1**	**$ 81.6**	**$ 89.8**	**$ 94.4**	**$ 98.1**	**$ 130.4**	**$ 126.5**	**$ 122.3**	**$ 118.4**	**$ 114.7**	**$ 111.0**	**$ 107.4**	**$ 104.5**	**$ 101.3**	**$ 97.8**	**$ 94.7**	**$ 91.6**	**$ 88.5**	**$ 86.7**	**$ 83.1**	**$ 81.2**	**$ 76.3**	**$ 79.0**	**$ 74.2**	**$ 69.8**
		Fixed O&M		$millions/yr		$ 9.2	$ 12.2	$ 13.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 20.0
		Fixed O&M adder CAMP Study and CA Development		$millions/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder ACR		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$millions/yr		$ 3.2	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8.4	$ -	$ -
		TOTAL Fixed O&M		**$millions/yr**	**$ 172.4**	**$ 12.5**	**$ 12.2**	**$ 13.2**	**$ 12.9**	**$ 13.0**	**$ 13.6**	**$ 14.2**	**$ 14.8**	**$ 15.1**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 16.9**	**$ 16.6**	**$ 17.0**	**$ 24.6**	**$ 19.0**	**$ 19.6**	**$ 19.1**	**$ 19.7**	**$ 20.3**	**$ 20.8**	**$ 21.8**	**$ 22.1**	**$ 22.8**	**$ 32.8**	**$ 24.2**	**$ 20.8**

Case 18 — Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Commercial Information Highlighted in Gray

			Source or Input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		513	507	507	550	550	550	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547	547
		Capacity Factor	A | K	%		67%	70%	70%	68%	70%	70%	70%	70%	70%	70%	70%	70%	70%	68%	70%	70%	70%	70%	70%	70%	70%	70%	70%	66%	70%	70%
		Energy Production		calc		3,021	3,127	3,127	3,165	3,284	3,294	3,376	3,376	3,376	3,376	3,376	3,376	3,376	3,152	3,376	3,376	3,376	3,376	3,376	3,376	3,376	3,376	3,376	3,152	3,376	3,376
		Average MISO Energy Price		O	$/MWh																										
		Annual Energy Revenue		calc	$million/yr	$ (1,320)																									
	CAPACITY MARKET VALUE	Reserve Capacity		L	MW		538	540	534	534	543	543	543	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540
		Capacity Value		H	$/MW-yr		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Annual Capacity Value		calc	$million/yr	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	PRODUCTION COST	Energy Production		calc	GWh		3,021	3,127	3,127	3,165	3,284	3,294	3,376	3,376	3,376	3,376	3,376	3,376	3,376	3,152	3,376	3,376	3,376	3,376	3,376	3,376	3,376	3,376	3,152	3,376	3,376
		Full Load Heat Rate		Q	Btu/kWh		10,518	10,534	10,534	10,105	10,105	10,165	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163	10,163
		MMBtu Fuel Burn		calc	Million MMBtu		31.8	33.0	33.0	32.0	34.5	34.3	34.3	34.3	34.3	34.3	34.3	34.3	32.0	34.3	34.3	34.3	34.3	34.3	34.3	34.3	34.3	34.3	32.0	34.3	34.3
		$/MMBtu Delivered Fuel Cost		E	$/MMBtu																										
		Annual Fuel Cost		calc	$Million/yr	$ 1,524																									
		$/MMBtu VO&M Cost		O	$/MMBtu																										
		Annual VO&M Cost		calc		$ 89																									
		NOx Rate		H	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions		calc	tons/yr		2,020	2,083	2,083	2,036	1,962	1,962	1,029	1,029	1,029	1,029	1,029	1,029	1,029	941	1,029	1,029	1,029	1,029	1,029	1,029	1,029	1,029	941	1,029	1,029
		NOx Credit Cost		Q	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost		calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate		B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions		calc	million tons/yr		3.22	3.44	3.44	3.34	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.34	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.34	3.58	3.58
		CO2 Credit Cost		F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost		calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)			$million/yr	$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.8	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades			$million/yr	$ 0.3	$ 7.3	$ 9.7	$ 19.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1			$million/yr	$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2			$million/yr	$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3			$million/yr	$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4			$million/yr	$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5			$million/yr	$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6			$million/yr	$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance			$million/yr	$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance			$million/yr	$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
	Revenue Requirements	Capital adder SCR			$million/yr		-	$ 1.2	$ 40.0	$ 60.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Clean Air Compliance Programs (CACP)			$million/yr	$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds			$million/yr	$ 172.5	$ 64.3	$ 26.8	$ 83.4	$ 94.1	$ 116.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.5	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.8	$ 13.1	$ 13.4	$ 15.7	$ 14.0	$ 10.8	$ 10.9	$ 3.9	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom			$million/yr	$ 13.0	$ 12.3	$ 11.6	$ 10.8	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing			$million/yr	$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.8	$ 15.1	$ 15.9	$ 16.6	$ 17.9	$ 19.2	$ 20.6	$ 21.8	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.6	$ 32.8	$ 34.6	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills	J		$million/yr	$ 0.1	$ 0.8	$ 2.0	$ 11.4	$ 13.7	$ 13.1	$ 12.5	$ 12.0	$ 11.4	$ 10.8	$ 10.4	$ 9.8	$ 9.4	$ 9.4	$ 9.1	$ 8.8	$ 8.1	$ 7.6	$ 7.2	$ 6.7	$ 6.2	$ 5.8	$ 5.3	$ 6.5	$ 6.5	$ 5.7
		Capital Rev Req SCR			$million/yr	$ -	$ -	$ 0.8	$ 1.8	$ 5.3	$ 11.8	$ 46.9	$ 45.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP			$million/yr	$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.1	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total			$million/yr	$ 1,028.6	$ 31.6	$ 80.2	$ 81.7	$ 90.8	$ 96.6	$ 99.3	$ 131.4	$ 127.9	$ 122.3	$ 118.4	$ 116.4	$ 111.8	$ 109.3	$ 106.3	$ 102.1	$ 98.7	$ 95.4	$ 92.3	$ 89.1	$ 86.3	$ 83.7	$ 81.8	$ 78.7	$ 75.6	$ 74.7	$ 60.3
		Fixed O&M			$million/yr		9.2	$ 12.2	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 28.0
		Fixed O&M adder CAMP Study and CA Development			$million/yr		0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR			$million/yr		-	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance			$million/yr		3.2	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M			$million/yr	$ 171.4	$ 12.6	$ 12.2	$ 12.2	$ 12.8	$ 13.0	$ 13.8	$ 14.2	$ 14.8	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.3	$ 20.9	$ 21.5	$ 22.1	$ 22.8	$ 32.8	$ 24.2	$ 28.8

Case 19 | Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Unavailable Information is Highlighted in Grey

			Source on input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		513	507	507	540	560	560	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557	557
		Capacity Factor	K	%		82%	88%	86%	80%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%
		Energy Production	calc	GWh		3,693	3,821	3,821	3,940	4,220	4,220	4,199	4,199	4,199	4,199	4,199	4,199	4,199	3,921	4,199	4,199	4,199	4,199	4,199	4,199	4,199	4,199	4,199	3,921	4,199	4,199
		Average MISO Energy Price	O	$/MWh																											
		Annual Energy Revenue	calc	$million/yr	$ (2,740)																										
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		536	540	534	534	545	545	545	542	542	542	542	542	542	542	542	542	542	542	542	542	542	542	542	542	542	542
		Capacity Value	M	$/MW/yr		-	-	-	98,360	98,360	98,360	98,360	98,360	98,360	98,360	98,360	98,360	98,360	98,360	98,360	98,360	98,360	98,360	98,360	98,360	98,360	98,360	98,360	98,360	98,360	98,360
		Annual Capacity Value	calc	$million/yr	$ (438)	$ -	$ -	$ -	$ (52.5)	$ (53.6)	$ (53.6)	$ (53.6)	$ (53.3)	$ (53.3)	$ (53.3)	$ (53.3)	$ (53.3)	$ (53.3)	$ (53.3)	$ (53.3)	$ (53.3)	$ (53.3)	$ (53.3)	$ (53.3)	$ (53.3)	$ (53.3)	$ (53.3)	$ (53.3)	$ (53.3)	$ (53.3)	$ (53.3)
	PRODUCTION COST	Energy Production	calc	GWh		3,693	3,821	3,821	3,940	4,220	4,220	4,199	4,199	4,199	4,199	4,199	4,199	4,199	3,921	4,199	4,199	4,199	4,199	4,199	4,199	4,199	4,199	4,199	3,921	4,199	4,199
		Full Load Heat Rate	D	Btu/kWh		10,518	10,534	10,534	10,017	10,017	10,017	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075	10,075
		MMBtu Fuel Burn	calc	Million MMBtu		38.8	40.3	40.3	39.5	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	39.5	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	39.5	42.3	42.3
		$/MMBtu Delivered Fuel Cost	F	$/MMBtu																											
		Annual Fuel Cost	calc	$Million/yr	$ 1,126																										
		$/MMBtu VO&M Cost	O	$/MMBtu																											
		Annual VO&M Cost	calc		$ 116																										
		NOx Emission Rate	R	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,469	2,558	2,558	2,508	2,418	2,418	1,269	1,269	1,269	1,269	1,269	1,269	1,269	1,185	1,269	1,269	1,269	1,269	1,269	1,269	1,269	1,269	1,269	1,185	1,269	1,269
		NOx Credit Cost	O	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	R	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		4.05	4.20	4.20	4.12	4.41	4.41	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.12	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.12	4.42	4.42
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds Revenue Requirements	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ 7.1	$ 0.7	$ 19.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 7.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ -	$ 3.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.5	$ 64.3	$ 26.6	$ 83.4	$ 94.1	$ 116.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.5	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.8	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.8	$ 10.9	$ 3.8	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.8	$ 10.7	$ 9.8	$ 8.0	$ 6.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.3	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.6	$ 17.9	$ 19.2	$ 20.6	$ 21.9	$ 23.2	$ 24.9	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills		$million/yr		$ 0.1	$ 0.8	$ 1.6	$ 9.4	$ 11.2	$ 10.7	$ 10.3	$ 9.8	$ 9.3	$ 8.8	$ 8.3	$ 8.1	$ 7.7	$ 7.7	$ 7.5	$ 7.1	$ 6.7	$ 6.3	$ 5.9	$ 5.5	$ 5.1	$ 4.7	$ 4.3	$ 3.4	$ 5.3	$ 4.7
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 46.9	$ 45.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 58.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.8	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.1	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$million/yr	$ 1,012.7	$ 31.5	$ 80.0	$ 81.4	$ 88.8	$ 93.1	$ 96.9	$ 129.3	$ 125.5	$ 121.2	$ 117.4	$ 113.7	$ 110.1	$ 106.8	$ 103.6	$ 100.4	$ 97.1	$ 93.9	$ 90.8	$ 87.8	$ 85.1	$ 82.4	$ 80.7	$ 78.7	$ 77.4	$ 73.8	$ 69.3
		Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$million/yr		$ 3.2	$ -	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8.4	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 173.4	$ 12.5	$ 12.2	$ 12.2	$ 12.8	$ 13.9	$ 13.5	$ 14.2	$ 14.8	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 24.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.3	$ 20.8	$ 21.5	$ 22.1	$ 22.8	$ 32.3	$ 24.2	$ 29.8

Case 20 — Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

			Source on input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		513	507	507	555	505	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552	552
		Capacity Factor	A, J, K	%		75%	78%	75%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,604	3,604	3,765	3,765	3,765	3,765	3,765	3,765	3,765	3,765	3,503	3,765	3,765	3,765	3,765	3,765	3,765	3,765	3,765	3,503	3,765	3,765
		Average MISO Energy Price	D	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	$million/yr	$ (2,344)																										
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW		536	540	534	534	544	544	544	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541	541
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$million/yr	$ (218)	$ -	$ -	$ -	$ (26.3)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.5)	$ (26.5)	$ (26.5)	$ (26.5)	$ (26.5)	$ (26.5)	$ (26.5)	$ (26.5)	$ (26.5)	$ (26.5)	$ (26.5)	$ (26.5)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,604	3,604	3,765	3,765	3,765	3,765	3,765	3,765	3,765	3,765	3,503	3,765	3,765	3,765	3,765	3,765	3,765	3,765	3,765	3,503	3,765	3,765
		Full Load Heat Rate	Q	Btu/kWh		10,516	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
		MMBtu Fuel Burn	calc	Million MMBtu		35.3	36.6	36.6	35.7	36.3	36.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	35.8	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	35.8	38.3	38.3
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	$Million/yr	$ 1,286																										
		$/MMBtu VO&M Cost	O	$/MMBtu																											
		Annual VO&M Cost	calc	$	$ 100																										
		NOx Emission Rate	N	lbs/MMBtu		0.127	0.127	0.127	0.127	0.114	0.114	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	2,326	2,271	2,168	2,168	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,149	1,073	1,149	1,149
		NOx Credit Cost	O	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.69	3.82	3.82	3.73	3.99	3.99	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.73	4.00	4.00
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16	$ 17	$ 18	$ 20	$ 22	$ 24	$ 26	$ 28	$ 30	$ 33	$ 35	$ 38	$ 41	$ 44	$ 48	$ 52	$ 56
		Annual CO2 Cost	calc	$ Millions	$ 483	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 64.2	$ 69.4	$ 76.1	$ 81.2	$ 82.0	$ 84.9	$ 102.4	$ 110.9	$ 120.8	$ 129.7	$ 140.2	$ 151.6	$ 163.9	$ 177.2	$ 178.9	$ 207.1	$ 224.0
	Capital Adds / Revenue Requirements	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.6	$ 8.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.8	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.9	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 12.8	$ 10.5	$ 7.2	$ 3.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ 7.1	$ 0.2	$ 19.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 3.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.5	$ 84.2	$ 28.6	$ 83.4	$ 94.1	$ 116.1	$ 6.2	$ 6.3	$ 10.4	$ 10.8	$ 10.8	$ 11.1	$ 11.3	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.9	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.8	$ 10.9	$ 3.8	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 17.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.6	$ 17.8	$ 19.2	$ 20.6	$ 21.9	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.6	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.7	$ 1.6	$ 10.4	$ 12.4	$ 11.9	$ 11.4	$ 10.9	$ 10.4	$ 9.9	$ 9.4	$ 9.0	$ 8.5	$ 8.5	$ 8.2	$ 7.8	$ 7.4	$ 7.0	$ 6.5	$ 6.1	$ 5.6	$ 5.2	$ 4.8	$ 4.0	$ 5.9	$ 5.2
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.8	$ 48.9	$ 45.6	$ 43.7	$ 41.8	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.5
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 58.0	$ 57.7	$ 55.2	$ 57.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.1	$ 14.4	$ 13.2	$ 10.5
		Capital Rev Req Total		$million/yr	$ 1,020.6	$ 31.6	$ 89.1	$ 81.6	$ 89.8	$ 94.4	$ 98.1	$ 130.4	$ 126.5	$ 122.2	$ 118.4	$ 114.7	$ 111.0	$ 107.4	$ 104.6	$ 101.3	$ 97.9	$ 94.7	$ 91.8	$ 88.6	$ 86.7	$ 83.1	$ 81.2	$ 78.2	$ 76.0	$ 74.2	$ 59.8
		Fixed O&M		$million/yr		$ 10.7	$ 12.7	$ 12.2	$ 12.6	$ 13.0	$ 11.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.9
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$million/yr		$ 2.2	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 172.4	$ 12.8	$ 12.7	$ 12.2	$ 12.8	$ 13.0	$ 11.8	$ 14.2	$ 14.8	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 24.8	$ 25.0	$ 19.0	$ 19.1	$ 19.7	$ 20.3	$ 20.8	$ 21.5	$ 22.1	$ 22.8	$ 32.3	$ 24.2	$ 29.9

Case 21	Appendix B, Schedule 4 - CALCS - PROJECT (Upgrades with 2013 Technology) Columbia Unit 2 Turbine and Mill Upgrade Analysis

			Source or Input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 PROJECT	ENERGY REVENUE	Rated Capacity	M	MW		513	507	507	558	558	555	552	552	552	552	552	552	552	552	552	552	552	552	552	552	553	552	552	552	552	552
		Capacity Factor	A, J, K	%		75%	78%	78%	73%	78%	78%	78%	78%	78%	[redacted]																
		Energy Production	calc	GWh		[redacted]																									
		Average MISO Energy Price	D	$/MWh																											
		Annual Energy Revenue	calc	$million/yr	$ (2,168)																										
	CAPACITY MARKET VALUE	Reserve Capacity	L	MW																											
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$million/yr	$ (219)	$ -	$ -	$ -	$ (26.3)	$ (26.7)	$ (26.7)	$ (26.7)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.5)	$ (26.6)	$ (26.6)	$ (26.5)	$ (26.5)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.6)	$ (26.5)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	3,474	3,551	3,804	3,804	3,785	3,785	3,785	3,406	3,406	3,406	3,406	3,180	3,406	3,406	3,406	3,406	3,406	3,406	3,406	3,406	3,406	3,180	3,406	3,406
		Full Load Heat Rate	G	Btu/kWh		10,518	10,534	10,534	10,061	10,061	10,061	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119	10,119
		MMBtu Fuel Burn	calc	Millon MMBtu		[redacted]																									
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu																											
		Annual Fuel Cost	calc	$Million/yr	$ 1,286																										
		$/MMBtu VO&M Cost	O	$/MMBtu																											
		Annual VO&M Cost	calc		$ 84																										
		NOx Emission Rate	N	lbs/MMBtu																											
		NOx emissions	calc	tons/yr		2,244	2,326	2,326	2,271	2,189	2,189	1,149	1,149	1,168	1,034	1,034	1,034	1,034	965	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	965	1,034	1,034
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.69	3.82	3.82	3.73	3.99	3.99	4.00	4.00	4.00	3.60	3.60	3.60	3.60	3.36	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.36	3.60	3.60
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16	$ 17	$ 19	$ 20	$ 22	$ 24	$ 26	$ 28	$ 30	$ 32	$ 35	$ 38	$ 41	$ 44	$ 48	$ 52	$ 56
		Annual CO2 Cost	calc	$ Millions	$ 434	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 57.8	$ 62.6	$ 67.6	$ 72.1	$ 72.8	$ 85.4	$ 92.4	$ 99.8	$ 108.0	$ 116.7	$ 126.2	$ 136.4	$ 147.5	$ 159.5	$ 161.0	$ 186.4	$ 201.6
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.9	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.3	$ 7.1	$ 9.7	$ 16.9	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ 1.1	$ 3.4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ 1.1	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ 1.1	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ 1.1	$ -	$ 3.5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ 1.1	$ -	$ 1.4	$ 2.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ -	$ 1.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.5	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.6	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.5	$ 64.3	$ 28.6	$ 83.4	$ 94.1	$ 116.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.5	$ 14.5	$ 12.0	$ 12.3	$ 12.6	$ 12.8	$ 13.1	$ 13.4	$ 13.7	$ 14.0	$ 10.8	$ 10.8	$ 3.9	$ 0.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.3	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 6.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.6	$ 17.8	$ 18.2	$ 20.6	$ 21.9	$ 23.7	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 39.2	$ 40.3	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills	J	$million/yr		$ 0.1	$ 0.7	$ 1.6	$ 10.4	$ 12.4	$ 11.9	$ 11.4	$ 10.9	$ 10.4	$ 9.9	$ 9.4	$ 9.0	$ 8.5	$ 8.5	$ 8.3	$ 7.8	$ 7.4	$ 7.0	$ 6.5	$ 6.1	$ 5.6	$ 5.2	$ 4.8	$ 6.0	$ 5.9	$ 5.2
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 6.3	$ 11.6	$ 46.9	$ 45.9	$ 43.7	$ 41.8	$ 39.8	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.6	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 58.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.6	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$million/yr	$ 1,020.6	$ 31.5	$ 80.1	$ 81.8	$ 89.8	$ 94.4	$ 98.1	$ 130.4	$ 126.5	$ 122.1	$ 118.4	$ 114.7	$ 111.0	$ 107.4	$ 104.5	$ 101.3	$ 97.9	$ 94.7	$ 91.6	$ 88.6	$ 85.7	$ 83.1	$ 81.2	$ 79.2	$ 78.0	$ 74.2	$ 69.8
		Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.6
		Fixed O&M adder Turbine Maintenance		$million/yr		3.2	$ -	$ -	$ 0.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8.4	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 172.4	$ 12.5	$ 12.2	$ 12.2	$ 12.9	$ 13.0	$ 13.6	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 24.6	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.3	$ 20.9	$ 21.5	$ 22.1	$ 22.8	$ 31.9	$ 24.2	$ 29.6

Case 1

Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Source on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	A1-S	%		77%	73%	77%	59%	77%	77%	77%	77%	77%	71%	71%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,662)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (201)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Full Load Heat Rate	Y	Btu/kWh		10,658	10,676	10,678	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	28.0	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,194**																							
		$/MMBtu VO&M Cost	W	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 77**																							
		NOx Emission Rate	V	lb/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions	calc	tons/yr		2,731	2,583	2,705	2,087	2,699	2,699	2,699	2,699	2,699	2,698	2,514	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.98	3.08	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 8.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 8.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 16.3	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 25.6	$ 7.4	$ 7.3	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 9.9	$ 8.1	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.9
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.2	$ 0.4	$ 2.6	$ 3.7	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.3	$ 4.5	$ 4.5	$ 4.5	$ 4.4	$ 4.4	$ 4.3	$ 5.3	$ 5.5	$ 5.6	$ 5.7	$ 5.9	$ 6.4
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 58.6	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.6	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 13.6
		Capital Rev Req Total		$million/yr	**$ 675.1**	**$ 28.6**	**$ 76.8**	**$ 75.8**	**$ 77.1**	**$ 76.0**	**$ 73.8**	**$ 71.9**	**$ 69.8**	**$ 67.9**	**$ 66.1**	**$ 64.4**	**$ 63.0**	**$ 61.2**	**$ 59.4**	**$ 57.8**	**$ 56.2**	**$ 54.7**	**$ 54.2**	**$ 53.3**	**$ 51.6**	**$ 48.9**	**$ 47.8**	**$ 39.8**
		Fixed O&M		$million/yr		$ 8.8	$ 12.6	$ 11.9	$ 12.7	$ 12.9	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 20.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 159.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 15.8**	**$ 12.9**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 21.5**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 17.0**	**$ 17.6**	**$ 18.0**	**$ 26.4**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 20.5**

Case 2 — **Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information to Highlighted in Grey

			Source on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	A, I, S	%		77%	73%	77%	59%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,662)**	[redacted]																						
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		526	527	523	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (201)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Full Load Heat Rate	Y	Btu/kWh		10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	28.0	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,194**	[redacted]																						
		$/MMBtu VO&M Cost	W	$/MMBtu		[redacted]																						
		Annual VO&M Cost	**calc**	**$**	**77**	[redacted]																						
		NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,087	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698
		NOx Credit Cost	D	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	210.52	219.52	210.52	219.52	219.52	219.52	219.52	210.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.00	3.81	3.99	3.08	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 18.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.6	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 9.9	$ 8.1	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.8	$ 10.1	$ 9.6	$ 9.1	$ 8.8	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	B	$million/yr		$ 0.1	$ 0.2	$ 0.4	$ 2.6	$ 3.7	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.3	$ 4.5	$ 4.8	$ 4.5	$ 4.4	$ 4.4	$ 4.5	$ 5.3	$ 5.5	$ 5.5	$ 5.7	$ 6.0	$ 6.4
		Capital Rev Req CACP		$million/yr		$ 13.8	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 675.1**	**$ 28.6**	**$ 76.4**	**$ 76.8**	**$ 77.1**	**$ 76.0**	**$ 73.9**	**$ 71.8**	**$ 69.8**	**$ 67.9**	**$ 66.1**	**$ 64.6**	**$ 63.0**	**$ 61.2**	**$ 59.4**	**$ 57.8**	**$ 56.3**	**$ 54.7**	**$ 53.3**	**$ 51.9**	**$ 49.9**	**$ 47.6**	**$ 39.8**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.3	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.6	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 159.8**	**$ 8.9**	**$ 15.3**	**$ 11.8**	**$ 15.8**	**$ 12.6**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 21.5**	**$ 15.6**	**$ 16.0**	**$ 16.5**	**$ 17.0**	**$ 17.6**	**$ 18.0**	**$ 26.4**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 3	Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology) Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

		Source on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 ALTERNATIVE — ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	509	508
	Capacity Factor	A I S	%		77%	73%	77%	59%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%
	Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
	Average MISO Energy Price	O	$/MWh		[redacted]																						
	Annual Energy Revenue	calc	$million/yr	$ (1,862)																							
CAPACITY MARKET VALUE	Reserve Capacity	T	MW		529	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
	Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
	Annual Capacity Value	calc	$million/yr	$ (201)	$ -	$ -	$ -	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)
PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
	Full Load Heat Rate	Y	Btu/kWh		10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
	MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	28.0	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2
	$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
	Annual Fuel Cost	calc	$Million/yr	$ 1,184																							
	$/MMBtu VO&M Cost	W	$/MMBtu																								
	Annual VO&M Cost	calc		$ 77																							
	NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
	NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,087	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698
	NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
	CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.08	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98
	CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
	Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 16.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.6	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 9.9	$ 8.1	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.2
Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.0	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
	Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.8	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
	Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.2	$ 0.4	$ 2.6	$ 3.7	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.3	$ 4.5	$ 4.5	$ 4.5	$ 4.4	$ 4.4	$ 4.5	$ 5.3	$ 5.5	$ 5.5	$ 5.7	$ 6.0	$ 6.4
	Capital Rev Req CACP		$million/yr		$ 13.0	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
	Capital Rev Req Total		$million/yr	$ 676.1	$ 28.0	$ 76.6	$ 76.9	$ 77.1	$ 76.0	$ 73.9	$ 71.8	$ 69.8	$ 67.9	$ 66.1	$ 64.6	$ 63.0	$ 61.2	$ 59.4	$ 57.8	$ 55.6	$ 54.7	$ 64.2	$ 53.3	$ 51.8	$ 49.9	$ 47.6	$ 39.8
	Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
	Fixed O&M adder CAMP Study and CA Development		$million/yr		0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -
	TOTAL Fixed O&M		$million/yr	$ 151.5	$ 8.9	$ 15.3	$ 11.9	$ 15.8	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 21.5	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 26.4	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5

Case 4	Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology) Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

UNIT 1 ALTERNATIVE

Section	Item	Source on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	508	508	508	508	508
	Capacity Factor	A, I, 3	%		77%	73%	77%	59%	77%	77%	77%	77%	77%	77%	71%	77%
	Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404
	Average MISO Energy Price	D	$/MWh		[redacted]											
	Annual Energy Revenue	calc	$million/yr	$ (1,662)												
CAPACITY MARKET VALUE	Reserve Capacity	T	MW		528	527	522	522	522	522	522	522	522	522	522	522
	Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
	Annual Capacity Value	calc	$million/yr	$ (201)	$ -	$ -	$ -	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)
PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404
	Full Load Heat Rate	Y	Btu/kWh		10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
	MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	28.0	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2
	$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]											
	Annual Fuel Cost	calc	$Million/yr	$ 1,184												
	$/MMBtu VO&M Cost	W	$/MMBtu													
	Annual VO&M Cost	calc		$ 77												
	NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
	NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,087	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698
	NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
	CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.09	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98
	CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9
	Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 16.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -
Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.6	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 9.9	$ 8.1
Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0
	Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.7	$ 12.0	$ 12.8	$ 13.6	$ 14.4
	Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.2	$ 0.4	$ 2.8	$ 4.1	$ 4.2	$ 4.2	$ 4.3	$ 4.3	$ 4.4	$ 4.7	$ 4.9
	Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0
	Capital Rev Req Total		$million/yr	$ 678.4	$ 28.6	$ 76.7	$ 76.9	$ 77.3	$ 76.4	$ 74.3	$ 72.2	$ 70.2	$ 68.3	$ 66.5	$ 65.0	$ 63.4
	Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5
	Fixed O&M adder CAMP Study and CA Development		$million/yr		0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -
	TOTAL Fixed O&M		$million/yr	$ 161.9	$ 8.9	$ 15.3	$ 11.9	$ 15.8	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 21.5	$ 15.5

Item	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2036
Rated Capacity	508	508	508	508	508	508	508	508	508	508	508
Capacity Factor	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%
Energy Production	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
Average MISO Energy Price	[redacted]										
Annual Energy Revenue											
Reserve Capacity	522	522	522	522	522	522	522	522	522	522	522
Capacity Value	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
Annual Capacity Value	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)
Energy Production	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
Full Load Heat Rate	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
MMBtu Fuel Burn	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2
$/MMBtu Delivered Fuel Cost	[redacted]										
Annual Fuel Cost											
$/MMBtu VO&M Cost											
Annual VO&M Cost											
NOx Emission Rate	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
NOx emissions	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698
NOx Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual NOx Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
CO2 Emission Rate	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
CO2 emissions	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98
CO2 Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual CO2 Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ongoing Capital Adds (OGC)	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
Cap adder Turbine Upgrades	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Turbine Maintenance	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Maintenance	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
Cap adder Clean Air Compliance Programs (CACP)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Adds	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.2
Capital Rev Req Sunk/Decom	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
Capital Rev Req Ongoing	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
Capital Rev Req Turbine & Mills	$ 4.9	$ 4.9	$ 4.9	$ 4.9	$ 4.9	$ 5.8	$ 6.0	$ 6.1	$ 6.2	$ 6.6	$ 7.1
Capital Rev Req CACP	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
Capital Rev Req Total	$ 61.6	$ 59.9	$ 58.2	$ 56.6	$ 55.2	$ 54.7	$ 53.8	$ 52.4	$ 50.5	$ 48.3	$ 40.5
Fixed O&M	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
Fixed O&M adder CAMP Study and CA Development	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Fixed O&M adder Turbine Maintenance	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -
TOTAL Fixed O&M	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 26.4	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5

Case 5 — **Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Comparison Information is Highlighted in Grey

			Source on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	I	MW		514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	A, I, S	%		77%	73%	77%	59%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,259	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Average MISO Energy Price	D	$/MWh																								
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,662)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (201)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,259	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Full Load Heat Rate	Y	Btu/kWh		10,659	10,679	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	28.0	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu																								
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,194**																							
		$/MMBtu VO&M Cost	W	$/MMBtu																								
		Annual VO&M Cost	**calc**	**$ Millions**	**$ 77**																							
		NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions		tons/yr		2,731	2,583	2,708	2,087	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.08	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 18.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.3	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.0	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.6	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 9.8	$ 8.1	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.2
	Revenue Requirements	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.5	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	H	$million/yr		$ 0.1	$ 0.2	$ 0.3	$ 2.3	$ 3.4	$ 3.4	$ 3.5	$ 3.5	$ 3.5	$ 3.6	$ 3.9	$ 4.0	$ 4.0	$ 4.0	$ 4.0	$ 4.0	$ 4.0	$ 4.7	$ 4.9	$ 5.0	$ 5.1	$ 5.4	$ 5.8
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 671.8**	**$ 28.6**	**$ 76.8**	**$ 76.8**	**$ 76.8**	**$ 75.6**	**$ 73.6**	**$ 71.4**	**$ 69.4**	**$ 67.5**	**$ 65.7**	**$ 64.3**	**$ 63.6**	**$ 60.7**	**$ 59.0**	**$ 57.3**	**$ 55.7**	**$ 54.3**	**$ 53.7**	**$ 52.7**	**$ 51.3**	**$ 48.4**	**$ 47.0**	**$ 38.2**
	Fixed O&M	Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M added CAMP Study and CA Development		$million/yr		0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M added Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.8	$ -	$ -	$ -	$ -	$ -	$ -	$ 5.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 159.9**	**$ 8.9**	**$ 15.3**	**$ 11.8**	**$ 15.8**	**$ 12.6**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 21.5**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 17.0**	**$ 17.6**	**$ 18.0**	**$ 26.4**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 6	Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology) Columbia Unit 1 Turbine and Mill Upgrade Analysis

UNIT 1 ALTERNATIVE

Section	Item	Source on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	508	508	508	508	508
	Capacity Factor	A | S	%		77%	73%	77%	59%	77%	77%	77%	77%	77%	77%	71%	77%
	Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404
	Average MISO Energy Price	D	$/MWh		[redacted]											
	Annual Energy Revenue	calc	$million/yr	$ (1,662)												
CAPACITY MARKET VALUE	Reserve Capacity	T	MW		520	527	522	522	522	522	522	522	522	522	522	522
	Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
	Annual Capacity Value	calc	$million/yr	$ (201)	$ -	$ -	$ -	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)
PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404
	Full Load Heat Rate	Y	Btu/kWh		10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
	MMBtu Fuel Burn	calc	Million MMBtu		[redacted]											
	$/MMBtu Delivered Fuel Cost	E	$/MMBtu													
	Annual Fuel Cost	calc	$Million/yr	$ 1,194												
	$/MMBtu VO&M Cost	W	$/MMBtu													
	Annual VO&M Cost	calc		$ 77												
	NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
	NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,057	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698
	NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
	CO2 emissions	calc	million tons/yr		4.03	3.81	3.98	3.08	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98
	CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9
	Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 16.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -
	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.6	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 9.9	$ 8.1
Revenue Requirements	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0
	Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4
	Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.2	$ 0.4	$ 2.6	$ 3.7	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.3	$ 4.5
	Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0
	Capital Rev Req Total		$million/yr	$ 676.1	$ 28.6	$ 76.6	$ 76.8	$ 77.1	$ 75.9	$ 73.8	$ 71.9	$ 69.8	$ 67.9	$ 66.1	$ 64.6	$ 63.0
Fixed O&M	Fixed O&M		$million/yr		$ 6.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5
	Fixed O&M adder CAMP Study and CA Development		$million/yr		0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -
	TOTAL Fixed O&M		$million/yr	$ 159.9	$ 6.9	$ 15.3	$ 11.9	$ 15.8	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 21.5	$ 15.5

Item	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Rated Capacity	508	508	508	508	508	508	508	508	508	508	508
Capacity Factor	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%
Energy Production	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
Average MISO Energy Price											
Annual Energy Revenue											
Reserve Capacity	522	522	522	522	522	522	522	522	522	522	522
Capacity Value	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
Annual Capacity Value	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)
Energy Production	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
Full Load Heat Rate	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
MMBtu Fuel Burn											
$/MMBtu Delivered Fuel Cost											
Annual Fuel Cost											
$/MMBtu VO&M Cost											
Annual VO&M Cost											
NOx Emission Rate	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
NOx emissions	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698
NOx Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual NOx Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
CO2 Emission Rate	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
CO2 emissions	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98
CO2 Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual CO2 Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ongoing Capital Adds (OGC)	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
Cap adder Turbine Upgrades	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Turbine Maintenance	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Maintenance	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
Cap adder Clean Air Compliance Programs (CACP)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Adds	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.2
Capital Rev Req Sunk/Decom	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
Capital Rev Req Ongoing	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
Capital Rev Req Turbine & Mills	$ 4.5	$ 4.5	$ 4.4	$ 4.4	$ 4.5	$ 5.3	$ 5.5	$ 5.5	$ 5.7	$ 6.0	$ 6.4
Capital Rev Req CACP	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
Capital Rev Req Total	$ 61.2	$ 59.4	$ 57.8	$ 56.2	$ 54.7	$ 54.2	$ 53.3	$ 51.8	$ 49.9	$ 47.6	$ 39.8
Fixed O&M	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
Fixed O&M adder CAMP Study and CA Development	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Fixed O&M adder Turbine Maintenance	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -
TOTAL Fixed O&M	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 26.4	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5

Case 7

Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

			Source on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	A, I, S	%		77%	73%	77%	59%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Average MISO Energy Price	D	$/MWh																								
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,652)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (201)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Full Load Heat Rate	Y	Btu/kWh		10,659	10,678	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	28.0	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu																								
		Annual Fuel Cost	**calc**	**$ Million/yr**	**$ 1,194**																							
		$/MMBtu VO&M Cost	W	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 77**																							
		NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,087	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.06	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 8.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 18.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.0
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.6	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 9.9	$ 8.1	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.9	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.9
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.9	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.2	$ 0.4	$ 2.6	$ 3.7	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.3	$ 4.5	$ 4.5	$ 4.5	$ 4.4	$ 4.4	$ 4.5	$ 5.3	$ 5.5	$ 5.5	$ 5.7	$ 6.0	$ 6.4
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 51.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 13.6
		Capital Rev Req Total		**$million/yr**	**$ 675.1**	**$ 28.6**	**$ 76.6**	**$ 76.8**	**$ 77.1**	**$ 76.0**	**$ 73.9**	**$ 71.9**	**$ 69.8**	**$ 67.9**	**$ 66.1**	**$ 64.6**	**$ 63.0**	**$ 61.2**	**$ 59.4**	**$ 58.2**	**$ 56.3**	**$ 54.7**	**$ 54.2**	**$ 53.3**	**$ 51.8**	**$ 49.3**	**$ 47.6**	**$ 39.8**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.3	$ 20.6	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 151.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 15.8**	**$ 12.8**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 21.5**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 17.0**	**$ 17.5**	**$ 18.0**	**$ 26.4**	**$ 19.1**	**$ 19.7**	**$ 20.3**	**$ 20.6**	**$ 25.5**

Case 8 — **Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

[redacted]

			Source on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	A, I, S	%		77%	73%	77%	59%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,562)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	527	522	522	522	522	522
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (201)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (26.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Full Load Heat Rate	Y	Btu/kWh		10,658	10,675	10,675	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	28.0	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,194**																							
		$/MMBtu VO&M Cost	W	$/MMBtu		[redacted]																						
		Annual VO&M Cost	**calc**		**$ 77**																							
		NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,097	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.09	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 8.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.6	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 16.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		**$million/yr**		**$ 158.5**	**$ 37.0**	**$ 12.6**	**$ 23.6**	**$ 7.4**	**$ 7.2**	**$ 7.4**	**$ 7.4**	**$ 7.6**	**$ 7.7**	**$ 9.0**	**$ 8.1**	**$ 8.0**	**$ 8.2**	**$ 8.4**	**$ 8.6**	**$ 8.7**	**$ 12.0**	**$ 9.1**	**$ 7.3**	**$ 5.3**	**$ 3.3**	**$ 1.3**
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.8	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.9
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.2	$ 0.4	$ 2.6	$ 3.7	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.3	$ 4.5	$ 4.5	$ 4.5	$ 4.4	$ 4.4	$ 4.5	$ 5.5	$ 5.5	$ 5.5	$ 5.7	$ 6.0	$ 6.4
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.0	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 13.6
		Capital Rev Req Total		**$million/yr**	**$ 675.1**	**$ 28.6**	**$ 76.5**	**$ 78.8**	**$ 77.1**	**$ 76.0**	**$ 73.8**	**$ 71.8**	**$ 69.8**	**$ 67.9**	**$ 66.1**	**$ 64.6**	**$ 63.0**	**$ 61.5**	**$ 59.4**	**$ 57.8**	**$ 56.2**	**$ 54.7**	**$ 54.2**	**$ 53.3**	**$ 51.8**	**$ 48.9**	**$ 47.6**	**$ 39.6**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 20.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 159.3**	**$ 8.8**	**$ 15.3**	**$ 11.9**	**$ 15.8**	**$ 12.6**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 21.5**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 17.0**	**$ 17.5**	**$ 18.0**	**$ 26.4**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 20.5**

Case 9 — **Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Space on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	D	MW		514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	A, I, S	%		77%	73%	77%	59%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	72%	71%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Average MISO Energy Price	O	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,662)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (201)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Full Load Heat Rate	Y	Btu/kWh		10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	28.0	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,194**																							
		$/MMBtu VO&M Cost	W	$/MMBtu		[redacted]																						
		Annual VO&M Cost	**calc**		**$ 77**																							
		NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,067	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.08	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds / Revenue Requirements / Fixed O&M	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 16.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.6	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 9.9	$ 8.1	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.2
		Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 9.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.2	$ 0.4	$ 3.0	$ 3.7	$ 3.8	$ 3.8	$ 3.8	$ 3.9	$ 4.0	$ 4.3	$ 4.5	$ 4.5	$ 4.5	$ 4.4	$ 4.4	$ 4.5	$ 5.3	$ 5.5	$ 5.5	$ 5.7	$ 6.0	$ 6.4
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 58.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 675.1**	**$ 28.6**	**$ 76.8**	**$ 78.8**	**$ 77.1**	**$ 76.8**	**$ 73.8**	**$ 71.8**	**$ 69.8**	**$ 67.8**	**$ 66.1**	**$ 64.6**	**$ 63.0**	**$ 61.2**	**$ 59.4**	**$ 57.8**	**$ 56.3**	**$ 54.7**	**$ 54.2**	**$ 53.3**	**$ 51.8**	**$ 49.9**	**$ 47.6**	**$ 39.8**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and DA Development		$million/yr		0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 159.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 15.8**	**$ 12.6**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 21.5**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 17.0**	**$ 17.5**	**$ 18.0**	**$ 26.4**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 10	Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology) Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information Highlighted in Grey

			Source on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
UNIT 1 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	A, E	%		84%	80%	84%	65%	84%	84%	84%	84%	84%	84%	78%
		Energy Production	calc	GWh		3,785	3,575	3,744	2,897	3,744	3,744	3,744	3,744	3,744	3,744	3,490
		Average MISO Energy Price	D	$/MWh		[redacted]										
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,828)**											
	CAPACITY MARKET VALUE	Reserve Capacity	F	MW		526	527	522	522	522	522	522	522	522	522	522
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (201)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**
	PRODUCTION COST	Energy Production	calc	GWh		3,785	3,575	3,744	2,897	3,744	3,744	3,744	3,744	3,744	3,744	3,490
		Full Load Heat Rate	Y	Btu/kWh		10,658	10,679	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	calc	Million MMBtu		40.3	38.2	40.0	30.8	39.9	39.9	39.9	39.9	39.9	39.9	37.1
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]										
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,313**											
		$/MMBtu VO&M Cost	W	$/MMBtu												
		Annual VO&M Cost	**calc**		**$ 84**											
		NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions	calc	tons/yr		3,004	2,842	2,976	2,296	2,967	2,967	2,967	2,967	2,967	2,967	2,766
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		210.52	219.52	218.52	219.52	218.52	219.52	219.52	219.52	218.52	218.52	219.52
		CO2 emissions	calc	million tons/yr		4.42	4.19	4.39	3.38	4.37	4.37	4.37	4.37	4.37	4.37	4.08
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8
		Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 16.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.6	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 8.0
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.8	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.3	$ 0.4	$ 2.6	$ 3.7	$ 3.8	$ 3.8	$ 3.8	$ 3.9	$ 4.0	$ 4.3
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 56.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.2
		Capital Rev Req Total		**$million/yr**	**$ 678.1**	**$ 28.6**	**$ 76.6**	**$ 74.8**	**$ 77.4**	**$ 75.0**	**$ 73.8**	**$ 71.6**	**$ 69.5**	**$ 67.8**	**$ 66.1**	**$ 64.6**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1
		Fixed O&M adder DAMP Study and CA Development		$million/yr		- 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 5.4
		TOTAL Fixed O&M		**$million/yr**	**$ 159.9**	**$ 8.8**	**$ 15.3**	**$ 11.9**	**$ 15.8**	**$ 12.6**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 21.6**

			2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	508	508	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	84%	84%	84%	84%	84%	84%	78%	84%	84%	84%	84%	84%
		Energy Production	3,744	3,744	3,744	3,744	3,744	3,744	3,490	3,744	3,744	3,744	3,744	3,744
		Average MISO Energy Price	[redacted]											
		Annual Energy Revenue												
	CAPACITY MARKET VALUE	Reserve Capacity	522	522	522	522	522	522	522	522	522	522	522	522
		Capacity Value	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**
	PRODUCTION COST	Energy Production	3,744	3,744	3,744	3,744	3,744	3,744	3,490	3,744	3,744	3,744	3,744	3,744
		Full Load Heat Rate	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	39.9	39.9	39.9	39.9	39.9	39.9	37.1	39.9	39.9	39.9	39.9	39.9
		$/MMBtu Delivered Fuel Cost	[redacted]											
		Annual Fuel Cost												
		$/MMBtu VO&M Cost												
		Annual VO&M Cost												
		NOx Emission Rate	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions	2,967	2,967	2,967	2,967	2,967	2,967	2,766	2,967	2,967	2,967	2,967	2,967
		NOx Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	219.52	219.52	219.52	218.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	4.37	4.37	4.37	4.37	4.37	4.37	4.08	4.37	4.37	4.37	4.37	4.37
		CO2 Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 8.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
		Cap adder Clean Air Compliance Programs (CACP)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds	$ 8.1	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Decom	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.1	$ 1.3
		Capital Rev Req Ongoing	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	$ 4.5	$ 4.5	$ 4.5	$ 4.4	$ 4.4	$ 4.5	$ 5.3	$ 5.5	$ 5.5	$ 5.7	$ 6.0	$ 6.4
		Capital Rev Req CACP	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.6	$ 12.6
		Capital Rev Req Total	**$ 63.0**	**$ 61.2**	**$ 59.4**	**$ 57.8**	**$ 56.2**	**$ 54.7**	**$ 54.2**	**$ 53.3**	**$ 51.8**	**$ 49.8**	**$ 47.8**	**$ 39.8**
		Fixed O&M	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder DAMP Study and CA Development	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 17.0**	**$ 17.5**	**$ 18.0**	**$ 26.4**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 11	Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology) Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

			Source on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	A, J, S	%		69%	66%	69%	53%	69%	69%	69%	69%	69%	69%	64%	69%	69%	69%	69%	69%	69%	64%	69%	69%	69%	69%	69%
		Energy Production	calc	GWh		3,097	2,925	3,063	2,370	3,063	3,063	3,063	3,063	3,063	3,063	2,855	3,063	3,063	3,063	3,063	3,063	3,063	2,855	3,063	3,063	3,063	3,063	3,063
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	calc	$million/yr	$ (1,496)																							
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$million/yr	$ (201)	$ -	$ -	$ -	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)	$ (25.7)
	PRODUCTION COST	Energy Production	calc	GWh		3,097	2,925	3,063	2,370	3,063	3,063	3,063	3,063	3,063	3,063	2,855	3,063	3,063	3,063	3,063	3,063	3,063	2,855	3,063	3,063	3,063	3,063	3,063
		Full Load Heat Rate	V	Btu/kWh		10,658	10,670	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	calc	Million MMBtu		33.0	31.2	32.7	25.2	32.6	32.6	32.6	32.6	32.6	32.6	30.4	32.6	32.6	32.6	32.6	32.6	32.6	30.4	32.6	32.6	32.6	32.6	32.6
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	calc	$Million/yr	$ 1,074																							
		$/MMBtu VO&M Cost	W	$/MMBtu																								
		Annual VO&M Cost	calc		$ 69																							
		NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions	calc	tons/yr		2,458	2,322	2,435	1,879	2,428	2,428	2,428	2,428	2,428	2,428	2,263	2,428	2,428	2,428	2,428	2,428	2,428	2,263	2,428	2,428	2,428	2,428	2,428
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		3.62	3.43	3.59	2.77	3.58	3.58	3.58	3.58	3.58	3.58	3.34	3.58	3.58	3.58	3.58	3.58	3.58	3.34	3.58	3.58	3.58	3.58	3.58
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.6	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 8.2	$ 4.2	$ 7.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 16.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.6	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.6	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 9.0	$ 8.1	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.2	$ 0.4	$ 2.6	$ 3.7	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.3	$ 4.5	$ 4.5	$ 4.5	$ 4.4	$ 4.4	$ 4.5	$ 5.3	$ 5.5	$ 5.6	$ 5.7	$ 6.0	$ 6.4
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.6	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.6	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.8
		Capital Rev Req Total		$million/yr	$ 675.1	$ 28.6	$ 76.8	$ 76.8	$ 77.1	$ 76.0	$ 73.8	$ 71.8	$ 69.8	$ 67.9	$ 66.1	$ 64.6	$ 63.0	$ 61.2	$ 59.4	$ 57.8	$ 56.2	$ 54.7	$ 54.2	$ 53.3	$ 51.0	$ 48.9	$ 47.6	$ 39.8
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 159.8	$ 8.9	$ 15.3	$ 11.9	$ 15.8	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 21.5	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 26.4	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5

Case 12 — **Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Capital additions highlighted in Gray

			Source on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	A, I, S	%		77%	73%	77%	59%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,662)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
		Capacity Value	H	$/MW-yr		-	-	-	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380
		Annual Capacity Value	**calc**	**$million/yr**	**$ (402)**	**$ -**	**$ -**	**$ -**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Full Load Heat Rate	Y	Btu/kWh		10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	calc	Million MMBtu		36,7	34,7	36,3	28,0	36,2	36,2	36,2	36,2	36,2	36,2	33,8	36,2	36,2	36,2	36,2	36,2	36,2	33,8	36,2	36,2	36,2	36,2	36,2
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,194**																							
		$/MMBtu VO&M Cost	W	$/MMBtu		[redacted]																						
		Annual VO&M Cost	calc		**$ 77**																							
		NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,087	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.08	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 8.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.7	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 18.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.8	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.3	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 29.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.6	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 9.8	$ 8.1	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.0	$ 10.1	$ 9.4	$ 8.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.6	$ 19.5
		Capital Rev Req Turbine & Mills		$million/yr		$ 0.1	$ 0.2	$ 0.4	$ 2.6	$ 3.7	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.3	$ 4.5	$ 4.5	$ 4.5	$ 4.4	$ 4.4	$ 4.5	$ 5.3	$ 5.5	$ 5.5	$ 5.7	$ 6.0	$ 6.4
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.6	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 675.1**	**$ 28.6**	**$ 76.6**	**$ 76.8**	**$ 77.1**	**$ 76.0**	**$ 73.9**	**$ 71.8**	**$ 69.8**	**$ 67.9**	**$ 66.1**	**$ 64.6**	**$ 63.0**	**$ 61.2**	**$ 59.4**	**$ 57.8**	**$ 56.2**	**$ 54.7**	**$ 54.2**	**$ 53.3**	**$ 51.8**	**$ 49.9**	**$ 47.4**	**$ 39.8**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.3	$ 20.8	$ 25.5
		Fixed O&M addel CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 155.3**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 15.8**	**$ 12.8**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 21.5**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 17.0**	**$ 17.5**	**$ 18.0**	**$ 26.4**	**$ 19.1**	**$ 19.7**	**$ 20.3**	**$ 20.8**	**$ 25.5**

Case 13	Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology) Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Source on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
	ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	528	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	A,I,S	%		77%	73%	77%	59%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	calc	$million/yr	$ (1,662)																							
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		528	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
		Capacity Value	H	$/MW-yr		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Annual Capacity Value	calc	$million/yr	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Full Load Heat Rate	V	Btu/kWh		10,655	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	28.0	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	calc	$Million/yr	$ 1,184																							
		$/MMBtu VO&M Cost	W	$/MMBtu																								
		Annual VO&M Cost	calc		$ 77																							
		NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,087	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
UNIT 1 ALTERNATIVE		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.08	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OCC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 8.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 10.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.6	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 9.8	$ 8.1	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.3
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 6.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.2	$ 0.4	$ 2.6	$ 3.7	$ 3.8	$ 3.8	$ 3.8	$ 3.9	$ 4.0	$ 4.3	$ 4.5	$ 4.5	$ 4.6	$ 4.4	$ 4.4	$ 4.5	$ 5.3	$ 5.5	$ 5.5	$ 5.7	$ 6.0	$ 6.4
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 58.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.6	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.6	$ 12.6
		Capital Rev Req Total		$million/yr	**$ 676.1**	**$ 28.6**	**$ 76.6**	**$ 76.8**	**$ 77.1**	**$ 76.0**	**$ 73.8**	**$ 71.8**	**$ 69.6**	**$ 67.5**	**$ 66.1**	**$ 64.6**	**$ 63.0**	**$ 61.2**	**$ 59.4**	**$ 57.8**	**$ 56.2**	**$ 54.7**	**$ 54.2**	**$ 53.3**	**$ 51.6**	**$ 49.9**	**$ 47.6**	**$ 39.8**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		$million/yr	**$ 155.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 15.8**	**$ 12.6**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 21.5**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 17.0**	**$ 17.5**	**$ 18.0**	**$ 26.4**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 14 — **Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

[redacted]

			Source (or Input Page)	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	A, I, S	%		77%	73%	77%	59%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (2,077)**	[redacted]																						
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		526	527	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (201)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Full Load Heat Rate	Y	Btu/kWh		10,658	10,678	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	28.0	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,194**	[redacted]																						
		$/MMBtu VO&M Cost	W	$/MMBtu		[redacted]																						
		Annual VO&M Cost	**calc**		**$ 77**	[redacted]																						
		NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions	calc	tons/yr		2,733	2,583	2,706	2,087	2,695	2,695	2,695	2,695	2,695	2,695	2,514	2,695	2,695	2,695	2,695	2,695	2,695	2,514	2,695	2,695	2,695	2,695	2,695
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.08	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 5.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 15.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.8	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.0	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 9.9	$ 8.1	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.2	$ 0.4	$ 2.8	$ 3.7	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.3	$ 4.5	$ 4.5	$ 4.5	$ 4.4	$ 4.4	$ 4.5	$ 5.3	$ 5.5	$ 5.5	$ 5.7	$ 6.0	$ 6.4
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 50.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.6	$ 13.6
		Capital Rev Req Total		**$million/yr**	**$ 678.1**	**$ 28.6**	**$ 76.6**	**$ 76.9**	**$ 77.1**	**$ 76.0**	**$ 73.9**	**$ 71.9**	**$ 69.8**	**$ 67.9**	**$ 66.1**	**$ 64.6**	**$ 63.0**	**$ 61.2**	**$ 59.4**	**$ 57.8**	**$ 56.2**	**$ 54.7**	**$ 64.2**	**$ 63.3**	**$ 61.0**	**$ 49.9**	**$ 47.0**	**$ 39.8**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.8	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 29.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 8.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.8	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 159.8**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 15.8**	**$ 12.6**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 21.6**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 17.0**	**$ 17.5**	**$ 18.0**	**$ 26.4**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 29.5**

Case 15 — **Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

			Source in Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	A, I, S	%		77%	73%	77%	59%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,246)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		526	527	522	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (201)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Full Load Heat Rate	Y	Btu/kWh		10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	calc	Million MMBtu		36,7	34,7	36,3	28,0	36,2	36,2	36,2	36,2	36,2	36,2	33,8	36,2	36,2	36,2	36,2	36,2	36,2	33,8	36,2	36,2	36,2	36,2	36,2
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,184**																							
		$/MMBtu VO&M Cost	W	$/MMBtu		[redacted]																						
		Annual VO&M Cost	**calc**		**$ 77**																							
		NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,087	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.08	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 16.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.8	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.6	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 9.9	$ 8.1	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.5	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.9
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.2	$ 0.4	$ 2.6	$ 3.7	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.3	$ 4.5	$ 4.5	$ 4.5	$ 4.4	$ 4.4	$ 4.5	$ 5.3	$ 5.5	$ 5.5	$ 5.7	$ 6.0	$ 6.4
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 876.1**	**$ 28.6**	**$ 76.6**	**$ 76.9**	**$ 77.1**	**$ 76.0**	**$ 73.9**	**$ 71.8**	**$ 69.8**	**$ 67.9**	**$ 66.1**	**$ 64.6**	**$ 63.0**	**$ 61.2**	**$ 59.4**	**$ 57.3**	**$ 55.2**	**$ 54.7**	**$ 54.2**	**$ 53.3**	**$ 51.8**	**$ 49.8**	**$ 47.6**	**$ 38.8**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 159.5**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 15.8**	**$ 12.6**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 21.5**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 17.0**	**$ 17.6**	**$ 18.0**	**$ 26.4**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 16 Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Source on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	A, I, S	%		77%	73%	77%	59%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,652)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (201)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Full Load Heat Rate	Y	Btu/kWh		10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	28.0	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,492**																							
		$/MMBtu VO&M Cost	W	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 77**																							
		NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,067	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.09	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds Revenue Requirements Fixed O&M	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 16.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.6	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 8.9	$ 8.1	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.2
		Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.2	$ 0.4	$ 2.8	$ 3.7	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.3	$ 4.5	$ 4.5	$ 4.5	$ 4.4	$ 4.4	$ 4.5	$ 5.3	$ 5.9	$ 5.5	$ 5.7	$ 6.0	$ 6.4
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.2	$ 29.1	$ 26.8	$ 24.6	$ 22.5	$ 20.1	$ 17.9	$ 15.8	$ 12.0
		Capital Rev Req Total		**$million/yr**	**$ 675.1**	**$ 28.6**	**$ 76.8**	**$ 76.8**	**$ 77.1**	**$ 76.0**	**$ 73.0**	**$ 71.0**	**$ 69.8**	**$ 67.8**	**$ 66.1**	**$ 64.6**	**$ 63.0**	**$ 61.2**	**$ 59.4**	**$ 57.5**	**$ 56.2**	**$ 54.7**	**$ 54.2**	**$ 53.3**	**$ 51.5**	**$ 49.9**	**$ 47.6**	**$ 39.8**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 159.9	$ 8.9	$ 15.3	$ 11.9	$ 15.8	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 21.5	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 26.4	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5

Case 17

Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Source on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	A_I_S	%		77%	73%	77%	59%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,662)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (281)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Full Load Heat Rate	Y	Btu/kWh		10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	28.0	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 698**																							
		$/MMBtu VO&M Cost	W	$/MMBtu		[redacted]																						
		Annual VO&M Cost	**calc**		**$ 77**																							
		NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,087	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.08	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.3	$ 8.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 8.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 15.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.0	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.8	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.6	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 9.9	$ 8.1	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.9
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.2	$ 0.4	$ 2.6	$ 3.7	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.3	$ 4.5	$ 4.5	$ 4.5	$ 4.4	$ 4.4	$ 4.5	$ 5.3	$ 6.5	$ 5.5	$ 5.7	$ 6.0	$ 6.4
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 676.1**	**$ 28.6**	**$ 76.8**	**$ 76.8**	**$ 77.1**	**$ 76.0**	**$ 73.9**	**$ 71.8**	**$ 69.8**	**$ 67.8**	**$ 66.1**	**$ 64.6**	**$ 63.0**	**$ 61.2**	**$ 59.4**	**$ 57.5**	**$ 56.2**	**$ 54.7**	**$ 54.2**	**$ 53.3**	**$ 51.8**	**$ 48.9**	**$ 47.6**	**$ 39.3**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.8	$ 12.3	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.6	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder GAMP Study and QA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.0	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 159.9**	**$ 8.9**	**$ 15.3**	**$ 11.8**	**$ 15.8**	**$ 12.6**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 21.5**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 17.0**	**$ 17.5**	**$ 18.0**	**$ 26.4**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

PUBLIC VERSION

Case 18

Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

Unit	Category	Item	Source on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	A, J, S	%		69%	66%	69%	53%	69%	69%	69%	69%	69%	69%	64%	69%	69%	69%	69%	69%	69%	64%	69%	69%	69%	69%	69%
		Energy Production	calc	GWh		3,097	2,925	3,063	2,370	3,063	3,063	3,063	3,063	3,063	3,063	2,855	3,063	3,063	3,063	3,063	3,063	3,063	2,855	3,063	3,063	3,063	3,063	3,063
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	calc	$million/yr	$ (1,122)																							
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
		Capacity Value	H	$/MW-yr		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Annual Capacity Value	calc	$million/yr	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	PRODUCTION COST	Energy Production	calc	GWh		3,097	2,925	3,063	2,370	3,063	3,063	3,063	3,063	3,063	3,063	2,855	3,063	3,063	3,063	3,063	3,063	3,063	2,855	3,063	3,063	3,063	3,063	3,063
		Full Load Heat Rate	Y	Btu/kWh		10,658	10,678	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	calc	Million MMBtu		33.0	31.2	32.7	25.2	32.6	32.6	32.6	32.6	32.6	32.6	30.4	32.6	32.6	32.6	32.6	32.6	32.6	30.4	32.6	32.6	32.6	32.6	32.6
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	calc	$Million/yr	$ 1,343																							
		$/MMBtu VO&M Cost	W	$/MMBtu																								
		Annual VO&M Cost	calc		$ 69																							
		NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions	calc	tons/yr		2,458	2,325	2,436	1,879	2,428	2,428	2,428	2,428	2,428	2,428	2,263	2,428	2,428	2,428	2,428	2,428	2,428	2,263	2,428	2,428	2,428	2,428	2,428
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		3.62	3.43	3.58	2.77	3.58	3.58	3.58	3.58	3.58	3.58	3.34	3.58	3.58	3.58	3.58	3.58	3.58	3.34	3.58	3.58	3.58	3.58	3.58
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds Revenue Requirements Fixed O&M	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 16.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.8	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.6	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 9.9	$ 8.1	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.2
		Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.2	$ 0.3	$ 2.3	$ 3.4	$ 3.4	$ 3.5	$ 3.5	$ 3.5	$ 3.6	$ 3.9	$ 4.0	$ 4.0	$ 4.0	$ 4.0	$ 4.0	$ 4.0	$ 4.7	$ 4.9	$ 5.0	$ 5.1	$ 5.4	$ 5.8
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		$million/yr	$ 671.8	$ 28.6	$ 76.6	$ 76.8	$ 76.8	$ 75.6	$ 73.5	$ 71.4	$ 69.4	$ 67.0	$ 65.7	$ 64.2	$ 62.8	$ 60.7	$ 59.0	$ 57.3	$ 55.7	$ 54.3	$ 53.7	$ 52.7	$ 51.2	$ 49.4	$ 47.0	$ 39.2
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ [illegible]	$ 8.9	$ 15.3	$ 11.9	$ 15.8	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 21.5	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 26.4	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5

Case 19 — **Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Source on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	A, I, S	%		84%	80%	84%	85%	84%	84%	84%	84%	84%	84%	78%	84%	84%	84%	84%	84%	84%	79%	84%	84%	84%	84%	84%
		Energy Production	calc	GWh		3,785	3,575	3,744	3,897	3,744	3,744	3,744	3,744	3,744	3,744	3,490	3,744	3,744	3,744	3,744	3,744	3,744	3,490	3,744	3,744	3,744	3,744	3,744
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (2,285)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		526	527	522	522	522	522	522	522	527	522	522	522	522	523	522	522	522	522	522	522	523	522	522
		Capacity Value	H	$/MW-yr		-	-	-	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380
		Annual Capacity Value	**calc**	**$million/yr**	**$ (402)**	**$ -**	**$ -**	**$ -**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**	**$ (51.3)**
	PRODUCTION COST	Energy Production	calc	GWh		3,785	3,575	3,744	3,897	3,744	3,744	3,744	3,744	3,744	3,744	3,490	3,744	3,744	3,744	3,744	3,744	3,744	3,490	3,744	3,744	3,744	3,744	3,744
		Full Load Heat Rate	V	Btu/kWh		10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	calc	Million MMBtu		40.3	38.2	40.0	39.8	39.9	39.9	39.9	39.9	39.9	39.9	37.1	39.9	39.9	39.9	39.9	39.9	39.9	37.1	39.9	39.9	39.9	39.9	39.9
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 985**																							
		$/MMBtu VO&M Cost	W	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 84**																							
		NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions	calc	tons/yr		3,004	2,842	2,979	2,296	2,967	2,967	2,967	2,967	2,967	2,967	2,769	2,967	2,967	2,967	2,967	2,967	2,967	2,768	2,967	2,967	2,967	2,967	2,967
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.43	4.19	4.39	3.38	4.37	4.37	4.37	4.37	4.37	4.37	4.08	4.37	4.37	4.37	4.37	4.37	4.37	4.08	4.37	4.37	4.37	4.37	4.37
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 6.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 16.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.8	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.6	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 9.0	$ 8.1	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.8	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.2	$ 0.4	$ 3.8	$ 4.1	$ 4.2	$ 4.2	$ 4.3	$ 4.3	$ 4.4	$ 4.7	$ 4.9	$ 4.9	$ 4.9	$ 4.9	$ 4.9	$ 4.9	$ 5.8	$ 6.0	$ 6.1	$ 6.2	$ 6.6	$ 7.1
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.6	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 678.4**	**$ 28.6**	**$ 76.7**	**$ 76.9**	**$ 77.3**	**$ 76.4**	**$ 74.2**	**$ 72.2**	**$ 70.2**	**$ 69.3**	**$ 68.0**	**$ 65.0**	**$ 63.4**	**$ 61.6**	**$ 60.0**	**$ 58.2**	**$ 56.6**	**$ 55.2**	**$ 54.7**	**$ 53.8**	**$ 52.4**	**$ 50.5**	**$ 48.3**	**$ 40.8**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.9	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 18.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder EAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.8	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 159.9**	**$ 8.9**	**$ 15.3**	**$ 11.9**	**$ 16.0**	**$ 12.6**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.9**	**$ 21.5**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 17.0**	**$ 17.5**	**$ 18.0**	**$ 26.4**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 20 — **Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

			Source on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	A, J, S	%		77%	73%	77%	90%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%	77%	71%	77%	77%	77%	77%	77%
		Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Average MISO Energy Price	O	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,025)**																							
	CAPACITY MARKET VALUE	Resource Capacity	T	MW		528	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (201)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	2,634	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404	3,404	3,173	3,404	3,404	3,404	3,404	3,404
		Full Load Heat Rate	Y	Btu/kWh		10,658	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	28.0	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2	36.2	33.8	36.2	36.2	36.2	36.2	36.2
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																						
		Annual Fuel Cost	calc	**$Million/yr**	**$ 1,133**																							
		$/MMBtu VO&M Cost	W	$/MMBtu																								
		Annual VO&M Cost	calc		**$ 77**																							
		NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,067	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698	2,698	2,514	2,698	2,698	2,698	2,698	2,698
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.08	3.98	3.98	3.98	3.98	3.98	3.98	3.71	2.98	3.98	3.98	3.98	3.98	3.98	3.71	3.98	3.98	3.98	3.98	3.98
		CO2 Credit Cost	I	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16	$ 17	$ 18	$ 20	$ 22	$ 24	$ 26	$ 28	$ 30	$ 32	$ 35	$ 38	$ 41	$ 44
		Annual CO2 Cost	**calc**	**$ Millions**	**$ 388**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 62.9**	**$ 64.4**	**$ 74.7**	**$ 80.8**	**$ 87.3**	**$ 94.4**	**$ 102.1**	**$ 110.3**	**$ 111.2**	**$ 120.0**	**$ 129.5**	**$ 150.8**	**$ 163.0**	**$ 176.3**
	Capital Adds	Ongoing Capital Adds (O&C)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.9	$ 8.1	$ 8.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 16.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.8	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.8	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.6	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 9.9	$ 8.1	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 6.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.0	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.2	$ 0.4	$ 2.6	$ 3.7	$ 3.5	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.3	$ 4.5	$ 4.5	$ 4.5	$ 4.4	$ 4.4	$ 4.5	$ 5.3	$ 5.5	$ 5.5	$ 5.7	$ 6.0	$ 6.4
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.6	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 676.1**	**$ 28.6**	**$ 76.6**	**$ 76.8**	**$ 77.1**	**$ 76.0**	**$ 73.9**	**$ 71.9**	**$ 69.8**	**$ 67.8**	**$ 66.1**	**$ 64.6**	**$ 63.0**	**$ 61.2**	**$ 59.4**	**$ 57.8**	**$ 56.2**	**$ 54.7**	**$ 54.2**	**$ 53.2**	**$ 51.5**	**$ 49.8**	**$ 47.4**	**$ 38.8**
		Fixed O&M		$million/yr		$ 8.6	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.3	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 169.9**	**$ 8.8**	**$ 15.3**	**$ 11.9**	**$ 15.8**	**$ 12.6**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 21.5**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 17.0**	**$ 17.5**	**$ 18.0**	**$ 26.4**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 21 — **Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)**
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Source on Input Page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		514	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
		Capacity Factor	A, J, S	%		77%	73%	77%	59%	77%	77%	77%	77%	77%	69%	64%	69%	69%	69%	69%	69%	69%	64%	69%	69%	69%	69%	69%
		Energy Production	calc	GWh		3,441	3,250	3,404	2,834	3,404	3,404	3,404	3,404	3,404	3,063	2,855	3,063	3,063	3,063	3,063	3,063	3,063	2,855	3,063	3,063	3,063	3,063	3,063
		Average MISO Energy Price	D	$/MWh		[redacted]																						
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,809)**																							
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		526	527	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (201)**	**$ -**	**$ -**	**$ -**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**	**$ (25.7)**
	PRODUCTION COST	Energy Production	calc	GWh		3,441	3,250	3,404	2,834	3,404	3,404	3,404	3,404	3,404	3,063	2,855	3,063	3,063	3,063	3,063	3,063	3,063	2,855	3,063	3,063	3,063	3,063	3,063
		Full Load Heat Rate	Y	Btu/kWh		10,656	10,676	10,676	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644	10,644
		MMBtu Fuel Burn	calc	Million MMBtu		36.7	34.7	36.3	30.0	36.2	36.2	36.2	36.2	36.2	32.6	30.4	32.6	32.6	32.6	32.6	32.6	32.6	30.4	32.6	32.6	32.6	32.6	32.6
		$/MMBtu Delivered Fuel Cost		$/MMBtu		[redacted]																						
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,133**																							
		$/MMBtu VO&M Cost	W	$/MMBtu																								
		Annual VO&M Cost	**calc**		**$ 73**																							
		NOx Emission Rate	V	lbs/MMBtu		0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.149
		NOx emissions	calc	tons/yr		2,731	2,583	2,706	2,087	2,698	2,698	2,698	2,698	2,698	2,428	2,263	2,428	2,428	2,428	2,428	2,428	2,428	2,263	2,428	2,428	2,428	2,428	2,428
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52	219.52
		CO2 emissions	calc	million tons/yr		4.03	3.81	3.99	3.08	3.98	3.98	3.98	3.98	3.98	3.58	3.34	3.58	3.58	3.58	3.58	3.58	3.58	3.34	3.58	3.58	3.58	3.58	3.58
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 18	$ 17	$ 19	$ 20	$ 22	$ 24	$ 26	$ 26	$ 30	$ 32	$ 35	$ 38	$ 41	$ 44
		Annual CO2 Cost	**calc**	**$ Millions**	**$ 358**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 57.8**	**$ 57.8**	**$ 67.2**	**$ 72.7**	**$ 78.5**	**$ 86.0**	**$ 91.9**	**$ 93.3**	**$ 100.1**	**$ 114.1**	**$ 125.5**	**$ 134.7**	**$ 140.7**	**$ 158.6**
	Capital Adds / Revenue Requirements / Fixed O&M	Ongoing Capital Adds (OGC)		$million/yr		$ 3.8	$ 11.0	$ 11.5	$ 6.3	$ 6.3	$ 6.1	$ 6.2	$ 6.3	$ 6.5	$ 6.6	$ 6.8	$ 6.9	$ 7.1	$ 7.2	$ 7.4	$ 7.6	$ 7.7	$ 7.0	$ 8.1	$ 8.2	$ 4.2	$ 2.2	$ -
		Cap adder Turbine Upgrades		$million/yr		$ 0.2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ 0.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ -	$ -	$ -	$ 16.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 158.5	$ 37.0	$ 12.6	$ 23.6	$ 7.4	$ 7.2	$ 7.4	$ 7.4	$ 7.6	$ 7.7	$ 9.0	$ 8.1	$ 8.0	$ 8.2	$ 8.4	$ 8.6	$ 8.7	$ 12.0	$ 9.1	$ 7.3	$ 5.3	$ 3.3	$ 1.2
		Capital Rev Req Sunk/Decom		$million/yr		$ 11.1	$ 10.6	$ 10.1	$ 9.6	$ 9.1	$ 8.6	$ 8.2	$ 7.7	$ 7.3	$ 6.8	$ 6.4	$ 6.0	$ 5.7	$ 5.3	$ 4.9	$ 4.6	$ 4.2	$ 3.8	$ 3.5	$ 3.1	$ 2.7	$ 2.3	$ 1.3
		Capital Rev Req Ongoing		$million/yr		$ 3.5	$ 4.9	$ 8.8	$ 8.0	$ 8.8	$ 9.6	$ 10.4	$ 11.2	$ 12.0	$ 12.8	$ 13.6	$ 14.4	$ 15.3	$ 16.2	$ 17.1	$ 18.1	$ 19.3	$ 20.5	$ 22.0	$ 23.1	$ 23.7	$ 23.5	$ 19.5
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.2	$ 0.4	$ 2.6	$ 3.7	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.3	$ 4.5	$ 4.5	$ 4.5	$ 4.4	$ 4.4	$ 4.5	$ 5.3	$ 5.5	$ 5.5	$ 5.7	$ 6.0	$ 6.4
		Capital Rev Req CACP		$million/yr		$ 13.9	$ 61.0	$ 59.6	$ 56.9	$ 54.3	$ 51.8	$ 49.4	$ 47.0	$ 44.7	$ 42.5	$ 40.3	$ 38.0	$ 35.8	$ 33.5	$ 31.3	$ 29.1	$ 26.8	$ 24.6	$ 22.3	$ 20.1	$ 17.9	$ 15.8	$ 12.6
		Capital Rev Req Total		**$million/yr**	**$ 676.1**	**$ 28.6**	**$ 76.6**	**$ 78.8**	**$ 77.1**	**$ 76.0**	**$ 73.0**	**$ 71.8**	**$ 69.8**	**$ 67.8**	**$ 66.1**	**$ 64.6**	**$ 63.0**	**$ 61.2**	**$ 59.4**	**$ 57.3**	**$ 55.2**	**$ 54.7**	**$ 54.3**	**$ 53.3**	**$ 51.8**	**$ 49.6**	**$ 47.4**	**$ 39.6**
		Fixed O&M		$million/yr		$ 8.8	$ 12.0	$ 11.9	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 18.1	$ 19.7	$ 20.2	$ 20.8	$ 25.5
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder Turbine Maintenance		$million/yr		$ -	$ 3.0	$ -	$ 3.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.4	$ -	$ -	$ -	$ -	$ -	$ 7.9	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 169.9**	**$ 8.8**	**$ 15.3**	**$ 11.9**	**$ 15.8**	**$ 12.6**	**$ 13.0**	**$ 13.4**	**$ 13.8**	**$ 14.2**	**$ 14.6**	**$ 21.5**	**$ 15.5**	**$ 16.0**	**$ 16.5**	**$ 17.0**	**$ 17.5**	**$ 18.0**	**$ 26.4**	**$ 19.1**	**$ 19.7**	**$ 20.2**	**$ 20.8**	**$ 25.5**

Case 1	Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
	Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Source on Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
		Capacity Factor	A.1.5	%		70%	78%	61%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Average MISO Energy Price	D	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	$million/yr	$ (1,812)																										
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$million/yr	$ (215)	$ -	$ -	$ -	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Full Load Heat Rate	Y	Btu/kWh		10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
		MMBtu Fuel Burn	calc	Million		35.5	36.6	28.5	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	$Million/yr	$ 1,289																										
		$/MMBtu VO&M Cost	W	$/MMBtu																											
		Annual VO&M Cost	calc		$ 34																										
		NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	1,811	2,318	2,318	2,318	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094
		NOx Credit Cost	O	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.69	3.82	2.97	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (ODC)		$million/yr		$ 17.5	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ 16.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.8	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.5	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.1	$ 50.8	$ 29.6	$ 53.1	$ 93.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.2	$ 12.3	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.8	$ 11.7	$ 11.8	$ 4.9	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Discon		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.6	$ 17.6	$ 19.2	$ 20.8	$ 21.9	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.5	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.3	$ 2.5	$ 3.8	$ 3.8	$ 3.8	$ 3.9	$ 3.8	$ 4.0	$ 4.2	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.3	$ 4.8	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.1	$ 6.8	$ 7.4	$ 7.8
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 40.9	$ 43.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 56.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$million/yr	$ 972.8	$ 31.5	$ 79.6	$ 82.2	$ 83.2	$ 85.7	$ 90.0	$ 121.5	$ 119.6	$ 115.9	$ 112.8	$ 109.6	$ 106.4	$ 103.3	$ 100.3	$ 97.3	$ 94.4	$ 92.1	$ 89.6	$ 87.0	$ 84.6	$ 82.4	$ 81.0	$ 79.8	$ 79.8	$ 75.7	$ 62.4
		Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 28.0
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$million/yr		$ 3.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 179.4	$ 12.5	$ 12.2	$ 16.6	$ 12.6	$ 13.0	$ 13.5	$ 14.2	$ 14.8	$ 15.1	$ 21.8	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 26.8	$ 19.7	$ 20.3	$ 20.8	$ 21.5	$ 22.1	$ 22.8	$ 32.9	$ 24.2	$ 28.8

PUBLIC VERSION

Case
2

Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Shown in Gray

			Source on Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
		Capacity Factor	A1B	%		75%	78%	61%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Average MISO Energy Price	D	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	$million/yr	$ (1,012)																										
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$million/yr	$ (215)	$ -	$ -	$ -	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Full Load Heat Rate	Y	Btu/kWh		10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
		MMBtu Fuel Burn	calc	Million		35.3	36.6	28.5	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	$Million/yr	$ 1,209																										
		$/MMBtu VO&M Cost	W	$/MMBtu																											
		Annual VO&M Cost	calc		$ 94																										
		NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	1,811	2,318	2,318	2,318	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094
		NOx Credit Cost	O	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.69	3.82	2.97	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds Revenue Requirements Fixed O&M	Ongoing Capital Adds (OCC)		$million/yr		$ 17.5	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ 15.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.6	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.1	$ 50.8	$ 26.6	$ 53.1	$ 93.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.3	$ 12.3	$ 12.5	$ 12.8	$ 13.1	$ 16.2	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.8	$ 4.9	$ 1.2
		Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.6	$ 17.8	$ 19.2	$ 20.6	$ 21.9	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.3	$ 2.5	$ 3.8	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.2	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.3	$ 4.9	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.1	$ 6.9	$ 7.4	$ 7.8
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 46.9	$ 45.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$million/yr	$ 979.6	$ 31.6	$ 79.9	$ 82.3	$ 83.2	$ 85.7	$ 90.0	$ 122.9	$ 119.6	$ 115.9	$ 112.8	$ 109.6	$ 106.4	$ 103.3	$ 100.3	$ 97.3	$ 94.4	$ 92.1	$ 89.4	$ 87.0	$ 84.6	$ 82.4	$ 81.0	$ 79.5	$ 79.8	$ 75.7	$ 62.4
		Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 22.4	$ 29.0
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$million/yr		3.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 178.4	$ 12.5	$ 12.2	$ 16.6	$ 12.6	$ 13.0	$ 13.5	$ 14.2	$ 14.6	$ 15.1	$ 21.8	$ 16.0	$ 16.6	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 26.8	$ 19.7	$ 20.3	$ 20.9	$ 21.5	$ 22.1	$ 22.8	$ 32.9	$ 24.2	$ 29.8

PUBLIC VERSION

Case 3	Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology) Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

Unit	Section	Item	Source on Input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
UNIT 2 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	D	MW		513	507	507	507	507	507	504	504	504	504	504	504	504
		Capacity Factor	A.1.5	%		75%	78%	61%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	2,700	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455
		Average MISO Energy Price	D	$/MWh		[redacted]												
		Annual Energy Revenue	calc	$million/yr	$ (1,812)													
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		530	540	534	534	534	534	534	532	532	532	532	532	532
		Capacity Value	H	$/MW-yr		-	-	-	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100
		Annual Capacity Value	calc	$million/yr	$ (218)	$ -	$ -	$ -	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	2,700	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455
		Full Load Heat Rate	Y	Btu/kWh		10,516	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560
		MMBtu Fuel Burn	calc	Million		35.3	36.6	28.5	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]												
		Annual Fuel Cost	calc	$Million/yr	$ 1,289													
		$/MMBtu VOAM Cost	W	$/MMBtu														
		Annual VO&M Cost	calc		$ 94													
		NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	1,811	2,319	2,319	2,310	1,094	1,094	1,094	1,022	1,094	1,094	1,094
		NOx Credit Cost	D	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.69	3.82	2.97	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds Revenue Requirements Fixed O&M	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3
		Cap adder Turbine Upgrades		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ 18.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.8	$ -	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 42.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.1	$ 50.8	$ 28.8	$ 55.1	$ 93.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.2	$ 12.3
		Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6
		Capital Rev Req Ongoing		$million/yr		$ 6.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.8	$ 16.6	$ 17.0	$ 19.2	$ 20.6	$ 21.8
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.3	$ 2.8	$ 3.8	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.2	$ 4.4	$ 4.4	$ 4.4
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 46.9	$ 45.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 58.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6
		Capital Rev Req Total		$million/yr	$ 978.5	$ 31.5	$ 79.6	$ 82.3	$ 83.2	$ 85.7	$ 90.0	$ 122.9	$ 119.6	$ 116.5	$ 112.8	$ 109.8	$ 106.4	$ 103.3
		Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5
		Fixed O&M adder Turbine Maintenance		$million/yr		3.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.2	$ -	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 178.4	$ 12.5	$ 12.2	$ 16.6	$ 12.6	$ 13.0	$ 13.5	$ 14.2	$ 14.8	$ 15.1	$ 21.8	$ 16.0	$ 16.5	$ 17.0

Item	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Rated Capacity	504	504	504	504	504	504	504	504	504	504	504	504	504
Capacity Factor	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%
Energy Production	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
Average MISO Energy Price	[redacted]												
Annual Energy Revenue													
Reserve Capacity	532	532	532	532	532	532	532	532	532	532	532	532	532
Capacity Value	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100
Annual Capacity Value	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
Energy Production	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
Full Load Heat Rate	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
MMBtu Fuel Burn	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5
$/MMBtu Delivered Fuel Cost	[redacted]												
Annual Fuel Cost													
$/MMBtu VOAM Cost													
Annual VO&M Cost													
NOx Emission Rate	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
NOx emissions	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094
NOx Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual NOx Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
CO2 Emission Rate	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
CO2 emissions	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81
CO2 Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual CO2 Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ongoing Capital Adds (OGC)	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
Cap adder Turbine Upgrades	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Turbine Maintenance	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
Cap adder Mill Maintenance	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
Capital adder SCR	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Clean Air Compliance Programs (CACP)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Adds	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.8	$ 4.9	$ 1.2
Capital Rev Req Sunk/Decom	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
Capital Rev Req Ongoing	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.8	$ 34.8	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
Capital Rev Req Turbine & Mills	$ 4.4	$ 4.4	$ 4.3	$ 4.8	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.1	$ 4.9	$ 7.4	$ 7.6
Capital Rev Req SCR	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.0	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
Capital Rev Req CACP	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
Capital Rev Req Total	$ 100.3	$ 97.3	$ 94.4	$ 92.1	$ 89.6	$ 87.0	$ 84.8	$ 82.4	$ 81.0	$ 79.5	$ 72.8	$ 76.7	$ 62.4
Fixed O&M	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
Fixed O&M adder CAMP Study and CA Development	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Fixed O&M adder SCR	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
Fixed O&M adder Turbine Maintenance	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 8.4	$ -	$ -
TOTAL Fixed O&M	$ 17.5	$ 18.0	$ 18.5	$ 26.8	$ 19.7	$ 20.3	$ 20.8	$ 21.5	$ 22.1	$ 22.8	$ 31.9	$ 24.1	$ 29.8

Case 4	Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology) Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information - Highlighted in Grey

			Source on Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
		Capacity Factor	A T S	%		75%	78%	61%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Average MISO Energy Price	D	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	$million/yr	$ (1,012)																										
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		536	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$million/yr	$ (210)	$ -	$ -	$ -	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Full Load Heat Rate	Y	Btu/kWh		10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
		MMBtu Fuel Burn	calc	MBtm		35.3	36.6	28.5	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	$Million/yr	$ 1,289																										
		$/MMBtu VO&M Cost	W	$/MMBtu																											
		Annual VO&M Cost	calc		$ 94																										
		NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	1,811	2,319	2,319	2,319	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.60	3.82	2.97	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds Revenue Requirements Fixed O&M	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 0.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ 18.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.1	$ 50.8	$ 29.8	$ 53.1	$ 93.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.2	$ 12.3	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.8	$ 4.9	$ 1.2
		Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 13.0	$ 13.6	$ 14.6	$ 15.1	$ 15.8	$ 16.6	$ 17.9	$ 19.2	$ 20.6	$ 21.8	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.7
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.3	$ 2.1	$ 4.1	$ 4.2	$ 4.2	$ 4.3	$ 4.3	$ 4.3	$ 4.7	$ 4.8	$ 4.9	$ 4.8	$ 4.8	$ 4.8	$ 4.8	$ 5.3	$ 5.5	$ 5.5	$ 5.4	$ 5.4	$ 5.5	$ 5.8	$ 7.9	$ 8.2	$ 8.5
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 46.9	$ 45.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$million/yr		$ 14.9	$ 59.9	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.9	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$million/yr	$ 883.5	$ 31.5	$ 79.7	$ 82.6	$ 83.6	$ 86.1	$ 90.4	$ 123.2	$ 120.0	$ 116.2	$ 113.2	$ 110.1	$ 108.5	$ 103.8	$ 100.7	$ 97.8	$ 94.8	$ 92.6	$ 90.1	$ 87.8	$ 85.0	$ 82.8	$ 81.8	$ 80.0	$ 79.5	$ 76.4	$ 63.2
		Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$million/yr		3.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 178.4	$ 12.8	$ 12.2	$ 16.6	$ 12.6	$ 13.0	$ 13.5	$ 14.3	$ 14.6	$ 16.1	$ 21.9	$ 16.0	$ 16.5	$ 17.6	$ 17.9	$ 18.0	$ 18.5	$ 26.8	$ 19.7	$ 20.3	$ 20.9	$ 31.8	$ 22.1	$ 22.8	$ 32.8	$ 24.2	$ 29.8

Case 5

Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Supplemental Information is Highlighted in Grey

			Source on Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
		Capacity Factor	A 1.0	%		75%	78%	61%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%
		Energy Production	calc	GWh		[redacted]																									
		Average MSO Energy Price	D	$/MWh																											
		Annual Energy Revenue	calc	$millions/yr	$ (1,912)																										
	CAPACITY MARKET VALUE	Reserve Capacity	J	MW		538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	533	532	532	532	532	532	532	532	532	532
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$millions/yr	$ (218)	$ -	$ -	$ -	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Full Load Heat Rate	Y	Btu/kWh		10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
		MMBtu Fuel Burn	calc	MBtu		35.3	36.6	28.5	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	$Millions/yr	$ 1,299																										
		$/MMBtu VO&M Cost	W	$/MMBtu																											
		Annual VO&M Cost	calc		$ 84																										
		NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	1,811	2,319	2,319	2,319	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094
		NOx Credit Cost	D	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	D	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.89	3.82	2.97	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds / Revenue Requirements	Ongoing Capital Adds (ODC)		$millions/yr		$ 17.5	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Capacitor Turbine Upgrades		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Capacitor Mill Upgrades - Set 1		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Capacitor Mill Upgrades - Set 2		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Capacitor Mill Upgrades - Set 3		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Capacitor Mill Upgrades - Set 4		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Capacitor Mill Upgrades - Set 5		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Capacitor Mill Upgrades - Set 6		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Capacitor Turbine Maintenance		$millions/yr		$ 0.2	$ -	$ 10.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Capacitor Mill Maintenance		$millions/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
		Capacitor SCR		$millions/yr		$ -	$ -	$ 1.2	$ 49.6	$ 40.0	$ 119.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Capacitor Clean Air Compliance Programs (CACP)		$millions/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$millions/yr		$ 172.1	$ 50.8	$ 29.6	$ 53.1	$ 93.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.2	$ 12.3	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.8	$ 4.9	$ 1.2
	Fixed O&M	Capital Rev Req Cont/Decom		$millions/yr		$ 15.0	$ 12.3	$ 11.8	$ 10.8	$ 10.2	$ 9.0	$ 9.0	$ 8.3	$ 7.6	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$millions/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.8	$ 16.5	$ 17.9	$ 19.2	$ 20.5	$ 21.9	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.6	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills	R	$millions/yr		$ 0.1	$ 0.2	$ 2.2	$ 3.4	$ 3.4	$ 3.0	$ 3.0	$ 3.5	$ 3.6	$ 3.8	$ 4.0	$ 4.0	$ 4.0	$ 3.9	$ 3.8	$ 3.9	$ 4.4	$ 4.5	$ 4.5	$ 4.5	$ 4.5	$ 4.5	$ 4.6	$ 6.2	$ 6.7	$ 7.0
		Capital Rev Req SCR		$millions/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 48.9	$ 45.6	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.5	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$millions/yr		$ 14.0	$ 58.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.8	$ 35.8	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$millions/yr	$ 978.0	$ 31.6	$ 79.0	$ 82.8	$ 82.8	$ 85.3	$ 89.8	$ 122.5	$ 119.2	$ 115.5	$ 112.3	$ 109.2	$ 106.0	$ 102.8	$ 99.5	$ 96.0	$ 94.0	$ 91.6	$ 89.1	$ 86.5	$ 84.1	$ 81.9	$ 80.5	$ 78.9	$ 78.1	$ 74.8	$ 61.8
		Fixed O&M		$millions/yr		$ 8.2	$ 12.3	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 28.0
		Fixed O&M adder CAMP Study and CA Development		$millions/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$millions/yr		$ 3.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 8.4	$ -	$ -
		TOTAL Fixed O&M		$millions/yr	$ 119.4	$ 12.5	$ 12.3	$ 16.6	$ 12.8	$ 13.0	$ 13.5	$ 14.2	$ 14.8	$ 15.1	$ 21.8	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 26.3	$ 19.7	$ 20.3	$ 20.8	$ 21.6	$ 22.1	$ 22.8	$ 31.3	$ 24.2	$ 28.8

PUBLIC VERSION

Case B	Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology) Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

Unit 2 ALTERNATIVE	Item	Source on Input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504	504	504	504
	Capacity Factor	A.1.3	%		75%	78%	61%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%
	Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455
	Average MISO Energy Price	D	$/MWh		[redacted]												
	Annual Energy Revenue	calc	$million/yr	$ (1,012)													
CAPACITY MARKET VALUE	Reserve Capacity	T	MW		530	540	534	534	534	534	534	532	532	532	532	532	532
	Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
	Annual Capacity Value	calc	$million/yr	$ (216)	$ -	$ -	$ -	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455
	Full Load Heat Rate	Y	Btu/kWh		10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560
	MMBtu Fuel Burn	calc	MMbtu		[redacted]												
	$/MMBtu Delivered Fuel Cost	E	$/MMBtu														
	Annual Fuel Cost	calc	$Million/yr	$ 1,289													
	$/MMBtu VO&M Cost	W	$/MMBtu														
	Annual VO&M Cost	calc		$ 94													
	NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060
	NOx emissions	calc	tons/yr		2,244	2,326	1,811	2,319	2,319	2,319	1,094	1,094	1,094	1,022	1,094	1,094	1,094
	NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
	CO2 emissions	calc	million tons/yr		3.68	3.82	2.97	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81
	CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3
	Cap adder Turbine Upgrades		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 1		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 2		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 3		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 4		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 5		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 6		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ 18.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -
	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9
	Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total Capital Adds		$million/yr		$ 172.1	$ 50.8	$ 29.6	$ 53.1	$ 93.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.2	$ 12.7
Revenue Requirements	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.6	$ 7.2	$ 6.7	$ 6.1	$ 5.6
	Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.8	$ 15.1	$ 15.6	$ 16.8	$ 17.8	$ 19.2	$ 20.8	$ 21.9
	Capital Rev Req Turbine & Mills	B	$million/yr		$ 0.1	$ 0.3	$ 2.5	$ 3.8	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.3	$ 4.4	$ 4.4	$ 4.4
	Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.8	$ 46.9	$ 45.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8
	Capital Rev Req CACP		$million/yr		$ 14.0	$ 58.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6
	Capital Rev Req Total		$million/yr	$ 978.6	$ 31.6	$ 78.6	$ 82.2	$ 83.2	$ 85.7	$ 90.8	$ 122.9	$ 119.6	$ 115.9	$ 112.8	$ 109.8	$ 106.4	$ 103.2
Fixed O&M	Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.6	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4
	Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5
	Fixed O&M adder Turbine Maintenance		$million/yr		3.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.2	$ -	$ -	$ -
	TOTAL Fixed O&M		$million/yr	$ 172.4	$ 12.5	$ 12.2	$ 16.6	$ 12.8	$ 13.0	$ 13.5	$ 14.2	$ 14.8	$ 15.1	$ 21.8	$ 16.0	$ 16.5	$ 17.0

Unit 2 ALTERNATIVE	Item	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
ENERGY REVENUE	Rated Capacity	504	504	504	504	504	504	504	504	504	504	504	504	504
	Capacity Factor	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%
	Energy Production	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
	Average MISO Energy Price													
	Annual Energy Revenue													
CAPACITY MARKET VALUE	Reserve Capacity	532	532	532	532	532	532	532	532	532	532	532	532	532
	Capacity Value	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
	Annual Capacity Value	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
PRODUCTION COST	Energy Production	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
	Full Load Heat Rate	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
	MMBtu Fuel Burn	[redacted]												
	$/MMBtu Delivered Fuel Cost													
	Annual Fuel Cost													
	$/MMBtu VO&M Cost													
	Annual VO&M Cost													
	NOx Emission Rate	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
	NOx emissions	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094
	NOx Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual NOx Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	CO2 Emission Rate	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
	CO2 emissions	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81
	CO2 Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual CO2 Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Ongoing Capital Adds (OGC)	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
	Cap adder Turbine Upgrades	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Turbine Maintenance	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
	Cap adder Mill Maintenance	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
	Capital adder SCR	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Clean Air Compliance Programs (CACP)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total Capital Adds	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.8	$ 4.9	$ 1.2
Revenue Requirements	Capital Rev Req Sunk/Decom	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
	Capital Rev Req Ongoing	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
	Capital Rev Req Turbine & Mills	$ 4.4	$ 4.4	$ 4.3	$ 4.8	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.1	$ 9.8	$ 7.4	$ 7.8
	Capital Rev Req SCR	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
	Capital Rev Req CACP	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
	Capital Rev Req Total	$ 100.3	$ 97.2	$ 94.4	$ 92.1	$ 89.9	$ 87.0	$ 84.9	$ 82.4	$ 81.0	$ 79.6	$ 79.9	$ 78.7	$ 62.4
Fixed O&M	Fixed O&M	$ 16.8	$ 17.3	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
	Fixed O&M adder CAMP Study and CA Development	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Fixed O&M adder SCR	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
	Fixed O&M adder Turbine Maintenance	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
	TOTAL Fixed O&M	$ 17.3	$ 18.0	$ 18.5	$ 26.8	$ 19.7	$ 20.3	$ 20.8	$ 21.5	$ 22.1	$ 22.8	$ 32.9	$ 24.2	$ 29.8

Case 7	Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology) Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

UNIT 2 ALTERNATIVE

Section	Item	Source on Input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504	504	504	504
ENERGY REVENUE	Capacity Factor	A I S	%		75%	78%	61%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%
ENERGY REVENUE	Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455
ENERGY REVENUE	Average MISO Energy Price	O	$/MWh		[redacted]												
ENERGY REVENUE	Annual Energy Revenue	calc	$million/yr	$ (1,812)													
CAPACITY MARKET VALUE	Reserve Capacity	T	MW		538	540	534	534	534	534	534	532	532	532	532	532	532
CAPACITY MARKET VALUE	Capacity Value	H	$/MW-yr		-	-	-	49,180	49,180	49,180	49,180	49,180	49,180	49,180	49,180	49,180	49,180
CAPACITY MARKET VALUE	Annual Capacity Value	calc	$million/yr	$ (715)	$ -	$ -	$ -	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455
PRODUCTION COST	Full Load Heat Rate	Y	Btu/kWh		10,516	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560
PRODUCTION COST	MMBtu Fuel Burn	calc	Million		35.3	36.6	28.5	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5
PRODUCTION COST	$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]												
PRODUCTION COST	Annual Fuel Cost	calc	$Million/yr	$ 1,289													
PRODUCTION COST	$/MMBtu VO&M Cost	W	$/MMBtu														
PRODUCTION COST	Annual VO&M Cost	calc		$ 84													
PRODUCTION COST	NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060
PRODUCTION COST	NOx emissions	calc	tons/yr		2,244	2,326	1,811	2,319	2,319	2,319	1,094	1,094	1,094	1,022	1,094	1,094	1,094
PRODUCTION COST	NOx Credit Cost	O	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
PRODUCTION COST	Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
PRODUCTION COST	CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
PRODUCTION COST	CO2 emissions	calc	million tons/yr		3.69	3.82	2.97	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81
PRODUCTION COST	CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
PRODUCTION COST	Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3
Capital Adds	Cap adder Turbine Upgrades		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Cap adder Mill Upgrades - Set 1		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Cap adder Mill Upgrades - Set 2		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Cap adder Mill Upgrades - Set 3		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Cap adder Mill Upgrades - Set 4		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Cap adder Mill Upgrades - Set 5		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Cap adder Mill Upgrades - Set 6		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ 18.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -
Capital Adds	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9
Capital Adds	Capital adder SCR		$million/yr		$ -	$ -	$ 1.7	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Total Capital Adds		$million/yr		$ 172.1	$ 50.8	$ 29.6	$ 53.1	$ 93.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.2	$ 12.3
Revenue Requirements	Capital Rev Req Sunk/Decom		$million/yr		$ 13.6	$ 12.3	$ 11.6	$ 10.8	$ 10.2	$ 9.6	$ 9.0	$ 6.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6
Revenue Requirements	Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.9	$ 17.9	$ 19.2	$ 20.6	$ 21.9
Revenue Requirements	Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.3	$ 2.5	$ 3.8	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.2	$ 4.4	$ 4.4	$ 4.4
Revenue Requirements	Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.5	$ 11.6	$ 48.9	$ 45.8	$ 41.7	$ 41.6	$ 39.9	$ 37.7	$ 35.8
Revenue Requirements	Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6
Revenue Requirements	Capital Rev Req Total		$million/yr	$ 979.6	$ 31.6	$ 79.6	$ 83.3	$ 83.2	$ 85.7	$ 90.0	$ 122.9	$ 118.6	$ 116.9	$ 112.8	$ 109.8	$ 106.4	$ 103.3
Fixed O&M	Fixed O&M		$million/yr		$ 8.2	$ 12.2	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.6	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4
Fixed O&M	Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Fixed O&M	Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5
Fixed O&M	Fixed O&M adder Turbine Maintenance		$million/yr		3.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.2	$ -	$ -	$ -
Fixed O&M	TOTAL Fixed O&M		$million/yr	$ 179.4	$ 11.5	$ 12.2	$ 16.6	$ 12.6	$ 13.0	$ 13.5	$ 14.0	$ 14.6	$ 15.1	$ 21.8	$ 16.0	$ 16.5	$ 17.0

Section	Item	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
ENERGY REVENUE	Rated Capacity	504	504	504	504	504	504	504	504	504	504	504	504	504
ENERGY REVENUE	Capacity Factor	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%
ENERGY REVENUE	Energy Production	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
ENERGY REVENUE	Average MISO Energy Price	[redacted]												
ENERGY REVENUE	Annual Energy Revenue													
CAPACITY MARKET VALUE	Reserve Capacity	532	532	532	532	532	532	532	532	532	532	532	532	532
CAPACITY MARKET VALUE	Capacity Value	49,180	49,180	49,180	49,180	49,180	49,180	49,180	49,180	49,180	49,180	49,180	49,180	49,180
CAPACITY MARKET VALUE	Annual Capacity Value	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
PRODUCTION COST	Energy Production	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
PRODUCTION COST	Full Load Heat Rate	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
PRODUCTION COST	MMBtu Fuel Burn	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5
PRODUCTION COST	$/MMBtu Delivered Fuel Cost	[redacted]												
PRODUCTION COST	Annual Fuel Cost													
PRODUCTION COST	$/MMBtu VO&M Cost													
PRODUCTION COST	Annual VO&M Cost													
PRODUCTION COST	NOx Emission Rate	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
PRODUCTION COST	NOx emissions	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094
PRODUCTION COST	NOx Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
PRODUCTION COST	Annual NOx Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
PRODUCTION COST	CO2 Emission Rate	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
PRODUCTION COST	CO2 emissions	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81
PRODUCTION COST	CO2 Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
PRODUCTION COST	Annual CO2 Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Ongoing Capital Adds (OGC)	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
Capital Adds	Cap adder Turbine Upgrades	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Cap adder Mill Upgrades - Set 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Cap adder Mill Upgrades - Set 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Cap adder Mill Upgrades - Set 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Cap adder Mill Upgrades - Set 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Cap adder Mill Upgrades - Set 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Cap adder Mill Upgrades - Set 6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Cap adder Turbine Maintenance	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
Capital Adds	Cap adder Mill Maintenance	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
Capital Adds	Capital adder SCR	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Cap adder Clean Air Compliance Programs (CACP)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Total Capital Adds	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.8	$ 11.7	$ 11.8	$ 4.9	$ 1.2
Revenue Requirements	Capital Rev Req Sunk/Decom	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
Revenue Requirements	Capital Rev Req Ongoing	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.0	$ 30.6	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.7
Revenue Requirements	Capital Rev Req Turbine & Mills	$ 4.4	$ 4.4	$ 4.3	$ 4.9	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.1	$ 6.9	$ 7.4	$ 7.8
Revenue Requirements	Capital Rev Req SCR	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
Revenue Requirements	Capital Rev Req CACP	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
Revenue Requirements	Capital Rev Req Total	$ 100.3	$ 97.3	$ 94.4	$ 92.1	$ 89.6	$ 87.0	$ 84.6	$ 82.4	$ 81.0	$ 78.6	$ 78.9	$ 75.7	$ 62.4
Fixed O&M	Fixed O&M	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 28.0
Fixed O&M	Fixed O&M adder CAMP Study and CA Development	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Fixed O&M	Fixed O&M adder SCR	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
Fixed O&M	Fixed O&M adder Turbine Maintenance	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
Fixed O&M	TOTAL Fixed O&M	$ 17.5	$ 18.0	$ 18.6	$ 26.8	$ 19.7	$ 20.3	$ 20.8	$ 21.6	$ 22.1	$ 22.8	$ 32.9	$ 24.2	$ 28.8

PUBLIC VERSION

Case 8	Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology) Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

			Source on Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
		Capacity Factor	A 1:5	%		75%	78%	61%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Average MISO Energy Price	D	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	$million/yr	$ (1,812)																										
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		538	540	534	534	534	534	534	533	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$million/yr	$ (215)	$ -	$ -	$ -	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.2)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Full Load Heat Rate	Y	Btu/kWh		10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
		MMBtu Fuel Burn	calc	MMbtu		35.3	36.6	28.5	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5
		$/MMBtu Delivered Fuel Cost	C	$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	$Million/yr	$ 1,289																										
		$/MMBtu VOAM Cost	W	$/MMBtu																											
		Annual VOAM Cost	calc		$ 54																										
		NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	1,811	2,319	2,319	2,319	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094
		NOx Credit Cost	O	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.49	3.82	2.97	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OOC)		$million/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ 18.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.7	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.1	$ 50.8	$ 29.8	$ 53.1	$ 93.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.2	$ 12.3	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.8	$ 4.9	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.8	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.3	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.8	$ 14.8	$ 15.1	$ 15.8	$ 16.6	$ 17.9	$ 19.2	$ 20.6	$ 21.8	$ 23.2	$ 24.8	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills	[illegible]	$million/yr		$ 0.1	$ 0.3	$ 2.5	$ 3.8	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.2	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.3	$ 4.9	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.1	$ 6.9	$ 7.4	$ 7.8
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 45.9	$ 45.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.2
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 58.8	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$million/yr	$ 879.8	$ 31.5	$ 79.6	$ 82.2	$ 83.2	$ 85.7	$ 86.0	$ 122.9	$ 119.6	$ 116.6	$ 113.2	$ 109.4	$ 106.4	$ 103.2	$ 100.3	$ 97.3	$ 94.4	$ 92.1	$ 89.6	$ 87.0	$ 84.6	$ 83.4	$ 81.0	$ 79.5	$ 78.8	$ 75.7	$ 62.4
		Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$million/yr		3.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 179.4	$ 12.5	$ 12.2	$ 16.6	$ 12.8	$ 13.0	$ 13.5	$ 14.2	$ 14.8	$ 15.1	$ 21.8	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.6	$ 26.8	$ 19.7	$ 20.3	$ 20.8	$ 21.5	$ 22.1	$ 22.8	$ 32.8	$ 24.2	$ 29.9

Case 9

Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information - Highlighted in Grey

			Source on input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
UNIT 2 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504
		Capacity Factor	A / B	%		75%	78%	61%	78%	78%	78%	78%	78%	78%	73%
		Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225
		Average MISO Energy Price	D	$/MWh		[redacted]									
		Annual Energy Revenue	**calc**	**$million/yr**	**$ (1,812)**										
	CAPACITY MARKET VALUE	Rizzone Capacity	T	MW		538	543	534	534	534	534	534	532	532	532
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**calc**	**$million/yr**	**$ (218)**	$ -	$ -	$ -	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.1)	$ (26.1)	$ (26.1)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225
		Full Load Heat Rate	Y	Btu/kWh		10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560
		MMBtu Fuel Burn	calc	MBtu		35.3	36.6	28.5	36.5	36.5	36.5	36.5	36.5	36.5	34.1
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu											
		Annual Fuel Cost	**calc**	**$Million/yr**	**$ 1,269**	[redacted]									
		$/MMBtu VO&M Cost	**W**	**$/MMBtu**											
		Annual VO&M Cost	**calc**		**$ 84**										
		NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	1,831	2,318	2,318	2,318	1,094	1,094	1,094	1,022
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	**calc**	**$ Millions**	**$ -**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.69	3.82	2.97	3.81	3.81	3.81	3.81	3.81	3.81	3.56
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	**calc**	**$ Millions**	**$ -**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6
		Cap adder Turbine Upgrades		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ 18.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1
	Revenue Requirements	Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.1	$ 50.8	$ 29.6	$ 53.1	$ 93.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.8	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.6	$ 17.8
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.3	$ 2.5	$ 3.8	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.2
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.5	$ 46.9	$ 45.8	$ 43.7	$ 41.6
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.3	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8
		Capital Rev Req Total		**$million/yr**	**$ 979.5**	**$ 31.8**	**$ 79.8**	**$ 82.3**	**$ 82.2**	**$ 85.7**	**$ 90.8**	**$ 123.8**	**$ 119.6**	**$ 116.9**	**$ 112.8**
		Fixed O&M		$million/yr		$ 8.2	$ 12.2	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0
		Fixed O&M adder CAMP Study and EA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5
		Fixed O&M adder Turbine Maintenance		$million/yr		$ 3.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ 8.2	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 178.4**	**$ 12.5**	**$ 12.2**	**$ 16.6**	**$ 12.6**	**$ 13.0**	**$ 13.5**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 21.8**

			2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
		Capacity Factor	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%
		Energy Production	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Average MISO Energy Price	[redacted]															
		Annual Energy Revenue																
	CAPACITY MARKET VALUE	Rizzone Capacity	532	533	532	532	532	532	533	533	532	532	532	532	532	532	533	533
		Capacity Value	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**
	PRODUCTION COST	Energy Production	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Full Load Heat Rate	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
		MMBtu Fuel Burn	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5
		$/MMBtu Delivered Fuel Cost																
		Annual Fuel Cost																
		$/MMBtu VO&M Cost																
		Annual VO&M Cost																
		NOx Emission Rate	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094
		NOx Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81
		CO2 Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)	$ 6.1	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
	Revenue Requirements	Capital adder SCR	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Clean Air Compliance Programs (CACP)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds	$ 12.0	$ 12.2	$ 12.3	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.8	$ 4.9	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Decom	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing	$ 19.2	$ 20.6	$ 21.9	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.6	$ 37.1	$ 39.3	$ 40.2	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.3	$ 4.9	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.1	$ 6.8	$ 7.4	$ 7.8
		Capital Rev Req SCR	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.3	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.2	$ 14.4	$ 12.2	$ 10.3
		Capital Rev Req Total	**$ 109.4**	**$ 106.4**	**$ 103.3**	**$ 100.3**	**$ 97.3**	**$ 94.4**	**$ 92.1**	**$ 89.6**	**$ 87.0**	**$ 84.4**	**$ 82.4**	**$ 81.0**	**$ 79.8**	**$ 78.8**	**$ 76.7**	**$ 67.4**
		Fixed O&M	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 24.0
		Fixed O&M adder CAMP Study and EA Development	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 8.4	$ -	$ -
		TOTAL Fixed O&M	**$ 16.0**	**$ 16.5**	**$ 17.0**	**$ 17.6**	**$ 18.0**	**$ 18.5**	**$ 26.8**	**$ 19.7**	**$ 20.3**	**$ 20.8**	**$ 21.5**	**$ 22.1**	**$ 22.8**	**$ 32.9**	**$ 24.2**	**$ 24.8**

Case 10 — Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

			Source on Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
		Capacity Factor	A, T, S	%		82%	88%	87%	86%	85%	86%	86%	86%	86%	87%	88%	86%	86%	86%	86%	86%	80%	86%	86%	86%	86%	86%	86%	80%	86%	86%
		Energy Production	calc	GWh		3,693	3,821	2,676	3,821	3,821	3,821	3,806	3,806	3,800	3,548	3,800	3,800	3,800	3,800	3,800	3,800	3,548	3,800	3,800	3,800	3,800	3,800	3,800	3,548	3,800	3,800
		Average MISO Energy Price	D	$/MWh																											
		Annual Energy Revenue	calc	$millions/yr	$ 11,994																										
	CAPACITY MARKET VALUE	Winter-ie Capacity	E	MW		538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$millions/yr	$ (215)	$ -	$ -	$ -	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
	PRODUCTION COST	Energy Production	calc	GWh		3,693	3,821	2,676	3,821	3,821	3,821	3,806	3,806	3,800	3,548	3,800	3,800	3,800	3,800	3,800	3,800	3,548	3,800	3,800	3,800	3,800	3,800	3,800	3,548	3,800	3,800
		Full Load Heat Rate	N	Btu/kWh		10,519	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
		MMBtu Fuel Burn	calc	Million		38,8	40.3	31.3	40.1	40.1	40.1	40.1	40.1	40.1	37.5	40.1	40.1	40.1	40.1	40.1	40.1	37.5	40.1	40.1	40.1	40.1	40.1	40.1	37.5	40.1	40.1
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu																											
		Annual Fuel Cost	calc	$Millions/yr	$ 1,418																										
		$/MMBtu VO&M Cost	W	$/MMBtu																											
		Annual VO&M Cost	calc		$ 104																										
		NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		3,468	2,558	1,860	2,551	2,551	2,551	1,204	1,204	1,204	1,124	1,204	1,204	1,204	1,204	1,204	1,204	1,124	1,204	1,204	1,204	1,204	1,204	1,204	1,124	1,204	1,204
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		4.05	4.20	3.27	4.19	4.18	4.19	4.19	4.19	4.19	3.81	4.19	4.19	4.19	4.19	4.19	4.19	3.81	4.19	4.19	4.19	4.19	4.19	4.19	3.81	4.19	4.19
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds / Revenue Requirements	Ongoing Capital Adds (OOC)		$millions/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$millions/yr		$ 0.3	$ -	$ 16.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$millions/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
		Capital adder SCR		$millions/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Clean Air Compliance Programs (CACP)		$millions/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$millions/yr		$ 172.1	$ 50.8	$ 29.6	$ 53.1	$ 93.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.3	$ 12.3	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.8	$ 4.6	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Decom		$millions/yr		$ 12.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.8	$ 2.7	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$millions/yr		$ 4.4	$ 6.1	$ 10.4	$ 12.0	$ 13.6	$ 14.8	$ 15.3	$ 15.6	$ 16.6	$ 17.8	$ 19.2	$ 20.6	$ 21.9	$ 23.2	$ 24.8	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.6	$ 37.3	$ 39.3	$ 40.1	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills	R	$millions/yr		$ 0.1	$ 0.3	$ 2.5	$ 3.8	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.2	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.3	$ 4.9	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.1	$ 6.0	$ 7.4	$ 7.6
		Capital Rev Req SCR		$millions/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.5	$ 46.9	$ 45.8	$ 43.7	$ 41.6	$ 39.8	$ 37.7	$ 35.6	$ 34.0	$ 32.3	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$millions/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 45.6	$ 43.6	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.7	$ 10.3
		Capital Rev Req Total		$millions/yr	$ 379.6	$ 31.6	$ 78.0	$ 82.2	$ 83.2	$ 85.7	$ 90.0	$ 123.9	$ 119.4	$ 115.9	$ 112.6	$ 109.6	$ 106.4	$ 103.3	$ 100.3	$ 97.3	$ 94.4	$ 92.1	$ 88.6	$ 87.0	$ 84.6	$ 82.4	$ 81.6	$ 79.8	$ 78.9	$ 75.7	$ 63.4
		Fixed O&M		$millions/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
		Fixed O&M adder CAVP Study and CA Development		$millions/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ 0.3	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$millions/yr		$ 3.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 8.4	$ -	$ -
		TOTAL Fixed O&M		$millions/yr	$ 119.4	$ 12.5	$ 12.2	$ 16.6	$ 12.6	$ 13.0	$ 13.6	$ 14.2	$ 14.6	$ 15.1	$ 21.8	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 26.8	$ 19.7	$ 20.3	$ 20.9	$ 21.6	$ 22.1	$ 22.8	$ 32.2	$ 24.3	$ 29.8

Case 11	Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
	Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is maintained in Gray

UNIT 2 ALTERNATIVE

Group	Item	Source on Input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504	504	504	504
	Capacity Factor	A 1.5	%		67%	70%	55%	70%	70%	70%	70%	70%	70%	66%	70%	70%	70%
	Energy Production	calc	GWh		3,021	3,127	2,435	3,127	3,127	3,127	3,109	3,109	3,109	2,903	3,109	3,109	3,109
	Average MISO Energy Price	D	$/MWh		[redacted]												
	Annual Energy Revenue	calc	$million/yr	$ (1,621)													
CAPACITY MARKET VALUE	Reserve Capacity	T	MW		538	540	534	534	534	534	534	532	532	532	532	532	532
	Capacity Value	H	$/MW-yr				-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
	Annual Capacity Value	calc	$million/yr	$ (215)	$ -	$ -	$ -	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
PRODUCTION COST	Energy Production	calc	GWh		3,021	3,127	2,435	3,127	3,127	3,127	3,109	3,109	3,109	2,903	3,109	3,109	3,109
	Full Load Heat Rate	Y	Btu/kWh		10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560
	MMBtu Fuel Burn	calc	Million		31.8	32.9	25.6	32.8	32.8	32.8	32.8	32.8	32.8	30.7	32.8	32.8	32.8
	$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]												
	Annual Fuel Cost	calc	$Million/yr	$ 1,160													
	$/MMBtu VO&M Cost	W	$/MMBtu														
	Annual VO&M Cost	calc		$ 85													
	NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060
	NOx emissions	calc	tons/yr		2,020	2,093	1,630	2,087	2,087	2,087	985	985	985	920	985	985	985
	NOx Credit Cost	O	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
	CO2 emissions	calc	million tons/yr		3.32	3.44	2.68	3.43	3.43	3.43	3.43	3.43	3.43	3.20	3.43	3.43	3.43
	CO2 Credit Cost	P	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds Revenue Requirements Fixed O&M	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.3	$ 11.3
	Cap adder Turbine Upgrades		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 1		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 2		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 3		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 4		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 5		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 6		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ 18.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -
	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9
	Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 152.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total Capital Adds		$million/yr		$ 172.1	$ 50.8	$ 29.6	$ 53.1	$ 93.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.2	$ 12.3
	Capital Rev Req Sunk/Decom		$million/yr		$ 12.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6
	Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.6	$ 17.9	$ 19.2	$ 20.6	$ 21.9
	Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.3	$ 2.5	$ 3.8	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.2	$ 4.4	$ 4.4	$ 4.4
	Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.9	$ 40.9	$ 45.9	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8
	Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6
	Capital Rev Req Total		$million/yr	$ 979.6	$ 31.5	$ 79.6	$ 82.2	$ 83.2	$ 85.7	$ 90.9	$ 122.9	$ 119.6	$ 116.9	$ 112.8	$ 109.8	$ 106.4	$ 103.3
	Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4
	Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5
	Fixed O&M adder Turbine Maintenance		$million/yr		$ 0.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.2	$ -	$ -	$ -
	TOTAL Fixed O&M		$million/yr	$ 179.4	$ [illegible]	$ 12.2	$ 16.6	$ 12.6	$ 13.0	$ 13.5	$ 14.2	$ 14.6	$ 15.1	$ 21.8	$ 16.0	$ 16.5	$ 17.0

Group	Item	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
ENERGY REVENUE	Rated Capacity	504	504	504	504	504	504	504	504	504	504	504	504	504
	Capacity Factor	70%	70%	70%	66%	70%	70%	70%	70%	70%	70%	66%	70%	70%
	Energy Production	3,109	3,109	3,109	2,903	3,109	3,109	3,109	3,109	3,109	3,109	2,903	3,109	3,109
	Average MISO Energy Price	[redacted]												
	Annual Energy Revenue													
CAPACITY MARKET VALUE	Reserve Capacity	532	532	532	532	532	532	532	532	532	532	532	532	532
	Capacity Value	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
	Annual Capacity Value	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
PRODUCTION COST	Energy Production	3,109	3,109	3,109	2,903	3,109	3,109	3,109	3,109	3,109	3,109	2,903	3,109	3,109
	Full Load Heat Rate	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
	MMBtu Fuel Burn	32.8	32.8	32.8	30.7	32.8	32.8	32.8	32.8	32.8	32.8	30.7	32.8	32.8
	$/MMBtu Delivered Fuel Cost	[redacted]												
	Annual Fuel Cost													
	$/MMBtu VO&M Cost													
	Annual VO&M Cost													
	NOx Emission Rate	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
	NOx emissions	985	985	985	920	985	985	985	985	985	985	920	985	985
	NOx Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual NOx Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	CO2 Emission Rate	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
	CO2 emissions	3.43	3.43	3.43	3.20	3.43	3.43	3.43	3.43	3.43	3.43	3.20	3.43	3.43
	CO2 Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual CO2 Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds Revenue Requirements Fixed O&M	Ongoing Capital Adds (OGC)	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
	Cap adder Turbine Upgrades	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Turbine Maintenance	$ -	$ -	$ -	$ 3.9	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
	Cap adder Mill Maintenance	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
	Capital adder SCR	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Clean Air Compliance Programs (CACP)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total Capital Adds	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.8	$ 4.9	$ 1.2
	Capital Rev Req Sunk/Decom	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
	Capital Rev Req Ongoing	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
	Capital Rev Req Turbine & Mills	$ 4.4	$ 4.4	$ 4.3	$ 4.9	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.1	$ 6.9	$ 7.4	$ 7.8
	Capital Rev Req SCR	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
	Capital Rev Req CACP	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
	Capital Rev Req Total	$ 100.3	$ 97.3	$ 94.4	$ 92.1	$ 89.6	$ 87.0	$ 84.6	$ 82.4	$ 81.0	$ 79.6	$ 78.9	$ 75.7	$ 62.6
	Fixed O&M	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.0	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 20.0
	Fixed O&M adder CAMP Study and CA Development	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Fixed O&M adder SCR	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
	Fixed O&M adder Turbine Maintenance	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
	TOTAL Fixed O&M	$ 17.4	$ 18.0	$ 18.5	$ 26.8	$ 19.7	$ 20.3	$ 20.9	$ 21.5	$ 22.1	$ 22.8	$ 32.8	$ 24.2	$ 20.8

Case 12 — Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Cost/Revenue Information is Highlighted in Grey

			Source or Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Unit 2 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
		Capacity Factor	A, I, S	%		79%	78%	61%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Average MISO Energy Price	D	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	$ million/yr	$ (1,812)																										
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
		Capacity Value	H	$/MW/yr		-	-	-	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380	98,380
		Annual Capacity Value	calc	$ million/yr	$ (631)	$ -	$ -	$ -	$ (52.9)	$ (52.9)	$ (52.9)	$ (52.9)	$ (52.3)	$ (52.3)	$ (52.3)	$ (52.3)	$ (52.3)	$ (52.3)	$ (52.3)	$ (52.3)	$ (52.3)	$ (52.3)	$ (52.3)	$ (52.3)	$ (52.3)	$ (52.3)	$ (52.3)	$ (52.3)	$ (52.3)	$ (52.3)	$ (52.3)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Full Load Heat Rate	Y	Btu/kWh		10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
		MMBtu Fuel Burn	calc	MBtu		35.3	36.6	28.5	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5
		$/MMBtu Delivered Fuel Cost	F	$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	$ million/yr	$ 1,269																										
		$/MMBtu VO&M Cost	W	$/MMBtu																											
		Annual VO&M Cost	calc		$ 94																										
		NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.080	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	1,811	2,319	2,319	2,319	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094
		NOx Credit Cost	B	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.69	3.82	2.97	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.9	$ 24.8	$ 9.2	$ 13.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 2.7	$ -
		Cap adder Turbine Upgrades		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ 19.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.1	$ 50.8	$ 29.6	$ 53.1	$ 93.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.3	$ 12.3	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.8	$ 4.9	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.3	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.9	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.6	$ 17.9	$ 19.2	$ 20.6	$ 21.9	$ 23.3	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.2	$ 40.1	$ 37.2
		Capital Rev Req Turbine & Mills	H	$million/yr		$ 0.1	$ 0.3	$ 2.5	$ 3.6	$ 3.8	$ 3.9	$ 3.9	$ 3.8	$ 4.0	$ 4.2	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.3	$ 4.9	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.1	$ 6.0	$ 7.4	$ 7.8
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.8	$ 46.8	$ 45.3	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.2	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$million/yr	$ 919.8	$ 31.6	$ 79.8	$ 82.2	$ 83.2	$ 85.7	$ 90.0	$ 122.9	$ 119.6	$ 118.9	$ 112.6	$ 109.8	$ 106.4	$ 103.5	$ 100.3	$ 97.3	$ 94.4	$ 92.1	$ 88.6	$ 87.0	$ 86.5	$ 82.4	$ 81.8	$ 79.5	$ 78.8	$ 76.7	$ 62.4
		Fixed O&M		$million/yr		$ 8.2	$ 12.2	$ 13.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$million/yr		$ 3.3	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 179.4	$ 12.6	$ 12.3	$ 18.6	$ 12.8	$ 13.0	$ 13.3	$ 14.3	$ 14.8	$ 15.1	$ 21.8	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.3	$ 28.3	$ 19.7	$ 20.3	$ 20.9	$ 31.6	$ 22.1	$ 22.8	$ 32.3	$ 24.1	$ 29.8

Case 13

Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information Highlighted in Yellow

			Source on Input page		PV Discounted to end of year 2015	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
		Capacity Factor	A, J, G	%		79%	78%	81%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	78%	73%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Average MISO Energy Price	D	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	$million/yr	$ (1,812)																										
	CAPACITY MARKET VALUE	Heavies Capacity	T	MW		538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
		Capacity Value	H	$/MW-yr		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Annual Capacity Value	calc	$million/yr	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Full Load Heat Rate	Y	Btu/kWh		10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
		MMBtu Fuel Burn	calc	Million		35.3	36.6	28.5	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	$Million/yr	$ 1,259																										
		$/MMBtu VO&M Cost	W	$/MMBtu																											
		Annual VO&M Cost	calc		$ 84																										
		NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,326	1,811	2,319	2,319	2,319	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.69	3.82	2.97	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGIC)		$million/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ 18.1	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.9	$ 80.9	$ 119.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.1	$ 50.8	$ 29.6	$ 53.1	$ 93.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.7	$ 12.3	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.8	$ 4.9	$ 1.2
	Revenue Requirements	Capital Rev Req Sunk Cause		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.6	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$million/yr		$ 6.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.8	$ 16.6	$ 17.8	$ 18.2	$ 20.6	$ 21.9	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.6	$ 37.3	$ 39.3	$ 40.5	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.3	$ 2.5	$ 3.8	$ 3.8	$ 3.8	$ 3.9	$ 3.8	$ 4.0	$ 4.2	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.3	$ 4.9	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.1	$ 6.9	$ 7.4	$ 7.8
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.5	$ 40.9	$ 45.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.6	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 38.0	$ 37.7	$ 35.2	$ 32.7	$ 30.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.8	$ 35.8	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$million/yr	$ 978.8	$ 31.6	$ 79.6	$ 82.2	$ 93.2	$ 95.7	$ 90.6	$ 122.9	$ 119.6	$ 115.9	$ 112.8	$ 109.6	$ 106.4	$ 103.3	$ 100.3	$ 97.3	$ 94.4	$ 92.1	$ 89.6	$ 87.0	$ 84.5	$ 82.4	$ 81.0	$ 79.8	$ 79.8	$ 75.7	$ 62.4
	Fixed O&M	Fixed O&M		$million/yr		$ 8.2	$ 12.2	$ 12.3	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.6	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$million/yr		$ 0.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8.4	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 179.4	$ 13.5	$ 12.2	$ 16.8	$ 12.8	$ 13.0	$ 13.5	$ 14.2	$ 14.8	$ 15.1	$ 15.5	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 19.1	$ 19.7	$ 20.3	$ 20.9	$ 21.5	$ 22.1	$ 22.8	$ 31.2	$ 24.1	$ 29.8

Case 14 — Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

			Source in Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
		Capacity Factor	R, I, S	%		75%	78%	81%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%
		Energy Production		calc	GWh	3,357	3,474	3,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Average MISO Energy Price	D	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	$millions/yr	$ (2,269)																										
	CAPACITY MARKET VALUE	Reserve Capacity	I	MW		538	540	534	534	534	534	534	532	532	532	532	530	532	530	532	532	530	532	532	532	532	532	532	532	532	532
		Capacity Value	H	$/MW/yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$millions/yr	$ (215)	$ -	$ -	$ -	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
	PRODUCTION COST	Energy Production		calc	GWh	3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Full Load Heat Rate	Y	Btu/kWh		10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
		MMBtu Fuel Burn	calc	Million		35.3	36.6	28.5	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	$Millions/yr	$ 1,289																										
		$/MMBtu VO&M Cost	W	$/MMBtu																											
		Annual VO&M Cost	calc		$ 94																										
		NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,336	1,811	2,319	2,319	2,319	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094
		NOx Credit Cost	D	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	R	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.63	3.82	2.97	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)		$millions/yr		$ 17.3	$ 24.6	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.8	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$millions/yr		$ 0.3	$ -	$ 19.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$millions/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
	Revenue Requirements	Capital adder SCR		$millions/yr		$ -	$ -	$ 1.2	$ 40.0	$ 60.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Clean Air Compliance Programs (CACP)		$millions/yr		$ 157.6	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$millions/yr		$ 172.1	$ 50.6	$ 29.6	$ 53.1	$ 83.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.3	$ 12.3	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.8	$ 4.9	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Decom		$millions/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.5	$ 8.9	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$millions/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.6	$ 17.6	$ 19.7	$ 20.6	$ 21.8	$ 23.2	$ 24.8	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.7	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills	R	$millions/yr		$ 0.1	$ 0.3	$ 2.5	$ 3.6	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.2	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.3	$ 4.9	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.1	$ 6.9	$ 7.4	$ 7.8
		Capital Rev Req SCR		$millions/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 40.9	$ 45.8	$ 43.7	$ 41.9	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$millions/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.6	$ 41.8	$ 39.7	$ 37.8	$ 35.9	$ 33.5	$ 31.4	$ 29.4	$ 27.5	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$millions/yr	$ 979.6	$ 31.5	$ 79.5	$ 82.2	$ 83.2	$ 86.7	$ 90.0	$ 122.8	$ 119.6	$ 116.8	$ 112.8	$ 108.6	$ 106.4	$ 103.3	$ 100.3	$ 97.3	$ 94.4	$ 92.1	$ 89.6	$ 87.0	$ 84.8	$ 82.4	$ 81.0	$ 79.5	$ 78.8	$ 76.7	$ 62.8
		Fixed O&M		$millions/yr		$ 8.2	$ 12.2	$ 13.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.9
		Fixed O&M adder CAIMM Study and CA Development		$millions/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.6	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$millions/yr		$ 3.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 8.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M		$millions/yr	$ 170.4	$ 12.5	$ 12.2	$ 18.8	$ 12.6	$ 13.0	$ 13.5	$ 14.2	$ 14.8	$ 15.1	$ 21.8	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.5	$ 26.8	$ 19.7	$ 20.3	$ 20.9	$ 21.5	$ 22.1	$ 22.8	$ 32.3	$ 24.2	$ 29.8

Case 15

Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

UNIT 2 ALTERNATIVE

Section	Item	Source on Input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504	504	504	504
	Capacity Factor	A J 5	%		75%	78%	61%	78%	78%	78%	75%	78%	78%	73%	78%	78%	78%
	Energy Production	calc	GWh		[redacted]												
	Average MISO Energy Price	D	$/MWh		[redacted]												
	Annual Energy Revenue	calc	$million/yr	$ (1,359)	[redacted]												
CAPACITY MARKET VALUE	Reserve Capacity	T	MW		536	540	534	534	534	534	534	532	532	532	532	532	532
	Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
	Annual Capacity Value	calc	$million/yr	$ (219)	$ -	$ -	$ -	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455
	Full Load Heat Rate	Y	Btu/kWh		10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560
	MMBtu Fuel Burn	calc	MMbtu		[redacted]												
	$/MMBtu Delivered Fuel Cost	F	$/MMBtu		[redacted]												
	Annual Fuel Cost	calc	$Millions/yr	$ 1,289	[redacted]												
	$/MMBtu VO&M Cost	W	$/MMBtu		[redacted]												
	Annual VO&M Cost	calc		$ 84	[redacted]												
	NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060
	NOx emissions	calc	tons/yr		2,244	2,329	1,811	2,318	2,318	2,318	1,094	1,094	1,094	1,022	1,094	1,094	1,094
	NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
	CO2 emissions	calc	million tons/yr		3.69	3.82	2.97	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81
	CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.9	$ 11.1	$ 11.3
	Cap adder Turbine Upgrades		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 1		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 2		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 3		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 4		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 5		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 6		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ 18.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -
	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9
	Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total Capital Adds		$million/yr		$ 172.1	$ 50.8	$ 29.6	$ 53.1	$ 93.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.2	$ 12.3
Revenue Requirements	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.6	$ 7.2	$ 6.7	$ 6.1	$ 5.6
	Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.8	$ 17.8	$ 19.2	$ 20.8	$ 21.8
	Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.3	$ 2.5	$ 3.8	$ 3.8	$ 3.8	$ 3.9	$ 3.8	$ 4.0	$ 4.2	$ 4.4	$ 4.4	$ 4.4
	Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.8	$ 46.9	$ 45.8	$ 43.7	$ 41.6	$ 39.8	$ 37.7	$ 35.8
	Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6
	Capital Rev Req Total		$million/yr	$ 978.6	$ 31.5	$ 79.6	$ 82.2	$ 83.2	$ 85.7	$ 90.0	$ 122.9	$ 118.6	$ 115.9	$ 112.8	$ 109.8	$ 106.4	$ 103.2
Fixed O&M	Fixed O&M		$million/yr		$ 8.7	$ 12.2	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4
	Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5
	Fixed O&M adder Turbine Maintenance		$million/yr		3.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.2	$ -	$ -	$ -
	TOTAL Fixed O&M		$million/yr	$ 179.4	$ 12.0	$ 12.2	$ 16.6	$ 12.6	$ 13.0	$ 13.5	$ 14.2	$ 14.7	$ 15.1	$ 21.8	$ 16.0	$ 16.5	$ 16.9

Item	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Rated Capacity	504	504	504	504	504	504	504	504	504	504	504	504	504
Capacity Factor	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%
Energy Production	[redacted]												
Average MISO Energy Price	[redacted]												
Annual Energy Revenue	[redacted]												
Reserve Capacity	532	532	532	530	532	532	532	532	532	532	532	532	532
Capacity Value	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
Annual Capacity Value	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
Energy Production	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
Full Load Heat Rate	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
MMBtu Fuel Burn	[redacted]												
$/MMBtu Delivered Fuel Cost	[redacted]												
Annual Fuel Cost	[redacted]												
$/MMBtu VO&M Cost	[redacted]												
Annual VO&M Cost	[redacted]												
NOx Emission Rate	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
NOx emissions	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094
NOx Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual NOx Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
CO2 Emission Rate	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
CO2 emissions	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81
CO2 Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual CO2 Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ongoing Capital Adds (OGC)	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
Cap adder Turbine Upgrades	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Mill Upgrades - Set 6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Turbine Maintenance	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
Cap adder Mill Maintenance	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
Capital adder SCR	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cap adder Clean Air Compliance Programs (CACP)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Adds	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.8	$ 4.9	$ 1.2
Capital Rev Req Sunk/Decom	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.7)
Capital Rev Req Ongoing	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.6	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
Capital Rev Req Turbine & Mills	$ 4.4	$ 4.4	$ 4.3	$ 4.9	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.1	$ 6.9	$ 7.4	$ 7.8
Capital Rev Req SCR	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
Capital Rev Req CACP	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.3	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.5	$ 13.3	$ 10.3
Capital Rev Req Total	$ 100.3	$ 97.3	$ 94.4	$ 92.1	$ 89.6	$ 87.0	$ 84.6	$ 82.4	$ 81.0	$ 79.6	$ 78.8	$ 75.7	$ 62.4
Fixed O&M	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 20.0
Fixed O&M adder CAMP Study and CA Development	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Fixed O&M adder SCR	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
Fixed O&M adder Turbine Maintenance	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
TOTAL Fixed O&M	$ 17.5	$ 18.0	$ 18.6	$ 26.8	$ 19.7	$ 20.3	$ 20.8	$ 21.5	$ 22.1	$ 22.8	$ 32.9	$ 24.2	$ 20.8

Case 16

Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

			Source or Input range		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
		Capacity Factor	A 1.5	%		79%	78%	81%	85%	78%	76%	76%	78%	76%	73%	78%	76%	78%	78%	78%	78%	73%	78%	76%	76%	76%	76%	76%	73%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Avg Ann MISO Energy Price	D	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	**$millions/yr**	**$ (1,812)**																										
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		539	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	**$millions/yr**	**$ (315)**	**$ -**	**$ -**	**$ -**	**$ (26.3)**	**$ (26.3)**	**$ (26.3)**	**$ (26.3)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**	**$ (26.1)**
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Full Load Heat Rate	Y	Btu/kWh		10,516	10,534	10,534	10,562	10,562	10,562	10,580	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
		MMBtu Fuel Burn	calc	Million		35.3	36.6	28.5	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	**$Millions/yr**	**$ 1,611**																										
		$/MMBtu VO&M Cost	W	$/MMBtu																											
		Annual VO&M Cost	calc		**$ 94**																										
		NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,378	1,811	2,319	2,319	2,319	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.89	3.82	2.97	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$millions/yr		$ 17.3	$ 34.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 8.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$millions/yr		$ 0.3	$ -	$ 18.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.8	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$millions/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
		Capital adder SCR		$millions/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$millions/yr		$ 153.6	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$millions/yr		$ 172.1	$ 60.8	$ 29.6	$ 53.1	$ 93.1	$ 117.7	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.2	$ 12.3	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.6	$ 4.9	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Decom		$millions/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.6	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.3)
		Capital Rev Req Ongoing		$millions/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.8	$ 15.1	$ 15.9	$ 16.6	$ 17.9	$ 19.2	$ 20.4	$ 21.9	$ 23.3	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 38.3	$ 40.3	$ 40.1	$ 39.2
		Capital Rev Req Turbine & Mills	R	$millions/yr		$ 0.1	$ 0.3	$ 2.5	$ 3.5	$ 3.8	$ 3.8	$ 3.8	$ 3.9	$ 4.0	$ 4.2	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.3	$ 4.9	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.1	$ 6.9	$ 7.4	$ 7.8
		Capital Rev Req SCR		$millions/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 46.9	$ 45.6	$ 43.7	$ 41.8	$ 39.8	$ 37.7	$ 35.5	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$millions/yr		$ 14.0	$ 50.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.6	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.1	$ 10.3
		Capital Rev Req Total		**$millions/yr**	**$ 878.3**	**$ 31.5**	**$ 79.6**	**$ 82.2**	**$ 83.2**	**$ 95.7**	**$ 90.0**	**$ 122.9**	**$ 118.6**	**$ 115.9**	**$ 112.8**	**$ 109.6**	**$ 106.4**	**$ 103.3**	**$ 100.3**	**$ 97.3**	**$ 94.4**	**$ 92.1**	**$ 89.6**	**$ 87.2**	**$ 84.8**	**$ 82.4**	**$ 81.0**	**$ 79.5**	**$ 78.8**	**$ 76.7**	**$ 62.4**
		Fixed O&M		$millions/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.5	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 20.0
		Fixed O&M adder CAUP Study and CA Development		$millions/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.6
		Fixed O&M adder Turbine Maintenance		$millions/yr		$ 3.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M		**$millions/yr**	**$ 179.4**	**$ 12.5**	**$ 12.2**	**$ 16.6**	**$ 12.5**	**$ 13.0**	**$ 13.5**	**$ 14.2**	**$ 14.8**	**$ 15.1**	**$ 21.8**	**$ 16.3**	**$ 16.8**	**$ 17.5**	**$ 17.8**	**$ 18.0**	**$ 18.6**	**$ 26.8**	**$ 18.7**	**$ 20.3**	**$ 20.8**	**$ 21.5**	**$ 22.1**	**$ 22.8**	**$ 32.5**	**$ 24.2**	**$ 20.6**

Case 17	Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology) Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is highlighted in Gray

			Source on Input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
		Capacity Factor	A I S	%		75%	78%	61%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%
		Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Average MISO Energy Price	D	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	$million/yr	$ (1,812)																										
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		538	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
		Capacity Value	H	$/MW-yr		-	-	-	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100	49,100
		Annual Capacity Value	calc	$million/yr	$ (215)	$ -	$ -	$ -	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
		Full Load Heat Rate	Y	Btu/kWh		10,536	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
		MMBtu Fuel Burn	calc	MMbtu		[redacted]																									
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu																											
		Annual Fuel Cost	calc	$Million/yr	$ 667																										
		$/MMBtu VO&M Cost	W	$/MMBtu																											
		Annual VO&M Cost	calc		$ 94																										
		NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,244	2,226	1,611	2,319	2,319	2,319	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		3.69	3.82	2.97	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ 18.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
		Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 82.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.1	$ 50.8	$ 29.6	$ 53.1	$ 95.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.2	$ 12.3	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.8	$ 4.9	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Docum		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.8	$ 16.6	$ 17.9	$ 19.2	$ 20.6	$ 21.9	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
		Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.3	$ 2.5	$ 3.8	$ 3.8	$ 3.8	$ 3.9	$ 3.8	$ 4.0	$ 4.2	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.3	$ 4.8	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.1	$ 6.9	$ 7.4	$ 7.8
		Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 46.9	$ 45.6	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.3	$ 15.7	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$million/yr	$ 979.6	$ 31.6	$ 79.6	$ 82.2	$ 83.2	$ 85.7	$ 90.0	$ 122.9	$ 119.6	$ 116.0	$ 112.8	$ 109.6	$ 106.4	$ 103.3	$ 100.3	$ 97.3	$ 94.4	$ 92.1	$ 89.6	$ 87.0	$ 84.6	$ 82.4	$ 81.0	$ 79.8	$ 78.8	$ 75.7	$ 62.4
		Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.8	$ 0.8	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$million/yr		3.3	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M		$million/yr	$ 178.4	$ 12.6	$ 12.2	$ 16.6	$ 12.6	$ 13.0	$ 13.5	$ 14.2	$ 14.6	$ 15.1	$ 21.8	$ 16.0	$ 16.5	$ 17.0	$ 17.5	$ 18.0	$ 18.6	$ 26.8	$ 19.7	$ 20.3	$ 20.8	$ 21.5	$ 22.1	$ 22.8	$ 32.8	$ 24.2	$ 29.8

Case 1A

Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

UNIT 2 ALTERNATIVE

Section	Item	Source on Input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504	504	504	504
	Capacity Factor	A,T,S	%		67%	70%	55%	70%	70%	70%	70%	70%	70%	68%	70%	70%	70%
	Energy Production	calc	GWh		3,021	3,127	2,435	3,127	3,127	3,127	3,109	3,109	3,109	2,903	3,109	3,109	3,109
	Average MISO Energy Price	D	$/MWh		[redacted]												
	Annual Energy Revenue	calc	$million/yr	$ (1,223)													
CAPACITY MARKET VALUE	Reserve Capacity	T	MW		535	540	534	534	534	534	534	532	532	532	532	532	532
	Capacity Value	H	$/MW-yr		-	-	-	-	-	-	-	-	-	-	-	-	-
	Annual Capacity Value	calc	$million/yr	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
PRODUCTION COST	Energy Production	calc	GWh		3,021	3,127	2,435	3,127	3,127	3,127	3,109	3,109	3,109	2,903	3,109	3,109	3,109
	Full Load Heat Rate	Y	Btu/kWh		10,516	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560
	MMBtu Fuel Burn	calc	Million		31.6	32.9	25.6	32.8	32.8	32.8	32.8	32.8	32.8	30.7	32.8	32.8	32.8
	$/MMBtu Delivered Fuel Cost	F	$/MMBtu		[redacted]												
	Annual Fuel Cost	calc	$Million/yr	$ 1,450													
	$/MMBtu VO&M Cost	W	$/MMBtu														
	Annual VO&M Cost	calc		$ 88													
	NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060
	NOx emissions	calc	tons/yr		2,020	2,093	1,630	2,087	2,087	2,087	985	985	985	920	985	985	985
	NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	CO_2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
	CO_2 emissions	calc	million tons/yr		3.32	3.44	2.68	3.43	3.43	3.43	3.43	3.43	3.43	3.20	3.43	3.43	3.43
	CO_2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual CO_2 Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3
	Cap adder Turbine Upgrades		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 1		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 2		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 3		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 4		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 5		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 6		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ 18.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.8	$ -	$ -	$ -
	Cap adder Mill Maintenance		$million/yr		$ 0.1	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9
	Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 153.8	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total Capital Adds		$million/yr		$ 172.1	$ 50.8	$ 29.6	$ 53.1	$ 93.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.2	$ 12.2
Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6
	Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.8	$ 15.1	$ 15.6	$ 16.6	$ 17.0	$ 19.2	$ 20.8	$ 21.9
	Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.2	$ 2.2	$ 3.4	$ 3.4	$ 3.5	$ 3.5	$ 3.5	$ 3.6	$ 3.8	$ 4.0	$ 4.0	$ 4.0
	Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.8	$ 49.9	$ 45.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8
	Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6
	Capital Rev Req Total		$million/yr	$ 975.8	$ 31.5	$ 79.8	$ 82.0	$ 82.9	$ 85.3	$ 89.8	$ 122.5	$ 119.2	$ 115.6	$ 112.3	$ 109.2	$ 106.0	$ 102.9
	Fixed O&M		$million/yr		$ 8.7	$ 12.2	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4
	Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5
	Fixed O&M adder Turbine Maintenance		$million/yr		$ 3.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.2	$ -	$ -	$ -
	TOTAL Fixed O&M		$million/yr	$ 179.4	$ 12.5	$ 12.2	$ 16.8	$ 12.6	$ 12.8	$ 13.5	$ 14.2	$ 14.8	$ 15.1	$ 21.6	$ 16.0	$ 16.5	$ 17.0

Section	Item	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
ENERGY REVENUE	Rated Capacity	504	504	504	504	504	504	504	504	504	504	504	504	504
	Capacity Factor	70%	70%	70%	66%	70%	70%	70%	70%	70%	70%	66%	70%	70%
	Energy Production	3,109	3,109	3,109	2,903	3,109	3,109	3,109	3,109	3,109	3,109	2,903	3,109	3,109
	Average MISO Energy Price													
	Annual Energy Revenue													
CAPACITY MARKET VALUE	Reserve Capacity	532	532	532	532	532	532	532	532	532	532	512	532	532
	Capacity Value	-	-	-	-	-	-	-	-	-	-	-	-	-
	Annual Capacity Value	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
PRODUCTION COST	Energy Production	3,109	3,109	3,109	2,903	3,109	3,109	3,109	3,109	3,109	3,109	2,903	3,109	3,109
	Full Load Heat Rate	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
	MMBtu Fuel Burn	32.8	32.8	32.8	30.7	32.8	32.8	32.8	32.8	32.8	32.8	30.7	32.8	32.8
	$/MMBtu Delivered Fuel Cost	[redacted]												
	Annual Fuel Cost													
	$/MMBtu VO&M Cost													
	Annual VO&M Cost													
	NOx Emission Rate	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
	NOx emissions	985	985	985	920	985	985	985	985	985	985	920	985	985
	NOx Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual NOx Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	CO_2 Emission Rate	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
	CO_2 emissions	3.43	3.43	3.43	3.20	3.43	3.43	3.43	3.43	3.43	3.43	3.20	3.43	3.43
	CO_2 Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual CO_2 Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Adds	Ongoing Capital Adds (OGC)	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
	Cap adder Turbine Upgrades	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Turbine Maintenance	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
	Cap adder Mill Maintenance	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
	Capital adder SCR	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Revenue Requirements	Cap adder Clean Air Compliance Programs (CACP)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total Capital Adds	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.6	$ 4.9	$ 1.2
Fixed O&M	Capital Rev Req Sunk/Decom	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
	Capital Rev Req Ongoing	$ 22.7	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.8	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.2
	Capital Rev Req Turbine & Mills	$ 3.9	$ 3.9	$ 3.9	$ 4.4	$ 4.5	$ 4.5	$ 4.5	$ 4.5	$ 4.5	$ 4.6	$ 6.2	$ 6.7	$ 7.0
	Capital Rev Req SCR	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
	Capital Rev Req CACP	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.8
	Capital Rev Req Total	$ 99.3	$ 96.3	$ 94.0	$ 91.6	$ 89.1	$ 86.5	$ 84.1	$ 81.8	$ 80.5	$ 78.9	$ 78.1	$ 74.9	$ 61.8
	Fixed O&M	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
	Fixed O&M adder CAMP Study and CA Development	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Fixed O&M adder SCR	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
	Fixed O&M adder Turbine Maintenance	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
	TOTAL Fixed O&M	$ 17.5	$ 18.0	$ 18.5	$ 26.8	$ 19.7	$ 20.3	$ 20.9	$ 21.5	$ 22.1	$ 22.8	$ 32.8	$ 24.2	$ 29.8

Case 19

Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

[redacted]

			Source or input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	O	MW		513	507	507	507	507	507	504	504	504	504	501	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
		Capacity Factor	A / B	%		83%	86%	67%	89%	86%	86%	86%	86%	86%	80%	86%	86%	86%	86%	86%	86%	80%	86%	86%	86%	86%	86%	86%	80%	86%	86%
		Energy Production	calc	GWh		3,693	3,621	2,976	3,821	3,821	3,621	3,600	3,600	3,600	2,548	3,601	3,601	3,600	3,600	3,600	3,600	2,548	3,600	3,600	3,600	3,600	3,600	3,600	2,548	3,600	3,600
		Average MISO Energy Price	D	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	**$ million/yr**	**$ 12,472**																										
	CAPACITY MARKET VALUE	Reserve Capacity	T	MW		533	540	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
		Capacity Value	H	$/MW/yr		-	-	-	86,380	86,380	86,380	86,380	86,380	86,380	86,380	86,380	86,380	86,380	86,380	86,380	86,380	86,380	86,380	86,380	86,380	86,380	86,380	86,380	86,380	86,380	86,380
		Annual Capacity Value	calc	**$million/yr**	**$ 1411**	**$ -**	**$ -**	**$ -**	**$ (62.6)**	**$ (62.6)**	**$ (62.6)**	**$ (62.6)**	**$ (62.3)**	**$ (62.3)**	**$ (62.3)**	**$ (62.3)**	**$ (62.3)**	**$ (62.3)**	**$ (62.3)**	**$ (62.3)**	**$ (62.3)**	**$ (62.3)**	**$ (62.3)**	**$ (62.3)**	**$ (62.3)**	**$ (62.3)**	**$ (62.3)**	**$ (62.3)**	**$ (62.3)**	**$ (62.3)**	**$ (62.3)**	**$ (62.3)**
	PRODUCTION COST	Energy Production	calc	GWh		3,693	3,621	2,976	3,821	3,821	3,621	3,600	3,600	3,600	2,548	3,600	3,600	3,600	3,600	3,600	3,600	2,548	3,600	3,600	3,600	3,600	3,600	3,600	2,548	3,600	3,600
		Full Load Heat Rate	F	Btu/kWh		10,518	10,534	10,534	10,502	10,502	10,507	10,508	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
		Million Fuel Burn	calc	MBtu		38,8	40.3	31.3	40.1	40.1	40.1	40.1	40.1	40.1	37.5	40.1	40.1	40.1	40.1	40.1	40.1	37.5	40.1	40.1	40.1	40.1	40.1	40.1	37.5	40.1	40.1
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	**$Million/yr**	**$ 1,064**																										
		$/MWhr VOAM Cost	W	$/MWhr																											
		Annual VOAM Cost	calc		**$ 104**																										
		NOx Emission Rate	V	lb/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,468	2,558	1,992	2,551	2,551	2,551	1,204	1,204	1,204	1,124	1,204	1,204	1,204	1,204	1,204	1,204	1,124	1,204	1,204	1,204	1,204	1,204	1,204	1,124	1,204	1,204
		NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
		CO2 Emission Rate	R	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
		CO2 emissions	calc	million tons/yr		4.05	4.20	3.27	4.19	4.19	4.19	4.19	4.19	4.19	3.91	4.19	4.19	4.19	4.19	4.19	4.19	3.91	4.19	4.19	4.19	4.19	4.19	4.19	3.91	4.19	4.19
		CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual CO2 Cost	calc	**$ Millions**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Capital Adds	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.6	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.8	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ 18.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
		Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
	Revenue Requirements	Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.0	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Clean Air Compliance Programs (CACP)		$million/yr		153.8	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$million/yr		$ 172.1	$ 50.6	$ 28.6	$ 53.1	$ 93.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.2	$ 12.3	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.6	$ 4.9	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.5	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.8	$ 15.1	$ 15.6	$ 16.6	$ 17.9	$ 19.2	$ 20.6	$ 21.9	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.6	$ 32.6	$ 34.6	$ 37.3	$ 39.3	$ 40.3	$ 40.1	$ 33.3
		Capital Rev Req Turbine & Mills	#	$million/yr		$ 0.1	$ 0.3	$ 2.7	$ 4.1	$ 4.2	$ 4.2	$ 4.3	$ 4.3	$ 4.3	$ 4.7	$ 4.8	$ 4.9	$ 4.8	$ 4.8	$ 4.8	$ 4.8	$ 5.3	$ 5.5	$ 5.5	$ 5.4	$ 5.4	$ 5.2	$ 5.8	$ 7.6	$ 8.2	$ 8.0
		Capital Rev Req SCR		$million/yr		-	$ -	$ 0.0	$ 1.4	$ 9.3	$ 11.0	$ 46.8	$ 45.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.8	$ 25.1	$ 23.3	$ 21.5	$ 19.6	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 53.7	$ 50.4	$ 45.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.8	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.3	$ 10.1
		Capital Rev Req Total		**$million/yr**	**$ 983.5**	**$ 31.5**	**$ 79.7**	**$ 82.5**	**$ 83.5**	**$ 91.1**	**$ 90.4**	**$ 123.2**	**$ 120.8**	**$ 116.2**	**$ 113.2**	**$ 110.1**	**$ 106.5**	**$ 103.0**	**$ 100.7**	**$ 97.9**	**$ 94.8**	**$ 92.6**	**$ 90.1**	**$ 87.8**	**$ 85.0**	**$ 82.8**	**$ 81.6**	**$ 80.8**	**$ 79.6**	**$ 76.4**	**$ 63.2**
		Fixed O&M		$million/yr		$ 9.7	$ 12.3	$ 12.3	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
		Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.8	$ 0.8	$ 0.8	$ 0.8	$ 0.8	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$million/yr		$ 3.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 8.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M		**$million/yr**	**$ 179.4**	**$ 12.8**	**$ 12.2**	**$ 16.8**	**$ 12.8**	**$ 13.0**	**$ 13.5**	**$ 14.2**	**$ 14.6**	**$ 15.1**	**$ 21.8**	**$ 16.0**	**$ 16.5**	**$ 17.0**	**$ 17.5**	**$ 19.0**	**$ 19.5**	**$ 26.8**	**$ 19.7**	**$ 20.3**	**$ 20.8**	**$ 21.8**	**$ 22.1**	**$ 32.3**	**$ 23.8**	**$ 24.2**	**$ 29.8**

Case 20 | Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

UNIT 2 ALTERNATIVE

	Item	Source on Input page	Units	PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504	504	504	504
	Capacity Factor	A,T,S	%		75%	78%	61%	78%	78%	78%	78%	78%	78%	73%	78%	78%	78%
	Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455
	Average MISO Energy Price	D	$/MWh		[redacted]												
	Annual Energy Revenue	calc	$million/yr	$ (2,145)	[redacted]												
CAPACITY MARKET VALUE	Reserve Capacity	T	MW		536	540	534	534	534	534	534	532	532	532	532	532	532
	Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
	Annual Capacity Value	calc	$million/yr	$ (215)	$ -	$ -	$ -	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	3,225	3,455	3,455	3,455
	Full Load Heat Rate	Y	Btu/kWh		10,518	10,534	10,534	10,502	10,502	10,502	10,560	10,560	10,560	10,560	10,560	10,560	10,560
	MMBtu Fuel Burn	calc	Million		35.3	36.6	28.5	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5	36.5
	$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]												
	Annual Fuel Cost	calc	$Million/yr	$ 1,219	[redacted]												
	$/MMBtu VOAM Cost	W	$/MMBtu		[redacted]												
	Annual VOAM Cost	calc		$ 94	[redacted]												
	NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060
	NOx emissions	calc	tons/yr		2,244	2,326	1,811	2,318	2,318	2,318	1,094	1,094	1,094	1,022	1,094	1,094	1,094
	NOx Credit Cost	G	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	CO2 Emission Rate	B	lbs/MMBtu		208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
	CO2 emissions	calc	million tons/yr		3.69	3.82	2.97	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81	3.81
	CO2 Credit Cost	F	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16	$ 17	$ 19	$ 20
	Annual CO2 Cost	calc	$ Millions	$ 458	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 57.1	$ 66.1	$ 71.8	$ 77.8
Capital Adds / Revenue Requirements / Fixed O&M	Ongoing Capital Adds (OGC)		$million/yr		$ 17.3	$ 24.8	$ 9.2	$ 12.0	$ 12.0	$ 6.1	$ 6.2	$ 6.3	$ 10.4	$ 10.6	$ 10.9	$ 11.1	$ 11.3
	Cap adder Turbine Upgrades		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 1		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 2		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 3		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 4		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 5		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 6		$million/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Turbine Maintenance		$million/yr		$ 0.3	$ -	$ 18.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -
	Cap adder Mill Maintenance		$million/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.9
	Capital adder SCR		$million/yr		$ -	$ -	$ 1.2	$ 40.6	$ 80.0	$ 110.0	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Clean Air Compliance Programs (CACP)		$million/yr		$ 103.8	$ 20.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total Capital Adds		$million/yr		$ 122.1	$ 50.8	$ 29.6	$ 53.1	$ 93.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.2	$ 12.3
	Capital Rev Req Sunk/Decom		$million/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6
	Capital Rev Req Ongoing		$million/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.9	$ 15.1	$ 15.6	$ 16.6	$ 17.9	$ 19.2	$ 20.6	$ 21.9
	Capital Rev Req Turbine & Mills	R	$million/yr		$ 0.1	$ 0.3	$ 2.5	$ 3.8	$ 3.8	$ 3.8	$ 3.9	$ 3.8	$ 4.0	$ 4.2	$ 4.4	$ 4.4	$ 4.4
	Capital Rev Req SCR		$million/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.8	$ 46.9	$ 45.6	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.9
	Capital Rev Req CACP		$million/yr		$ 14.0	$ 59.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.8	$ 35.8
	Capital Rev Req Total		$million/yr	$ 878.6	$ 31.5	$ 79.6	$ 82.2	$ 83.2	$ 85.7	$ 90.6	$ 122.9	$ 119.6	$ 116.0	$ 112.8	$ 109.8	$ 106.4	$ 103.3
	Fixed O&M		$million/yr		$ 9.2	$ 12.2	$ 12.2	$ 12.6	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4
	Fixed O&M adder CAMP Study and CA Development		$million/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Fixed O&M adder SCR		$million/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5
	Fixed O&M adder Turbine Maintenance		$million/yr		3.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.2	$ -	$ -	$ -
	TOTAL Fixed O&M		$million/yr	$ 179.4	$ 12.5	$ 12.2	$ 16.6	$ 12.6	$ 13.0	$ 13.5	$ 14.2	$ 14.6	$ 15.1	$ 21.8	$ 16.0	$ 16.5	$ 17.0

	Item	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
ENERGY REVENUE	Rated Capacity	504	504	504	504	504	504	504	504	504	504	504	504	504
	Capacity Factor	78%	78%	78%	73%	78%	78%	78%	78%	78%	78%	73%	78%	78%
	Energy Production	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
	Average MISO Energy Price	[redacted]												
	Annual Energy Revenue	[redacted]												
CAPACITY MARKET VALUE	Reserve Capacity	532	532	532	532	532	532	532	532	532	532	532	532	532
	Capacity Value	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
	Annual Capacity Value	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
PRODUCTION COST	Energy Production	3,455	3,455	3,455	3,225	3,455	3,455	3,455	3,455	3,455	3,455	3,225	3,455	3,455
	Full Load Heat Rate	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
	MMBtu Fuel Burn	36.5	36.5	36.5	34.1	36.5	36.5	36.5	36.5	36.5	36.5	34.1	36.5	36.5
	$/MMBtu Delivered Fuel Cost	[redacted]												
	Annual Fuel Cost	[redacted]												
	$/MMBtu VOAM Cost	[redacted]												
	Annual VOAM Cost	[redacted]												
	NOx Emission Rate	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
	NOx emissions	1,094	1,094	1,094	1,022	1,094	1,094	1,094	1,094	1,094	1,094	1,022	1,094	1,094
	NOx Credit Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual NOx Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	CO2 Emission Rate	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76	208.76
	CO2 emissions	3.81	3.81	3.81	3.56	3.81	3.81	3.81	3.81	3.81	3.81	3.56	3.81	3.81
	CO2 Credit Cost	$ 22	$ 24	$ 26	$ 28	$ 30	$ 32	$ 35	$ 38	$ 41	$ 44	$ 48	$ 52	$ 56
	Annual CO2 Cost	$ 83.6	$ 90.4	$ 97.8	$ 99.7	$ 114.3	$ 123.5	$ 133.5	$ 144.4	$ 156.1	$ 168.8	$ 170.4	$ 197.3	$ 213.4
Capital Adds / Revenue Requirements / Fixed O&M	Ongoing Capital Adds (OGC)	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.7	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
	Cap adder Turbine Upgrades	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Mill Upgrades - Set 6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Turbine Maintenance	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.4	$ -	$ -
	Cap adder Mill Maintenance	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
	Capital adder SCR	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cap adder Clean Air Compliance Programs (CACP)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total Capital Adds	$ 12.6	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.8	$ 4.9	$ 1.2
	Capital Rev Req Sunk/Decom	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
	Capital Rev Req Ongoing	$ 23.2	$ 24.6	$ 26.0	$ 27.5	$ 29.1	$ 30.6	$ 32.6	$ 34.8	$ 37.3	$ 39.3	$ 40.2	$ 40.1	$ 33.7
	Capital Rev Req Turbine & Mills	$ 4.4	$ 4.4	$ 4.3	$ 4.9	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.1	$ 6.9	$ 7.4	$ 7.8
	Capital Rev Req SCR	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 26.9	$ 25.1	$ 23.3	$ 21.5	$ 19.8	$ 18.0	$ 16.2	$ 14.4	$ 11.3
	Capital Rev Req CACP	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.7	$ 14.4	$ 13.2	$ 10.3
	Capital Rev Req Total	$ 100.3	$ 97.3	$ 94.4	$ 92.1	$ 89.6	$ 87.0	$ 84.9	$ 82.4	$ 81.0	$ 79.5	$ 78.6	$ 76.7	$ 52.4
	Fixed O&M	$ 16.9	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.6	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 29.0
	Fixed O&M adder CAMP Study and CA Development	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Fixed O&M adder SCR	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
	Fixed O&M adder Turbine Maintenance	$ -	$ -	$ -	$ 7.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
	TOTAL Fixed O&M	$ 17.5	$ 18.0	$ 18.6	$ 26.3	$ 19.7	$ 20.3	$ 20.9	$ 21.5	$ 22.1	$ 22.8	$ 32.8	$ 24.2	$ 29.8

Case 21 — Appendix B, Schedule 4 - CALCS - ALTERNATIVE (Without Upgrades - Maintenance with 1975 Technology)
Columbia Unit 2 Turbine and Mill Upgrade Analysis

			Source on input page		PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2 ALTERNATIVE	ENERGY REVENUE	Rated Capacity	U	MW		513	507	507	507	507	507	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
		Capacity Factor	A1:S	%		75%	78%	81%	79%	79%	78%	78%	78%	78%	66%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	66%	70%	70%
		Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	2,903	3,109	3,109	3,109	3,109	3,109	3,109	2,803	3,109	3,109	3,109	3,109	3,109	3,109	2,903	3,109	3,109
		Average MISO Energy Price	U	$/MWh		[redacted]																									
		Annual Energy Revenue	calc	$millions/yr	$ (1,885)	[redacted]																									
	CAPACITY MARKET VALUE	Remove Capacity	T	MW		528	543	534	534	534	534	534	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532	532
		Capacity Value	H	$/MW-yr		-	-	-	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190	49,190
		Annual Capacity Value	calc	$millions/yr	$ (215)	$ -	$ -	$ -	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.3)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)	$ (26.1)
	PRODUCTION COST	Energy Production	calc	GWh		3,357	3,474	2,705	3,474	3,474	3,474	3,455	3,455	3,455	2,903	3,109	3,108	3,109	3,109	3,109	3,109	2,903	3,109	3,109	3,109	3,109	3,109	3,109	2,903	3,109	3,109
		Full Load Heat Rate	Y	Btu/kWh		10,518	10,534	10,534	10,560	10,560	10,560	10,560	10,560	10,560	10,566	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
		MMBtu Fuel Burn	calc	Million		35,3	36.6	28.5	36.5	36.5	36.5	36.5	36.5	36.5	30.7	32.8	32.8	32.8	32.8	32.8	32.8	30.7	32.8	32.8	32.8	32.8	32.8	32.8	30.7	32.8	32.8
		$/MMBtu Delivered Fuel Cost	E	$/MMBtu		[redacted]																									
		Annual Fuel Cost	calc	$Millions/yr	$ 1,219	[redacted]																									
		$/MMBtu VO&M Cost	W	$/MMBtu		[redacted]																									
		Annual VO&M Cost	calc		$ 89	[redacted]																									
		NOx Emission Rate	V	lbs/MMBtu		0.127	0.127	0.127	0.127	0.127	0.127	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
		NOx emissions	calc	tons/yr		2,744	2,328	1,811	2,319	2,319	2,318	1,094	1,094	1,094	920	985	985	985	985	985	985	920	985	985	985	985	985	985	920	985	985
		NOx Credit Cost	D	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Annual NOx Cost	calc	$ Millions	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		CO2 Emission Rate	B	lbs/MMBtu		208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78	208.78
		CO2 emissions	calc	million tons/yr		3.69	3.82	2.97	3.81	3.81	3.81	3.81	3.81	3.81	3.20	3.43	3.43	3.43	3.43	3.43	3.43	3.20	3.43	3.43	3.43	3.43	3.43	3.43	3.20	3.43	3.43
		CO2 Credit Cost	E	$/ton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16	$ 17	$ 19	$ 20	$ 22	$ 24	$ 26	$ 28	$ 30	$ 32	$ 35	$ 38	$ 41	$ 44	$ 48	$ 52	$ 56
		Annual CO2 Cost	calc	$ Millions	$ 412	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 51.4	$ 59.5	$ 64.4	$ 69.6	$ 75.3	$ 81.4	$ 88.0	$ 96.4	$ 102.9	$ 111.2	$ 120.2	$ 130.0	$ 140.8	$ 151.9	$ 163.4	$ 177.6	$ 192.9
	Capital Adds	Ongoing Capital Adds (OGC)		$millions/yr		$ 17.3	$ 24.6	$ 9.2	$ 12.0	$ 12.0	$ 8.1	$ 6.2	$ 6.3	$ 10.4	$ 10.8	$ 10.8	$ 11.1	$ 11.3	$ 11.6	$ 11.8	$ 12.1	$ 12.3	$ 12.6	$ 12.9	$ 13.2	$ 13.5	$ 13.8	$ 10.5	$ 7.2	$ 3.7	$ -
		Cap adder Turbine Upgrades		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 1		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 2		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 3		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 4		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 5		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Mill Upgrades - Set 6		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Turbine Maintenance		$millions/yr		$ 0.2	$ -	$ 16.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.9	$ -	$ -	$ -	$ -	$ -	$ -	$ 3.0	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.4	$ -	$ -
		Cap adder Mill Maintenance		$millions/yr		$ 0.7	$ 0.7	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 0.8	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.2	$ 1.2
	Revenue Requirements	Capital adder SCR		$millions/yr		$ -	$ -	$ 1.2	$ 40.0	$ 89.0	$ 110.9	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Cap adder Clean Air Compliance Programs (CACP)		$millions/yr		$ 150.6	$ 25.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Total Capital Adds		$millions/yr		$ 172.1	$ 50.8	$ 29.8	$ 53.1	$ 93.1	$ 117.2	$ 7.4	$ 7.4	$ 11.5	$ 13.6	$ 12.0	$ 12.2	$ 12.3	$ 12.5	$ 12.8	$ 13.1	$ 16.3	$ 13.7	$ 14.0	$ 14.3	$ 14.6	$ 14.9	$ 11.7	$ 11.8	$ 4.9	$ 1.2
	Fixed O&M	Capital Rev Req Sunk/Decom		$millions/yr		$ 13.0	$ 12.3	$ 11.6	$ 10.9	$ 10.2	$ 9.6	$ 9.0	$ 8.3	$ 7.8	$ 7.2	$ 6.7	$ 6.1	$ 5.6	$ 5.2	$ 4.7	$ 4.2	$ 3.8	$ 3.4	$ 3.0	$ 2.6	$ 2.2	$ 1.8	$ 1.4	$ 1.0	$ 0.6	$ (0.2)
		Capital Rev Req Growth		$millions/yr		$ 4.4	$ 8.1	$ 10.4	$ 12.0	$ 13.6	$ 14.6	$ 15.1	$ 15.6	$ 16.0	$ 17.9	$ 19.7	$ 20.6	$ 21.0	$ 22.2	$ 24.6	$ 26.0	$ 27.5	$ 28.1	$ 30.8	$ 33.8	$ 34.8	$ 37.3	$ 39.3	$ 40.1	$ 40.1	$ 21.2
		Capital Rev Req Turbine & Mills	H	$millions/yr		$ 0.1	$ 0.3	$ 2.5	$ 3.8	$ 3.8	$ 3.8	$ 3.9	$ 3.9	$ 4.0	$ 4.2	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.4	$ 4.3	$ 4.9	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.0	$ 5.1	$ 6.8	$ 7.4	$ 7.8
		Capital Rev Req SCR		$millions/yr		$ -	$ -	$ 0.0	$ 1.4	$ 5.3	$ 11.6	$ 46.8	$ 45.8	$ 43.7	$ 41.6	$ 39.6	$ 37.7	$ 35.8	$ 34.0	$ 32.2	$ 30.5	$ 28.7	$ 28.9	$ 25.1	$ 23.3	$ 21.5	$ 19.6	$ 18.0	$ 16.2	$ 14.4	$ 11.3
		Capital Rev Req CACP		$millions/yr		$ 14.0	$ 55.0	$ 57.7	$ 55.2	$ 52.7	$ 50.4	$ 48.1	$ 46.0	$ 43.8	$ 41.8	$ 39.7	$ 37.6	$ 35.6	$ 33.5	$ 31.4	$ 29.4	$ 27.3	$ 25.2	$ 23.1	$ 21.1	$ 19.0	$ 17.1	$ 15.1	$ 14.4	$ 13.2	$ 10.3
		Capital Rev Req Total		$millions/yr	$ 978.4	$ 31.8	$ 76.6	$ 82.2	$ 83.2	$ 85.7	$ 90.0	$ 122.9	$ 119.6	$ 115.5	$ 112.8	$ 109.4	$ 106.4	$ 103.3	$ 100.3	$ 97.3	$ 93.4	$ 92.1	$ 89.6	$ 87.8	$ 84.6	$ 82.4	$ 81.0	$ 79.6	$ 78.8	$ 76.7	$ 62.4
		Fixed O&M		$millions/yr		$ 8.2	$ 12.2	$ 12.2	$ 12.8	$ 13.0	$ 13.4	$ 13.8	$ 14.2	$ 14.6	$ 15.0	$ 15.5	$ 16.0	$ 16.4	$ 16.8	$ 17.4	$ 18.0	$ 18.5	$ 19.1	$ 19.8	$ 20.2	$ 20.8	$ 21.4	$ 22.1	$ 22.8	$ 23.4	$ 79.0
		Fixed O&M adder CAMP Study and CA Development		$millions/yr		$ 0.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Fixed O&M adder SCR		$millions/yr		$ -	$ -	$ -	$ -	$ -	$ 0.1	$ 0.4	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.7	$ 0.8
		Fixed O&M adder Turbine Maintenance		$millions/yr		$ 0.2	$ -	$ 4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.7	$ -	$ -	$ -	$ -	$ -	$ -	$ 9.4	$ -	$ -
		TOTAL Fixed O&M		$millions/yr	$ 178.4	$ 13.5	$ 12.2	$ 16.6	$ 13.6	$ 13.0	$ 13.5	$ 14.2	$ 14.8	$ 15.1	$ 21.8	$ 16.0	$ 16.3	$ 17.0	$ 17.6	$ 18.0	$ 26.8	$ 19.7	$ 20.3	$ 20.8	$ 21.6	$ 22.1	$ 22.8	$ 31.8	$ 24.2	$ 80.8

Case 1

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 717	$ 675	$ 42
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,331	$ 1,271	$ 60
	Production Revenue	$ (1,799)	$ (1,662)	$ (138)
	Capacity Value	$ (206)	$ (201)	$ (5)
	Net Customer Cost (Benefit)	**$ 198**	**$ 243**	**$ (45)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (1,799)	[redacted]																						
		Capacity Value	$ (206)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,331	[redacted]																						
		Capital Revenue Requirements	$ 717	$ 29	$ 77	78	79	85	83	80	78	75	73	70	68	66	64	62	60	58	56	55	53	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,662)	[redacted]																						
		Capacity Value	$ (201)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,271	[redacted]																						
		Capital Revenue Requirements	$ 675	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	61	59	58	56	55	54	53	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (138)	$ -	$ -	-	(30)	(3)	(13)	(13)	(14)	(15)	(15)	(28)	(17)	(17)	(18)	(4)	(20)	(20)	(37)	(22)	(23)	(24)	(25)	(27)
		Capacity Value	$ (5)	$ -	$ -	-	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 60	$ -	$ -	-	19	(3)	5	5	6	6	6	16	7	7	7	(4)	8	8	21	9	9	10	10	10
		Capital Revenue Requirements	$ 42.3	$ 0	$ 0	1	2	9	9	8	8	7	7	6	5	5	4	4	4	3	2	1	1	0	(1)	(2)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 82	$ -	$ -	-	11	5	8	9	9	9	10	13	11	11	12	8	12	13	17	14	15	15	16	17
		Project Costs (savings)	$ 37	$ 0	$ 0	1	(2)	10	9	8	8	7	7	(1)	5	5	4	11	4	3	(6)	1	1	0	(1)	(2)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 45**	**$ (0)**	**$ (0)**	**(1)**	**13**	**(5)**	**(1)**	**0**	**1**	**2**	**3**	**14**	**6**	**7**	**7**	**(3)**	**9**	**9**	**22**	**13**	**14**	**15**	**17**	**19**
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	10	(3)	(0)	0	1	1	2	6	2	2	3	(1)	2	2	5	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	(1)	9	5	5	5	6	7	8	14	17	19	21	20	23	25	31	33	36	39	42	45

Case 2

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 725	$ 675	$ 50
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,331	$ 1,271	$ 60
	Production Revenue	$ (1,799)	$ (1,662)	$ (138)
	Capacity Value	$ (206)	$ (201)	$ (5)
	Net Customer Cost (Benefit)	**$ 206**	**$ 243**	**$ (37)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (1,799)																							
		Capacity Value	$ (206)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,331																							
		Capital Revenue Requirements	$ 725	$ 29	$ 77	78	79	87	84	81	79	76	74	71	69	67	64	63	61	59	57	55	53	51	48	39
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,662)																							
		Capacity Value	$ (201)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,271																							
		Capital Revenue Requirements	$ 675	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	61	59	58	56	55	54	53	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (138)	$ -	$ -	-	(30)	(3)	(13)	(13)	(14)	(15)	(15)	(28)	(17)	(17)	(18)	(4)	(20)	(20)	(37)	(22)	(23)	(24)	(25)	(27)
		Capacity Value	$ (5)	$ -	$ -	-	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 60	$ -	$ -	-	19	(3)	5	5	6	6	6	16	7	7	7	(4)	8	8	21	9	9	10	10	10
		Capital Revenue Requirements	$ 49.9	$ 0	$ 0	1	2	11	10	10	9	8	8	7	6	5	5	5	5	4	3	2	1	1	0	(1)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 82	$ -	$ -	-	11	5	8	9	9	9	10	13	11	11	12	8	12	13	17	14	15	15	16	17
		Project Costs (savings)	$ 45	$ 0	$ 0	1	(1)	11	10	10	9	8	8	0	6	5	5	12	5	4	(5)	2	1	1	0	(1)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 37**	**$ (0)**	**$ (0)**	**(1)**	**12**	**(6)**	**(2)**	**(1)**	**(0)**	**1**	**2**	**13**	**5**	**6**	**7**	**(4)**	**8**	**9**	**22**	**12**	**13**	**14**	**16**	**18**
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	9	(4)	(1)	(1)	(0)	1	1	5	2	2	2	(1)	2	2	5	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	(1)	8	4	3	2	2	3	4	9	11	13	15	14	16	19	24	26	29	32	34	37

Case 3

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 710	$ 675	$ 35
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,331	$ 1,271	$ 60
	Production Revenue	$ (1,799)	$ (1,662)	$ (138)
	Capacity Value	$ (206)	$ (201)	$ (5)
	Net Customer Cost (Benefit)	**$ 190**	**$ 243**	**$ (52)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (1,799)																							
		Capacity Value	$ (206)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,331																							
		Capital Revenue Requirements	$ 710	$ 29	$ 77	78	78	84	82	79	76	74	72	69	67	65	63	61	59	57	56	54	52	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,662)																							
		Capacity Value	$ (201)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,271																							
		Capital Revenue Requirements	$ 675	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	61	59	58	56	55	54	53	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (138)	$ -	$ -	-	(30)	(3)	(13)	(13)	(14)	(15)	(15)	(28)	(17)	(17)	(18)	(4)	(20)	(20)	(37)	(22)	(23)	(24)	(25)	(27)
		Capacity Value	$ (5)	$ -	$ -	-	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 60	$ -	$ -	-	19	(3)	5	5	6	6	6	16	7	7	7	(4)	8	8	21	9	9	10	10	10
		Capital Revenue Requirements	$ 34.8	$ 0	$ 0	1	1	8	8	7	7	6	6	5	4	4	3	3	3	3	1	1	0	(0)	(1)	(2)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 82	$ -	$ -	-	11	5	8	9	9	9	10	13	11	11	12	8	12	13	17	14	15	15	16	17
		Project Costs (savings)	$ 30	$ 0	$ 0	1	(2)	8	8	7	7	6	6	(2)	4	4	3	11	3	3	(7)	1	0	(0)	(1)	(2)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 52**	**$ (0)**	**$ (0)**	**(1)**	**13**	**(3)**	**1**	**1**	**2**	**3**	**4**	**15**	**7**	**8**	**8**	**(2)**	**9**	**10**	**23**	**13**	**14**	**15**	**17**	**19**
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	10	(2)	0	1	1	2	2	6	3	3	3	(1)	3	3	6	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	(1)	9	7	7	8	9	11	13	19	22	25	28	27	30	32	38	41	44	46	49	52

Case 4 Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 717	$ 678	$ 39
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,331	$ 1,271	$ 60
	Production Revenue	$ (1,799)	$ (1,662)	$ (138)
	Capacity Value	$ (206)	$ (201)	$ (5)
	Net Customer Cost (Benefit)	$ 198	$ 246	$ (48)

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (1,799)	[redacted]																						
		Capacity Value	$ (206)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,331	[redacted]																						
		Capital Revenue Requirements	$ 717	$ 29	$ 77	78	79	85	83	80	78	75	73	70	68	66	64	62	60	58	56	55	53	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,662)	[redacted]																						
		Capacity Value	$ (201)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,271	[redacted]																						
		Capital Revenue Requirements	$ 678	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	62	60	58	57	55	55	54	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (138)	$ -	$ -	-	(30)	(3)	(13)	(13)	(14)	(15)	(15)	(28)	(17)	(17)	(18)	(4)	(20)	(20)	(37)	(22)	(23)	(24)	(25)	(27)
		Capacity Value	$ (5)	$ -	$ -	-	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 60	$ -	$ -	-	19	(3)	5	5	6	6	6	16	7	7	7	(4)	8	8	21	9	9	10	10	10
		Capital Revenue Requirements	$ 39.0	$ 0	$ 0	1	1	9	9	8	7	7	6	5	5	4	4	4	3	3	2	1	0	(0)	(1)	(2)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 82	$ -	$ -	-	11	5	8	9	9	9	10	13	11	11	12	8	12	13	17	14	15	15	16	17
		Project Costs (savings)	$ 34	$ 0	$ 0	1	(2)	9	9	8	7	7	6	(1)	5	4	4	11	3	3	(6)	1	0	(0)	(1)	(2)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 48**	**$ (0)**	**$ (0)**	**(1)**	**13**	**(4)**	**(0)**	**1**	**1**	**3**	**4**	**14**	**6**	**7**	**8**	**(3)**	**9**	**10**	**23**	**13**	**14**	**15**	**17**	**20**
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	10	(3)	(0)	0	1	1	2	8	2	3	3	(1)	3	3	5	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	(1)	9	6	6	6	7	8	10	16	18	21	24	23	25	28	33	36	39	42	45	48

Case 5

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 717	$ 672	$ 46
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,331	$ 1,271	$ 60
	Production Revenue	$ (1,799)	$ (1,662)	$ (138)
	Capacity Value	$ (206)	$ (201)	$ (5)
	Net Customer Cost (Benefit)	**$ 198**	**$ 240**	**$ (41)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (1,799)																							
		Capacity Value	$ (206)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,331																							
		Capital Revenue Requirements	$ 717	$ 29	$ 77	78	79	85	83	80	78	75	73	70	68	66	64	62	60	58	56	55	53	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,662)																							
		Capacity Value	$ (201)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,271																							
		Capital Revenue Requirements	$ 672	$ 29	$ 77	77	77	76	73	71	69	68	66	64	63	61	59	57	56	54	54	53	51	49	47	39
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (138)	$ -	$ -	-	(30)	(3)	(13)	(13)	(14)	(15)	(15)	(28)	(17)	(17)	(18)	(4)	(20)	(20)	(37)	(22)	(23)	(24)	(25)	(27)
		Capacity Value	$ (5)	$ -	$ -	-	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 60	$ -	$ -	-	19	(3)	5	5	6	6	6	16	7	7	7	(4)	8	8	21	9	9	10	10	10
		Capital Revenue Requirements	$ 45.6	$ 0	$ 0	1	2	10	9	9	8	8	7	6	5	5	5	5	4	4	3	2	1	1	0	(1)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 82	$ -	$ -	-	11	5	8	9	9	9	10	13	11	11	12	8	12	13	17	14	15	15	16	17
		Project Costs (savings)	$ 41	$ 0	$ 0	1	(2)	10	9	9	8	8	7	(0)	5	5	5	12	4	4	(5)	2	1	1	0	(1)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 41**	**$ (0)**	**$ (0)**	**(1)**	**12**	**(5)**	**(1)**	**(0)**	**1**	**2**	**3**	**13**	**5**	**6**	**7**	**(4)**	**8**	**9**	**22**	**12**	**13**	**14**	**16**	**18**
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	10	(4)	(1)	(0)	0	1	1	6	2	2	2	(1)	2	2	5	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	(1)	9	5	4	4	4	5	7	12	15	17	19	18	20	23	28	31	33	36	39	41

Case 6

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 717	$ 675	$ 42
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,326	$ 1,271	$ 55
	Production Revenue	$ (1,799)	$ (1,662)	$ (138)
	Capacity Value	$ (206)	$ (201)	$ (5)
	Net Customer Cost (Benefit)	**$ 193**	**$ 243**	**$ (50)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (1,799)																							
		Capacity Value	$ (206)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,326																							
		Capital Revenue Requirements	$ 717	$ 29	$ 77	78	79	85	83	80	78	75	73	70	68	66	64	62	60	58	56	55	53	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,662)																							
		Capacity Value	$ (201)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,271																							
		Capital Revenue Requirements	$ 675	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	61	59	58	56	55	54	53	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (138)	$ -	$ -	-	(30)	(3)	(13)	(13)	(14)	(15)	(15)	(28)	(17)	(17)	(18)	(4)	(20)	(20)	(37)	(22)	(23)	(24)	(25)	(27)
		Capacity Value	$ (5)	$ -	$ -	-	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 55	$ -	$ -	-	19	(3)	5	5	5	5	6	15	6	6	7	(4)	7	7	20	8	8	9	9	9
		Capital Revenue Requirements	$ 42.3	$ 0	$ 0	1	2	9	9	8	8	7	7	6	5	5	4	4	4	3	2	1	1	0	(1)	(2)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 87	$ -	$ -	-	11	5	9	9	9	10	11	14	11	12	12	9	13	14	17	15	15	16	17	18
		Project Costs (savings)	$ 37	$ 0	$ 0	1	(2)	10	9	8	8	7	7	(1)	5	5	4	11	4	3	(6)	1	1	0	(1)	(2)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 50**	**$ (0)**	**$ (0)**	**(1)**	**13**	**(4)**	**(0)**	**1**	**2**	**3**	**4**	**14**	**6**	**7**	**8**	**(2)**	**9**	**10**	**23**	**13**	**15**	**16**	**18**	**20**
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	10	(3)	(0)	0	1	1	2	6	3	3	3	(1)	3	3	6	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	(1)	9	6	6	6	7	9	11	17	19	22	25	24	26	29	35	38	41	44	47	50

Case 7

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 717	$ 675	$ 42
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,336	$ 1,271	$ 65
	Production Revenue	$ (1,799)	$ (1,662)	$ (138)
	Capacity Value	$ (206)	$ (201)	$ (5)
	Net Customer Cost (Benefit)	**$ 203**	**$ 243**	**$ (40)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (1,799)																							
		Capacity Value	$ (206)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,336																							
		Capital Revenue Requirements	$ 717	$ 29	$ 77	78	79	85	83	80	78	75	73	70	68	66	64	62	60	58	56	55	53	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,662)																							
		Capacity Value	$ (201)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,271																							
		Capital Revenue Requirements	$ 675	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	61	59	58	56	55	54	53	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (138)	$ -	$ -	-	(30)	(3)	(13)	(13)	(14)	(15)	(15)	(28)	(17)	(17)	(18)	(4)	(20)	(20)	(37)	(22)	(23)	(24)	(25)	(27)
		Capacity Value	$ (5)	$ -	$ -	-	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 65	$ -	$ -	-	20	(2)	6	6	6	6	7	16	7	8	8	(3)	9	9	22	10	10	11	11	11
		Capital Revenue Requirements	$ 42.3	$ 0	$ 0	1	2	9	9	8	8	7	7	6	5	5	4	4	4	3	2	1	1	0	(1)	(2)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 77	$ -	$ -	-	10	5	8	8	8	9	9	12	10	10	11	8	12	12	16	13	14	14	15	16
		Project Costs (savings)	$ 37	$ 0	$ 0	1	(2)	10	9	8	8	7	7	(1)	5	5	4	11	4	3	(6)	1	1	0	(1)	(2)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 40**	**$ (0)**	**$ (0)**	**(1)**	**12**	**(5)**	**(1)**	**(0)**	**1**	**2**	**3**	**13**	**5**	**6**	**7**	**(4)**	**8**	**9**	**22**	**12**	**13**	**14**	**16**	**18**
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	9	(4)	(1)	(0)	0	1	1	6	2	2	2	(1)	2	2	5	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	(1)	8	5	4	4	4	5	6	12	14	16	18	17	19	22	27	29	32	34	37	40

Case 8

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 717	$ 675	$ 42
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,340	$ 1,271	$ 69
	Production Revenue	$ (1,811)	$ (1,662)	$ (149)
	Capacity Value	$ (206)	$ (201)	$ (5)
	Net Customer Cost (Benefit)	**$ 195**	**$ 243**	**$ (48)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (1,811)	[redacted]																						
		Capacity Value	$ (206)	$ -	$ -	-	(26)	(26)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)
		Variable Production Cost	$ 1,340	[redacted]																						
		Capital Revenue Requirements	$ 717	$ 29	$ 77	78	79	85	83	80	78	75	73	70	68	66	64	62	60	58	56	55	53	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,662)	[redacted]																						
		Capacity Value	$ (201)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,271	[redacted]																						
		Capital Revenue Requirements	$ 675	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	61	59	58	56	55	54	53	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (149)	$ -	$ -	-	(30)	(4)	(14)	(15)	(15)	(16)	(17)	(29)	(18)	(19)	(20)	(6)	(21)	(22)	(39)	(24)	(25)	(26)	(28)	(29)
		Capacity Value	$ (5)	$ -	$ -	-	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 69	$ -	$ -	-	19	(2)	6	7	7	7	7	17	8	8	9	(2)	9	10	22	11	11	11	12	12
		Capital Revenue Requirements	$ 42.3	$ 0	$ 0	1	2	9	9	8	8	7	7	6	5	5	4	4	4	3	2	1	1	0	(1)	(2)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 85	$ -	$ -	-	11	5	9	9	9	10	10	13	11	12	12	9	13	13	17	15	15	16	17	18
		Project Costs (savings)	$ 37	$ 0	$ 0	1	(2)	10	9	8	8	7	7	(1)	5	5	4	11	4	3	(6)	1	1	0	(1)	(2)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 48**	**$ (0)**	**$ (0)**	**(1)**	**13**	**(4)**	**(0)**	**1**	**1**	**3**	**4**	**14**	**6**	**7**	**8**	**(3)**	**9**	**10**	**23**	**13**	**14**	**16**	**17**	**20**
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	10	(3)	(0)	0	1	1	2	6	2	3	3	(1)	3	3	6	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	(1)	9	6	5	6	7	8	10	16	18	21	24	23	25	28	33	36	39	42	45	48

Case 9

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 717	$ 675	$ 42
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,322	$ 1,271	$ 51
	Production Revenue	$ (1,788)	$ (1,662)	$ (126)
	Capacity Value	$ (205)	$ (201)	$ (4)
	Net Customer Cost (Benefit)	**$ 201**	**$ 243**	**$ (41)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (1,788)	[redacted]																						
		Capacity Value	$ (205)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,322	[redacted]																						
		Capital Revenue Requirements	$ 717	$ 29	$ 77	78	79	85	83	80	78	75	73	70	68	66	64	62	60	58	56	55	53	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,662)	[redacted]																						
		Capacity Value	$ (201)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,271	[redacted]																						
		Capital Revenue Requirements	$ 675	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	61	59	58	56	55	54	53	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (126)	$ -	$ -	-	(30)	(1)	(12)	(12)	(12)	(13)	(14)	(26)	(15)	(16)	(16)	(2)	(18)	(18)	(35)	(20)	(21)	(22)	(23)	(24)
		Capacity Value	$ (4)	$ -	$ -	-	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 51	$ -	$ -	-	19	(3)	4	4	5	5	5	14	5	6	6	(5)	6	7	19	7	8	8	8	8
		Capital Revenue Requirements	$ 42.3	$ 0	$ 0	1	2	9	9	8	8	7	7	6	5	5	4	4	4	3	2	1	1	0	(1)	(2)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 79	$ -	$ -	-	11	5	8	8	8	9	9	12	10	11	11	8	12	12	16	13	14	14	15	16
		Project Costs (savings)	$ 37	$ 0	$ 0	1	(2)	10	9	8	8	7	7	(1)	5	5	4	11	4	3	(6)	1	1	0	(1)	(2)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 41**	**$ (0)**	**$ (0)**	**(1)**	**13**	**(5)**	**(1)**	**(0)**	**1**	**2**	**3**	**13**	**5**	**6**	**7**	**(4)**	**8**	**9**	**22**	**12**	**13**	**14**	**16**	**18**
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	10	(4)	(1)	(0)	0	1	1	6	2	2	2	(1)	2	2	5	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	(1)	9	5	5	4	5	6	7	13	15	17	19	18	21	23	28	31	33	36	39	41

Case 10	Appendix B, Schedule 5 - Economic Modeling Output Tables Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 717	$ 675	$ 42
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,464	$ 1,398	$ 66
	Production Revenue	$ (1,979)	$ (1,828)	$ (151)
	Capacity Value	$ (206)	$ (201)	$ (5)
	Net Customer Cost (Benefit)	**$ 151**	**$ 204**	**$ (53)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (1,979)																							
		Capacity Value	$ (206)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,464																							
		Capital Revenue Requirements	$ 717	$ 29	$ 77	78	79	85	83	80	78	75	73	70	68	66	64	62	60	58	56	55	53	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,828)																							
		Capacity Value	$ (201)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,398																							
		Capital Revenue Requirements	$ 675	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	61	59	58	56	55	54	53	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (151)	$ -	$ -	-	(33)	(3)	(14)	(15)	(15)	(16)	(17)	(31)	(18)	(19)	(20)	(4)	(21)	(22)	(40)	(24)	(25)	(26)	(28)	(29)
		Capacity Value	$ (5)	$ -	$ -	-	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 66	$ -	$ -	-	21	(3)	6	6	6	7	7	17	7	8	8	(4)	9	9	23	10	10	11	11	11
		Capital Revenue Requirements	$ 42.3	$ 0	$ 0	1	2	9	9	8	8	7	7	6	5	5	4	4	4	3	2	1	1	0	(1)	(2)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 90	$ -	$ -	-	12	6	9	9	10	10	11	14	12	12	13	9	14	14	18	15	16	17	18	19
		Project Costs (savings)	$ 37	$ 0	$ 0	1	(2)	10	9	8	8	7	7	(1)	5	5	4	11	4	3	(6)	1	1	0	(1)	(2)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 53**	**$ (0)**	**$ (0)**	**(1)**	**14**	**(4)**	**0**	**1**	**2**	**3**	**4**	**15**	**7**	**8**	**9**	**(2)**	**10**	**11**	**24**	**14**	**15**	**16**	**18**	**21**
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	11	(3)	0	1	1	2	2	6	3	3	3	(1)	3	3	6	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	(1)	10	7	7	7	8	10	12	18	21	24	27	26	29	31	37	40	43	46	49	53

Case 11

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 717	$ 675	$ 42
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,198	$ 1,144	$ 54
	Production Revenue	$ (1,620)	$ (1,496)	$ (124)
	Capacity Value	$ (206)	$ (201)	$ (5)
	Net Customer Cost (Benefit)	**$ 245**	**$ 282**	**$ (37)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (1,620)																							
		Capacity Value	$ (206)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,198																							
		Capital Revenue Requirements	$ 717	$ 29	$ 77	78	79	85	83	80	78	75	73	70	68	66	64	62	60	58	56	55	53	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,496)																							
		Capacity Value	$ (201)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,144																							
		Capital Revenue Requirements	$ 675	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	61	59	58	56	55	54	53	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (124)	$ -	$ -	-	(27)	(2)	(12)	(12)	(12)	(13)	(14)	(25)	(15)	(16)	(16)	(3)	(18)	(18)	(33)	(20)	(21)	(22)	(23)	(24)
		Capacity Value	$ (5)	$ -	$ -	-	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 54	$ -	$ -	-	17	(2)	5	5	5	5	6	14	6	6	7	(3)	7	7	19	8	8	9	9	9
		Capital Revenue Requirements	$ 42.3	$ 0	$ 0	1	2	9	9	8	8	7	7	6	5	5	4	4	4	3	2	1	1	0	(1)	(2)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 74	$ -	$ -	-	10	5	8	8	8	8	9	12	10	10	10	8	11	12	15	13	13	14	15	16
		Project Costs (savings)	$ 37	$ 0	$ 0	1	(2)	10	9	8	8	7	7	(1)	5	5	4	11	4	3	(6)	1	1	0	(1)	(2)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 37**	**$ (0)**	**$ (0)**	**(1)**	**11**	**(5)**	**(1)**	**(1)**	**0**	**1**	**2**	**12**	**5**	**6**	**6**	**(4)**	**7**	**8**	**21**	**11**	**12**	**13**	**15**	**17**
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	9	(4)	(1)	(0)	0	1	1	5	2	2	2	(1)	2	2	5	2	2	2	3	3
		Cumulative PV		$ (0)	$ (0)	(1)	8	4	3	3	3	4	5	10	12	14	16	15	17	19	24	27	29	32	34	37

Case 12

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 717	$ 675	$ 42
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,331	$ 1,271	$ 60
	Production Revenue	$ (1,799)	$ (1,662)	$ (138)
	Capacity Value	$ (411)	$ (402)	$ (10)
	Net Customer Cost (Benefit)	**$ (8)**	**$ 42**	**$ (50)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (1,799)	[redacted]																						
		Capacity Value	$ (411)	$ -	$ -	-	(51)	(51)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)
		Variable Production Cost	$ 1,331	[redacted]																						
		Capital Revenue Requirements	$ 717	$ 29	$ 77	78	79	85	83	80	78	75	73	70	68	66	64	62	60	58	56	55	53	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,662)	[redacted]																						
		Capacity Value	$ (402)	$ -	$ -	-	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)
		Variable Production Cost	$ 1,271	[redacted]																						
		Capital Revenue Requirements	$ 675	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	61	59	58	56	55	54	53	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (138)	$ -	$ -	-	(30)	(3)	(13)	(13)	(14)	(15)	(15)	(28)	(17)	(17)	(18)	(4)	(20)	(20)	(37)	(22)	(23)	(24)	(25)	(27)
		Capacity Value	$ (10)	$ -	$ -	-	-	-	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
		Variable Production Cost	$ 60	$ -	$ -	-	19	(3)	5	5	6	6	6	16	7	7	7	(4)	8	8	21	9	9	10	10	10
		Capital Revenue Requirements	$ 42.3	$ 0	$ 0	1	2	9	9	8	8	7	7	6	5	5	4	4	4	3	2	1	1	0	(1)	(2)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 87	$ -	$ -	-	11	5	9	9	10	10	11	14	11	12	12	9	13	14	17	15	15	16	17	18
		Project Costs (savings)	$ 37	$ 0	$ 0	1	(2)	10	9	8	8	7	7	(1)	5	5	4	11	4	3	(6)	1	1	0	(1)	(2)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 50**	**$ (0)**	**$ (0)**	**(1)**	**13**	**(5)**	**0**	**1**	**2**	**3**	**4**	**14**	**6**	**7**	**8**	**(2)**	**9**	**10**	**23**	**13**	**14**	**16**	**17**	**20**
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	10	(3)	0	1	1	2	2	8	3	3	3	(1)	3	3	8	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	(1)	9	5	5	6	7	9	11	17	19	22	25	24	27	29	35	38	41	44	47	50

Case 13

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 717	$ 675	$ 42
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,331	$ 1,271	$ 60
	Production Revenue	$ (1,799)	$ (1,662)	$ (138)
	Capacity Value	$ -	$ -	$ -
	Net Customer Cost (Benefit)	**$ 404**	**$ 444**	**$ (40)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (1,799)																							
		Capacity Value	$ -	$ -	$ -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Variable Production Cost	$ 1,331																							
		Capital Revenue Requirements	$ 717	$ 29	$ 77	78	79	85	83	80	78	75	73	70	68	66	64	62	60	58	56	55	53	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,662)																							
		Capacity Value	$ -	$ -	$ -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Variable Production Cost	$ 1,271																							
		Capital Revenue Requirements	$ 675	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	61	59	58	56	55	54	53	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (138)	$ -	$ -	-	(30)	(3)	(13)	(13)	(14)	(15)	(15)	(28)	(17)	(17)	(18)	(4)	(20)	(20)	(37)	(22)	(23)	(24)	(25)	(27)
		Capacity Value	$ -	$ -	$ -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Variable Production Cost	$ 60	$ -	$ -	-	19	(3)	5	5	6	6	6	16	7	7	7	(4)	8	8	21	9	9	10	10	10
		Capital Revenue Requirements	$ 42.3	$ 0	$ 0	1	2	9	9	8	8	7	7	6	5	5	4	4	4	3	2	1	1	0	(1)	(2)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 77	$ -	$ -	-	11	5	8	8	8	9	9	12	10	10	11	8	12	12	16	13	14	14	15	16
		Project Costs (savings)	$ 37	$ 0	$ 0	1	(2)	10	9	8	8	7	7	(1)	5	5	4	11	4	3	(6)	1	1	0	(1)	(2)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 40**	**$ (0)**	**$ (0)**	**(1)**	**13**	**(5)**	**(1)**	**(1)**	**0**	**1**	**3**	**13**	**5**	**6**	**7**	**(4)**	**8**	**9**	**22**	**12**	**13**	**14**	**16**	**18**
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	10	(3)	(1)	(0)	0	1	1	6	2	2	2	(1)	2	2	5	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	(1)	9	5	4	4	4	5	6	12	14	16	18	17	19	21	27	29	32	34	37	40

Case 14

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 717	$ 675	$ 42
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,331	$ 1 271	$ 60
	Production Revenue	$ (2,249)	$ (2,077)	$ (172)
	Capacity Value	$ (206)	$ (201)	$ (5)
	Net Customer Cost (Benefit)	**$ (252)**	**$ (173)**	**$ (79)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (2,249)																							
		Capacity Value	$ (206)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,331																							
		Capital Revenue Requirements	$ 717	$ 29	$ 77	78	79	85	83	80	78	75	73	70	68	66	64	62	60	58	56	55	53	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (2,077)																							
		Capacity Value	$ (201)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,271																							
		Capital Revenue Requirements	$ 675	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	61	59	58	56	55	54	53	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (172)	$ -	$ -	-	(37)	(3)	(16)	(17)	(17)	(18)	(19)	(35)	(21)	(22)	(23)	(5)	(24)	(25)	(46)	(28)	(29)	(30)	(32)	(33)
		Capacity Value	$ (5)	$ -	$ -	-	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 60	$ -	$ -	-	19	(3)	5	5	6	6	6	16	7	7	7	(4)	8	8	21	9	9	10	10	10
		Capital Revenue Requirements	$ 42.3	$ 0	$ 0	1	2	9	9	8	8	7	7	6	5	5	4	4	4	3	2	1	1	0	(1)	(2)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 117	$ -	$ -	-	18	6	12	12	12	13	14	20	15	15	16	9	17	18	26	20	20	21	23	24
		Project Costs (savings)	$ 37	$ 0	$ 0	1	(2)	10	9	8	8	7	7	(1)	5	5	4	11	4	3	(6)	1	1	0	(1)	(2)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 79**	**$ (0)**	**$ (0)**	**(1)**	**20**	**(4)**	**3**	**4**	**5**	**6**	**7**	**21**	**10**	**11**	**12**	**(2)**	**13**	**15**	**32**	**18**	**19**	**21**	**23**	**26**
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	16	(3)	2	2	3	3	3	9	4	4	4	(1)	4	4	8	4	4	4	4	4
		Cumulative PV		$ (0)	$ (0)	(1)	15	12	13	15	18	21	24	33	37	41	45	44	48	52	60	63	67	71	75	79

Case 15

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 717	$ 675	$ 42
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,331	$ 1,271	$ 60
	Production Revenue	$ (1,350)	$ (1,246)	$ (103)
	Capacity Value	$ (206)	$ (201)	$ (5)
	Net Customer Cost (Benefit)	**$ 648**	**$ 658**	**$ (10)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (1,350)																							
		Capacity Value	$ (206)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,331																							
		Capital Revenue Requirements	$ 717	$ 29	$ 77	78	79	85	83	80	78	75	73	70	68	66	64	62	60	58	56	55	53	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,246)																							
		Capacity Value	$ (201)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,271																							
		Capital Revenue Requirements	$ 675	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	61	59	58	56	55	54	53	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (103)	$ -	$ -	-	(22)	(2)	(10)	(10)	(10)	(11)	(12)	(21)	(12)	(13)	(14)	(3)	(15)	(15)	(28)	(17)	(17)	(18)	(19)	(20)
		Capacity Value	$ (5)	$ -	$ -	-	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 60	$ -	$ -	-	19	(3)	5	5	6	6	6	16	7	7	7	(4)	8	8	21	9	9	10	10	10
		Capital Revenue Requirements	$ 42.3	$ 0	$ 0	1	2	9	9	8	8	7	7	6	5	5	4	4	4	3	2	1	1	0	(1)	(2)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(6)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 48	$ -	$ -	-	3	4	5	5	5	6	6	6	7	7	7	7	8	8	7	8	9	9	10	10
		Project Costs (savings)	$ 37	$ 0	$ 0	1	(2)	10	9	8	8	7	7	(1)	5	5	4	11	4	3	(6)	1	1	0	(1)	(2)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 10**	**$ (0)**	**$ (0)**	**(1)**	**5**	**(5)**	**(4)**	**(3)**	**(2)**	**(1)**	**(0)**	**7**	**2**	**2**	**3**	**(4)**	**4**	**4**	**13**	**7**	**8**	**9**	**10**	**12**
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	4	(4)	(3)	(2)	(1)	(1)	(0)	3	1	1	1	(1)	1	1	3	2	2	2	2	2
		Cumulative PV		$ (0)	$ (0)	(1)	3	(1)	(3)	(5)	(7)	(7)	(7)	(5)	(4)	(3)	(2)	(3)	(2)	(1)	2	3	5	7	8	10

Case 16

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 717	$ 675	$ 42
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,643	$ 1,569	$ 74
	Production Revenue	$ (1,799)	$ (1,662)	$ (138)
	Capacity Value	$ (206)	$ (201)	$ (5)
	Net Customer Cost (Benefit)	$ 511	$ 541	$ (31)

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (1,799)																							
		Capacity Value	$ (206)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,643																							
		Capital Revenue Requirements	$ 717	$ 29	$ 77	78	79	85	83	80	78	75	73	70	68	66	64	62	60	58	56	55	53	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,662)																							
		Capacity Value	$ (201)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,569																							
		Capital Revenue Requirements	$ 675	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	61	59	58	56	55	54	53	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (138)	$ -	$ -	-	(30)	(3)	(13)	(13)	(14)	(15)	(15)	(28)	(17)	(17)	(18)	(4)	(20)	(20)	(37)	(22)	(23)	(24)	(25)	(27)
		Capacity Value	$ (5)	$ -	$ -	-	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 74	$ -	$ -	-	24	(3)	7	7	7	7	8	19	8	9	9	(5)	10	10	26	11	11	12	12	13
		Capital Revenue Requirements	$ 42.3	$ 0	$ 0	1	2	9	9	8	8	7	7	6	5	5	4	4	4	3	2	1	1	0	(1)	(2)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 68	$ -	$ -	-	6	6	7	7	8	8	8	9	9	10	10	9	11	11	12	12	12	13	14	15
		Project Costs (savings)	$ 37	$ 0	$ 0	1	(2)	10	9	8	8	7	7	(1)	5	5	4	11	4	3	(6)	1	1	0	(1)	(2)
		TOTAL CUSTOMER BENEFIT BY YEAR	$ 31	$ (0)	$ (0)	(1)	8	(4)	(2)	(1)	(0)	1	2	10	4	5	6	(2)	7	8	18	11	12	13	14	16
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	6	(3)	(1)	(1)	(0)	0	1	4	2	2	2	(1)	2	2	4	2	2	2	2	3
		Cumulative PV		$ (0)	$ (0)	(1)	5	2	1	1	0	1	2	6	8	9	11	11	13	15	19	21	23	26	28	31

Case 17

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 717	$ 675	$ 42
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,018	$ 972	$ 46
	Production Revenue	$ (1,799)	$ (1,662)	$ (138)
	Capacity Value	$ (206)	$ (201)	$ (5)
	Net Customer Cost (Benefit)	**$ (115)**	**$ (56)**	**$ (59)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (1,799)																							
		Capacity Value	$ (206)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,018																							
		Capital Revenue Requirements	$ 717	$ 29	$ 77	78	79	85	83	80	78	75	73	70	68	66	64	62	60	58	56	55	53	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,662)																							
		Capacity Value	$ (201)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 972																							
		Capital Revenue Requirements	$ 675	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	61	59	58	56	55	54	53	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (138)	$ -	$ -	-	(30)	(3)	(13)	(13)	(14)	(15)	(15)	(28)	(17)	(17)	(18)	(4)	(20)	(20)	(37)	(22)	(23)	(24)	(25)	(27)
		Capacity Value	$ (5)	$ -	$ -	-	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 46	$ -	$ -	-	15	(2)	4	4	4	5	5	12	5	5	6	(3)	6	6	16	7	7	7	8	8
		Capital Revenue Requirements	$ 42.3	$ 0	$ 0	1	2	9	9	8	8	7	7	6	5	5	4	4	4	3	2	1	1	0	(1)	(2)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 96	$ -	$ -	-	15	4	10	10	10	11	11	17	12	13	13	7	14	15	22	16	17	17	19	20
		Project Costs (savings)	$ 37	$ 0	$ 0	1	(2)	10	9	8	8	7	7	(1)	5	5	4	11	4	3	(6)	1	1	0	(1)	(2)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 59**	**$ (0)**	**$ (0)**	**(1)**	**17**	**(5)**	**1**	**2**	**2**	**4**	**5**	**17**	**7**	**8**	**9**	**(4)**	**10**	**11**	**27**	**15**	**16**	**17**	**19**	**21**
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	13	(4)	0	1	1	2	2	7	3	3	3	(1)	3	3	7	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	(1)	12	8	9	10	11	13	15	23	25	28	32	30	33	36	43	46	49	52	56	59

Case 18

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 725	$ 672	$ 53
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,475	$ 1,412	$ 63
	Production Revenue	$ (1,207)	$ (1,122)	$ (85)
	Capacity Value	$ -	$ -	$ -
	Net Customer Cost (Benefit)	**$ 1,148**	**$ 1,122**	**$ 26**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (1,207)																							
		Capacity Value	$ -	$ -	$ -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Variable Production Cost	$ 1,475																							
		Capital Revenue Requirements	$ 725	$ 29	$ 77	78	79	87	84	81	79	76	74	71	69	67	64	63	61	59	57	55	53	51	48	39
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,122)																							
		Capacity Value	$ -	$ -	$ -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Variable Production Cost	$ 1,412																							
		Capital Revenue Requirements	$ 672	$ 29	$ 77	77	77	76	73	71	69	68	66	64	63	61	59	57	56	54	54	53	51	49	47	39
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (85)	$ -	$ -	-	(20)	(1)	(8)	(8)	(8)	(9)	(9)	(18)	(10)	(11)	(11)	(1)	(12)	(12)	(23)	(13)	(14)	(15)	(15)	(16)
		Capacity Value	$ -	$ -	$ -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Variable Production Cost	$ 63	$ -	$ -	-	22	(3)	5	6	6	6	6	17	7	7	7	(5)	8	8	22	9	9	10	10	10
		Capital Revenue Requirements	$ 53.2	$ 0	$ 0	1	2	11	11	10	9	9	8	7	6	6	5	5	5	5	3	3	2	1	1	(1)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 23	$ -	$ -	-	(2)	4	2	3	3	3	3	1	3	4	4	6	4	4	1	4	5	5	5	6
		Project Costs (savings)	$ 48	$ 0	$ 0	1	(1)	11	11	10	9	9	8	1	6	6	5	13	5	5	(5)	3	2	1	1	(1)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ (26)**	**$ (0)**	**$ (0)**	**(1)**	**(0)**	**(7)**	**(8)**	**(7)**	**(7)**	**(6)**	**(5)**	**0**	**(3)**	**(2)**	**(2)**	**(6)**	**(1)**	**(1)**	**6**	**2**	**3**	**3**	**5**	**6**
		NPV ($2013)		$ (0.0)	$ (0.3)	(1)	(0)	(5)	(5)	(4)	(4)	(3)	(2)	0	(1)	(1)	(1)	(2)	(0)	(0)	1	0	1	1	1	1
		Cumulative PV		$ (0)	$ (0)	(1)	(1)	(7)	(12)	(16)	(20)	(23)	(25)	(25)	(27)	(27)	(28)	(30)	(30)	(30)	(29)	(29)	(28)	(28)	(27)	(26)

Case 19

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 710	$ 678	$ 31
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,123	$ 1,069	$ 54
	Production Revenue	$ (2,490)	$ (2,285)	$ (205)
	Capacity Value	$ (412)	$ (402)	$ (11)
	Net Customer Cost (Benefit)	**$ (914)**	**$ (779)**	**$ (135)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (2,490)																							
		Capacity Value	$ (412)	$ -	$ -	-	(51)	(51)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)
		Variable Production Cost	$ 1,123																							
		Capital Revenue Requirements	$ 710	$ 29	$ 77	78	78	84	82	79	76	74	72	69	67	65	63	61	59	57	56	54	52	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (2,285)																							
		Capacity Value	$ (402)	$ -	$ -	-	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)
		Variable Production Cost	$ 1,069																							
		Capital Revenue Requirements	$ 678	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	62	60	58	57	55	55	54	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (205)	$ -	$ -	-	(41)	(5)	(19)	(20)	(21)	(22)	(23)	(40)	(25)	(26)	(27)	(8)	(30)	(31)	(53)	(33)	(35)	(36)	(38)	(40)
		Capacity Value	$ (11)	$ -	$ -	-	-	-	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
		Variable Production Cost	$ 54	$ -	$ -	-	16	(2)	5	5	5	5	6	14	6	6	7	(3)	7	8	18	8	8	9	9	9
		Capital Revenue Requirements	$ 31.4	$ (0)	$ 0	1	1	8	7	7	6	6	5	4	4	3	3	3	3	2	1	0	(0)	(1)	(2)	(3)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 162	$ -	$ -	-	25	7	16	17	17	18	19	28	21	22	22	12	24	25	37	27	28	29	31	33
		Project Costs (savings)	$ 26	$ (0)	$ 0	1	(3)	8	7	7	6	6	5	(2)	4	3	3	10	3	2	(7)	0	(0)	(1)	(2)	(3)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 135**	**$ 0**	**$ (0)**	**(1)**	**28**	**(1)**	**9**	**10**	**11**	**13**	**14**	**31**	**17**	**18**	**20**	**2**	**21**	**23**	**44**	**27**	**28**	**30**	**33**	**36**
		NPV ($2013)		$ 0.0	$ (0.1)	(1)	22	(1)	6	6	6	6	7	13	7	7	7	1	6	6	10	6	6	6	6	6
		Cumulative PV		$ 0	$ (0)	(1)	21	20	26	32	38	44	51	64	71	77	84	85	91	97	107	113	119	124	130	135

Case 20

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 717	$ 675	$ 42
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,686	$ 1,608	$ 78
	Production Revenue	$ (2,100)	$ (1,936)	$ (165)
	Capacity Value	$ (206)	$ (201)	$ (5)
	Net Customer Cost (Benefit)	**$ 252**	**$ 306**	**$ (54)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (2,100)	[redacted]																						
		Capacity Value	$ (206)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,686	[redacted]																						
		Capital Revenue Requirements	$ 717	$ 29	$ 77	78	79	85	83	80	78	75	73	70	68	66	64	62	60	58	56	55	53	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,936)	[redacted]																						
		Capacity Value	$ (201)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,608	[redacted]																						
		Capital Revenue Requirements	$ 675	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	61	59	58	56	55	54	53	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (165)	$ -	$ -	-	(30)	(3)	(13)	(13)	(14)	(15)	(20)	(36)	(21)	(23)	(24)	(5)	(26)	(27)	(50)	(30)	(32)	(33)	(36)	(38)
		Capacity Value	$ (5)	$ -	$ -	-	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 78	$ -	$ -	-	19	(3)	5	5	6	6	9	22	10	10	11	(6)	12	13	33	14	15	16	17	18
		Capital Revenue Requirements	$ 42.3	$ 0	$ 0	1	2	9	9	8	8	7	7	6	5	5	4	4	4	3	2	1	1	0	(1)	(2)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 91	$ -	$ -	-	11	5	8	9	9	9	12	14	13	13	14	11	15	15	18	17	18	18	20	21
		Project Costs (savings)	$ 37	$ 0	$ 0	1	(2)	10	9	8	8	7	7	(1)	5	5	4	11	4	3	(6)	1	1	0	(1)	(2)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 54**	**$ (0)**	**$ (0)**	**(1)**	**13**	**(5)**	**(1)**	**0**	**1**	**2**	**5**	**15**	**8**	**9**	**10**	**(0)**	**11**	**12**	**24**	**15**	**17**	**18**	**20**	**23**
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	10	(3)	(0)	0	1	1	2	6	3	3	3	(0)	3	3	6	3	3	3	3	4
		Cumulative PV		$ (0)	$ (0)	(1)	9	5	5	5	6	7	9	16	19	22	25	25	28	31	37	40	44	47	50	54.0

Case 21

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 1 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 1 SUMMARY	Capital Revenue Requirements	$ 717	$ 675	$ 42
	Fixed O&M Revenue Requirements	$ 155	$ 160	$ (5)
	Variable Production Cost	$ 1,640	$ 1,564	$ 76
	Production Revenue	$ (1,951)	$ (1,800)	$ (151)
	Capacity Value	$ (206)	$ (201)	$ (5)
	Net Customer Cost (Benefit)	**$ 356**	**$ 399**	**$ (43)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
UNIT 1	PROJECT WITH UPGRADES	Energy Revenue	$ (1,951)																							
		Capacity Value	$ (206)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,640																							
		Capital Revenue Requirements	$ 717	$ 29	$ 77	78	79	85	83	80	78	75	73	70	68	66	64	62	60	58	56	55	53	50	47	38
		Fixed O&M Revenue Requirements	$ 155	$ 9	$ 15	12	12	13	13	13	14	14	15	15	16	16	16	24	17	18	19	19	20	20	21	26
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,800)																							
		Capacity Value	$ (201)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,564																							
		Capital Revenue Requirements	$ 675	$ 29	$ 77	77	77	76	74	72	70	68	66	65	63	61	59	58	56	55	54	53	52	50	48	40
		Fixed O&M Revenue Requirements	$ 160	$ 9	$ 15	12	16	13	13	13	14	14	15	21	16	16	16	17	17	18	26	19	20	20	21	26
	DELTA	Energy Revenue	$ (151)	$ -	$ -	-	(30)	(3)	(13)	(13)	(14)	(15)	(17)	(31)	(19)	(20)	(21)	(4)	(23)	(24)	(44)	(27)	(28)	(29)	(31)	(33)
		Capacity Value	$ (5)	$ -	$ -	-	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 76	$ -	$ -	-	19	(3)	5	5	6	6	8	21	9	10	10	(5)	11	12	31	14	14	15	16	17
		Capital Revenue Requirements	$ 42.3	$ 0	$ 0	1	2	9	9	8	8	7	7	6	5	5	4	4	4	3	2	1	1	0	(1)	(2)
		Fixed O&M Revenue Requirements	$ (5.0)	$ -	$ -	-	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 80	$ -	$ -	-	11	5	8	9	9	9	10	11	10	11	11	11	12	13	13	14	14	15	16	17
		Project Costs (savings)	$ 37	$ 0	$ 0	1	(2)	10	9	8	8	7	7	(1)	5	5	4	11	4	3	(6)	1	1	0	(1)	(2)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 43**	**$ (0)**	**$ (0)**	**(1)**	**13**	**(5)**	**(1)**	**0**	**1**	**2**	**3**	**11**	**5**	**6**	**7**	**(1)**	**8**	**9**	**19**	**12**	**14**	**15**	**17**	**19**
		NPV ($2013)		$ (0.0)	$ (0.2)	(1)	10	(3)	(0)	0	1	1	1	5	2	2	2	(0)	2	2	5	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	(1)	9	5	5	5	6	7	8	13	15	18	20	20	22	24	29	32	34	37	40	42.9

Case 1

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,021	$ 980	$ 41
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,459	$ 1,384	$ 76
	Production Revenue	$ (1,978)	$ (1,812)	$ (166)
	Capacity Value	$ (219)	$ (215)	$ (3)
	Net Customer Cost (Benefit)	**$ 457**	**$ 515**	**$ (58.3)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (1,978)	[redacted]																									
		Capacity Value	$ (219)	$ -	$ -	-	(26)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)
		Variable Production Cost	$ 1,459	[redacted]																									
		Capital Revenue Requirements	$ 1,021	$ 32	$ 80	82	90	94	98	130	127	122	118	115	111	107	104	101	98	95	92	88	86	83	81	79	78	74	68
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	16	16	16	17	24	18	19	19	20	20	21	21	22	23	33	24	30
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,812)	[redacted]																									
		Capacity Value	$ (215)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,384	[redacted]																									
		Capital Revenue Requirements	$ 980	$ 32	$ 80	82	83	86	90	123	120	116	113	110	106	103	100	97	94	92	90	87	85	82	81	78	79	76	62
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	16	16	17	17	18	19	27	20	20	21	21	22	23	33	24	30
	DELTA Project less Alternative	Energy Revenue	$ (166)	$ -	$ -	(29)	(3)	(13)	(13)	(14)	(14)	(15)	(27)	(17)	(17)	(18)	(5)	(20)	(20)	(36)	(22)	(23)	(24)	(25)	(27)	(28)	(27)	(30)	(32)
		Capacity Value	$ (3)	$ -	$ -	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		Variable Production Cost	$ 76	$ -	$ -	22	(2)	5	9	6	6	6	15	7	7	7	(3)	8	8	20	9	10	10	10	11	11	11	12	12
		Capital Revenue Requirements	$ 41.0	$ 0	$ 0	(1)	7	9	8	8	7	6	6	5	5	4	4	4	4	3	2	2	1	1	0	(0)	(1)	(2)	(3)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 93	$ -	$ -	7	5	8	8	9	9	9	12	10	11	11	8	12	12	16	13	14	15	15	16	17	17	19	20
		Project Costs (savings)	$ 35	$ 0	$ 0	(5)	7	9	8	8	7	5	(1)	5	5	4	11	4	4	(5)	2	2	1	1	0	(0)	(1)	(2)	(3)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 58**	**$ (0)**	**$ (0)**	**12**	**(2)**	**(0)**	**0**	**1**	**2**	**3**	**13**	**5**	**6**	**7**	**(3)**	**8**	**9**	**21**	**12**	**13**	**14**	**15**	**16**	**18**	**18**	**21**	**22**
		PV ($2013)		$ (0)	$ (0.4)	10	(1)	(0)	0	1	1	1	6	2	2	3	(1)	2	3	5	3	3	3	3	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	10	8	8	8	9	10	11	17	18	22	24	23	26	28	34	37	39	42	45	48	50	53	56	58

Case 2 Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,029	$ 980	$ 49
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,459	$ 1,384	$ 76
	Production Revenue	$ (1,976)	$ (1,812)	$ (166)
	Capacity Value	$ (219)	$ (215)	$ (3)
	Net Customer Cost (Benefit)	**$ 465**	**$ 515**	**$ (50.3)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (1,976)	[redacted]																									
		Capacity Value	$ (219)	$ -	$ -	-	(26)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)
		Variable Production Cost	$ 1,459	[redacted]																									
		Capital Revenue Requirements	$ 1,029	$ 32	$ 80	82	91	96	99	132	126	123	119	116	112	108	105	102	99	95	92	89	86	84	82	80	79	75	60	
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	16	16	16	17	24	18	19	19	20	20	21	21	22	23	33	24	30	
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,812)	[redacted]																									
		Capacity Value	$ (215)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	
		Variable Production Cost	$ 1,384	[redacted]																									
		Capital Revenue Requirements	$ 980	$ 32	$ 80	82	83	86	90	123	120	116	113	110	106	103	100	97	94	92	90	87	85	82	81	79	79	76	82	
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	18	16	17	17	18	19	27	20	20	21	21	22	23	33	24	30	
	DELTA Project less Alternative	Energy Revenue	$ (166)	$ -	$ -	(29)	(3)	(13)	(13)	(14)	(14)	(15)	(27)	(17)	(17)	(18)	(5)	(20)	(20)	(36)	(22)	(23)	(24)	(25)	(27)	(28)	(27)	(30)	(32)
		Capacity Value	$ (3)	$ -	$ -	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		Variable Production Cost	$ 76	$ -	$ -	22	(2)	5	6	6	6	6	15	7	7	7	(3)	8	8	20	9	10	10	10	11	11	11	12	12	
		Capital Revenue Requirements	$ 48.9	$ 0	$ 1	(0)	8	10	9	9	8	7	7	6	5	5	5	5	4	3	3	2	2	1	1	0	(0)	(1)	(2)	
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-	
	SUMMARY	Net Market Benefits (costs)	$ 93	$ -	$ -	7	5	8	8	9	9	9	12	10	11	11	8	12	12	16	13	14	15	15	16	17	17	19	20	
		Project Costs (savings)	$ 43	$ 0	$ 1	(5)	8	10	9	9	8	7	0	6	5	5	12	5	4	(4)	3	2	2	1	1	0	(0)	(1)	(2)	
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 50**	**$ (0)**	**$ (1)**	**12**	**(3)**	**(2)**	**(1)**	**(0)**	**1**	**2**	**12**	**4**	**5**	**6**	**(4)**	**7**	**8**	**20**	**11**	**12**	**13**	**14**	**16**	**17**	**17**	**20**	**22**	
		PV ($2013)		$ (0)	$ (0.5)	10	(2)	(1)	(1)	(0)	0	1	6	2	2	2	(1)	2	2	5	3	3	3	3	3	3	2	3	3	
		Cumulative PV		$ (0)	$ (1)	9	7	6	5	5	6	7	12	14	16	18	17	19	22	27	29	32	35	37	40	43	45	48	50	

Case 3 **Appendix B, Schedule 5 - Economic Modeling Output Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,013	$ 980	$ 33
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,459	$ 1,384	$ 76
	Production Revenue	$ (1,978)	$ (1,812)	$ (166)
	Capacity Value	$ (219)	$ (215)	$ (3)
	Net Customer Cost (Benefit)	**$ 449**	**$ 515**	**$ (66.2)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (1,978)																										
		Capacity Value	$ (219)	$ -	$ -	-	(26)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)
		Variable Production Cost	$ 1,459																										
		Capital Revenue Requirements	$ 1,013	$ 32	$ 80	81	89	93	97	129	125	121	117	114	110	107	104	100	97	94	91	88	85	83	81	79	77	74	59
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	16	16	16	17	24	18	19	19	20	20	21	21	22	23	33	24	30
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,812)																										
		Capacity Value	$ (215)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,384																										
		Capital Revenue Requirements	$ 980	$ 32	$ 80	82	83	86	90	123	120	116	113	110	106	103	100	97	94	92	88	87	85	82	81	79	76	76	62
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	16	16	17	17	18	19	27	20	20	21	21	22	23	33	24	30
	DELTA Project less Alternative	Energy Revenue	$ (166)	$ -	$ -	(29)	(3)	(13)	(13)	(14)	(14)	(15)	(27)	(17)	(17)	(18)	(5)	(20)	(20)	(36)	(22)	(23)	(24)	(25)	(27)	(28)	(27)	(30)	(32)
		Capacity Value	$ (3)	$ -	$ -	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		Variable Production Cost	$ 76	$ -	$ -	22	(2)	5	6	6	6	6	15	7	7	7	(3)	8	8	20	9	10	10	10	11	11	11	12	12
		Capital Revenue Requirements	$ 33.1	$ 0	$ 0	(1)	6	7	7	6	6	5	5	4	4	3	3	3	3	2	1	1	1	0	(0)	(1)	(1)	(2)	(3)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 93	$ -	$ -	7	5	8	8	8	9	9	12	10	11	11	8	12	12	16	13	14	15	15	16	17	17	19	20
		Project Costs (savings)	$ 27	$ 0	$ 0	(5)	6	7	7	6	6	5	(2)	4	4	3	10	3	3	(6)	1	1	1	0	(0)	(1)	(1)	(2)	(3)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 66**	**$ (0)**	**$ (0)**	**12**	**(1)**	**1**	**1**	**2**	**3**	**4**	**14**	**6**	**7**	**8**	**(2)**	**9**	**10**	**22**	**12**	**13**	**14**	**15**	**17**	**18**	**18**	**21**	**23**
		PV ($2013)		$ (0)	$ (0.4)	10	(1)	1	1	1	2	2	6	3	3	3	(1)	3	3	6	3	3	3	3	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	10	9	10	11	12	14	16	22	25	28	30	30	32	35	41	44	47	50	52	55	58	61	63	66

Case 4 **Appendix B, Schedule 5 - Economic Modeling Output Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,021	$ 983	$ 37
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,459	$ 1,384	$ 76
	Production Revenue	$ (1,978)	$ (1,812)	$ (166)
	Capacity Value	$ (219)	$ (215)	$ (3)
	Net Customer Cost (Benefit)	$ 457	$ 519	$ (62.1)

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (1,978)	[redacted]																									
		Capacity Value	$ (219)	$ -	$ -	-	(26)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)
		Variable Production Cost	$ 1,459	[redacted]																									
		Capital Revenue Requirements	$ 1,021	$ 32	$ 80	82	80	94	98	150	127	122	118	115	111	107	104	101	98	95	92	88	86	83	81	79	76	74	60
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	16	16	16	17	24	18	19	19	20	20	21	21	22	23	33	24	30
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,812)	[redacted]																									
		Capacity Value	$ (215)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,384	[redacted]																									
		Capital Revenue Requirements	$ 983	$ 32	$ 80	82	84	86	90	123	120	116	113	110	107	104	101	98	95	92	90	87	85	83	81	80	80	76	63
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	16	16	17	17	18	19	27	20	20	21	21	22	23	33	24	30
	DELTA Project less Alternative	Energy Revenue	$ (166)	$ -	$ -	(29)	(3)	(13)	(13)	(14)	(14)	(15)	(27)	(17)	(17)	(18)	(5)	(20)	(20)	(36)	(22)	(23)	(24)	(25)	(27)	(28)	(27)	(30)	(32)
		Capacity Value	$ (3)	$ -	$ -	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		Variable Production Cost	$ 76	$ -	$ -	22	(2)	5	6	6	6	6	15	7	7	7	(3)	8	8	20	9	10	10	10	11	11	11	12	12
		Capital Revenue Requirements	$ 37.2	$ 0	$ 0	(1)	6	8	8	7	7	6	5	5	4	4	4	3	3	2	1	1	1	0	(0)	(1)	(2)	(2)	(3)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 93	$ -	$ -	7	5	8	8	9	9	9	12	10	11	11	8	12	12	16	13	14	15	15	16	17	17	19	20
		Project Costs (savings)	$ 31	$ 0	$ 0	(5)	7	8	8	7	7	6	(1)	5	4	4	11	3	3	(6)	1	1	1	0	(0)	(1)	(2)	(2)	(3)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 62**	**$ (0)**	**$ (0)**	**12**	**(1)**	**(0)**	**1**	**1**	**2**	**3**	**13**	**6**	**7**	**7**	**(3)**	**9**	**9**	**22**	**12**	**13**	**14**	**15**	**17**	**18**	**19**	**21**	**23**
		PV (12013)		$ (0)	$ (0.4)	10	(1)	(0)	0	1	1	2	6	2	3	3	(1)	3	3	6	3	3	3	3	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	10	9	9	9	10	11	13	19	22	24	27	26	29	31	37	40	43	45	48	51	54	56	59	62

Case 5 **Appendix B, Schedule 5 - Economic Modeling Output Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,021	$ 976	$ 45
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,459	$ 1,384	$ 76
	Production Revenue	$ (1,978)	$ (1,812)	$ (166)
	Capacity Value	$ (219)	$ (215)	$ (3)
	Net Customer Cost (Benefit)	**$ 457**	**$ 511**	**$ (54.4)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (1,978)	[redacted]																									
		Capacity Value	$ (219)	$ -	$ -	-	(26)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)
		Variable Production Cost	$ 1,459	[redacted]																									
		Capital Revenue Requirements	$ 1,021	$ 32	$ 80	82	90	94	98	138	127	122	118	115	111	107	104	101	98	95	92	86	86	83	81	79	78	74	60
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	16	16	16	17	24	18	19	19	20	20	21	21	22	23	33	24	30
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,812)	[redacted]																									
		Capacity Value	$ (215)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,384	[redacted]																									
		Capital Revenue Requirements	$ 976	$ 31	$ 80	82	83	85	90	123	119	115	112	109	106	103	100	97	94	92	89	88	84	82	80	79	76	75	62
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	16	16	17	17	18	18	27	20	20	21	21	22	23	33	24	30
	DELTA Project less Alternative	Energy Revenue	$ (166)	$ -	$ -	(29)	(3)	(13)	(13)	(14)	(14)	(15)	(27)	(17)	(17)	(18)	(5)	(20)	(20)	(36)	(22)	(23)	(24)	(25)	(27)	(26)	(27)	(30)	(32)
		Capacity Value	$ (3)	$ -	$ -	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		Variable Production Cost	$ 76	$ -	$ -	22	(2)	5	6	6	6	6	15	7	7	7	(3)	8	8	20	9	10	10	10	11	11	11	12	12
		Capital Revenue Requirements	$ 44.8	$ 0	$ 0	(0)	7	9	8	8	7	7	8	5	5	5	5	4	4	3	2	2	2	1	1	0	(0)	(1)	(2)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 93	$ -	$ -	7	5	8	8	9	8	9	12	10	11	11	8	12	12	16	13	14	15	15	16	17	17	19	20
		Project Costs (savings)	$ 38	$ 0	$ 0	(5)	7	9	8	8	7	7	(0)	5	5	5	12	4	4	(5)	2	2	2	1	1	0	(0)	(1)	(2)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 54**	**$ (0)**	**$ (0)**	**12**	**(2)**	**(1)**	**(0)**	**1**	**1**	**2**	**12**	**5**	**6**	**7**	**(4)**	**8**	**9**	**21**	**11**	**12**	**13**	**14**	**16**	**17**	**17**	**20**	**22**
		PV ($2013)		$ (0)	$ (0.4)	10	(2)	(1)	(0)	0	1	1	8	2	2	2	(1)	2	2	5	3	3	3	3	3	3	2	3	3
		Cumulative PV		$ (0)	$ (0)	9	8	7	7	7	8	9	15	17	20	22	21	23	25	31	34	36	39	41	44	47	49	52	54

Case 6 Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,021	$ 980	$ 41
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,454	$ 1,384	$ 70
	Production Revenue	$ (1,978)	$ (1,812)	$ (166)
	Capacity Value	$ (219)	$ (215)	$ (3)
	Net Customer Cost (Benefit)	**$ 451**	**$ 515**	**$ (63.7)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (1,978)	[redacted]																									
		Capacity Value	$ (219)	$ -	$ -	-	(26)	(27)	(27)	(27)	(27)	(26)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)
		Variable Production Cost	$ 1,454	[redacted]																									
		Capital Revenue Requirements	$ 1,021	$ 32	$ 80	82	90	94	98	130	127	122	118	115	111	107	104	101	88	85	82	68	69	63	61	79	78	74	60
		Fixed O&M Revenue Requirements	$ 173	$ 12	$ 12	12	13	13	13	14	15	15	16	16	16	17	24	18	19	19	20	20	21	21	22	23	33	24	30
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,812)	[redacted]																									
		Capacity Value	$ (215)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,384	[redacted]																									
		Capital Revenue Requirements	$ 980	$ 32	$ 80	82	83	86	90	123	120	116	113	110	106	103	100	97	94	92	90	67	65	62	61	79	79	76	62
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	16	16	17	17	18	19	27	20	20	21	21	22	23	33	24	30
	DELTA Project less Alternative	Energy Revenue	$ (166)	$ -	$ -	(29)	(3)	(13)	(13)	(14)	(14)	(15)	(27)	(17)	(17)	(18)	(5)	(20)	(26)	(36)	(22)	(23)	(24)	(25)	(27)	(26)	(27)	(39)	(32)
		Capacity Value	$ (3)	$ -	$ -	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		Variable Production Cost	$ 70	$ -	$ -	22	(3)	5	5	3	6	0	15	6	7	7	(4)	7	8	20	8	9	9	9	10	10	10	11	11
		Capital Revenue Requirements	$ 41.0	$ 0	$ 0	(1)	7	9	8	8	7	6	6	5	5	4	4	4	4	3	2	2	1	1	0	(0)	(1)	(2)	(3)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(8)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 99	$ -	$ -	7	8	9	9	8	9	10	13	11	11	12	9	13	13	17	14	15	16	16	17	18	18	20	21
		Project Costs (savings)	$ 35	$ 0	$ 0	(5)	7	9	8	8	7	6	(1)	5	5	4	11	4	4	(5)	2	2	1	1	0	(0)	(1)	(2)	(3)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 64**	**$ (0)**	**$ (0)**	**12**	**(1)**	**0**	**1**	**2**	**2**	**3**	**13**	**6**	**7**	**8**	**(2)**	**9**	**10**	**22**	**12**	**13**	**14**	**15**	**17**	**19**	**19**	**22**	**24**
		PV ($2013)		$ (0)	$ (0.4)	10	(1)	0	1	1	1	2	8	3	3	3	(1)	3	3	6	3	3	3	3	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	10	8	9	9	10	11	13	19	22	25	27	27	29	32	38	41	44	47	49	52	55	58	61	64

Case 7 **Appendix B, Schedule 5 - Economic Modeling Output Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,021	$ 980	$ 41
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,465	$ 1,384	$ 81
	Production Revenue	$ (1,978)	$ (1,812)	$ (166)
	Capacity Value	$ (219)	$ (215)	$ (3)
	Net Customer Cost (Benefit)	**$ 462**	**$ 515**	**$ (52.8)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (1,978)	[redacted]																									
		Capacity Value	$ (219)	$ -	$ -	-	(26)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)
		Variable Production Cost	$ 1,465	[redacted]																									
		Capital Revenue Requirements	$ 1,021	$ 32	$ 80	82	90	94	96	130	127	122	118	115	111	107	104	101	98	95	92	88	86	83	81	79	78	74	80
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	16	16	16	17	24	18	19	19	20	20	21	21	22	23	33	24	30
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,812)	[redacted]																									
		Capacity Value	$ (215)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,384	[redacted]																									
		Capital Revenue Requirements	$ 980	$ 32	$ 80	82	83	86	90	123	120	116	113	110	108	103	100	97	94	92	90	87	85	82	81	79	79	76	62
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	16	16	17	17	18	19	27	20	20	21	21	22	23	33	24	30
	DELTA Project less Alternative	Energy Revenue	$ (166)	$ -	$ -	(29)	(3)	(13)	(13)	(14)	(14)	(15)	(27)	(17)	(17)	(18)	(5)	(20)	(20)	(36)	(22)	(23)	(24)	(25)	(27)	(28)	(27)	(30)	(32)
		Capacity Value	$ (3)	$ -	$ -	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		Variable Production Cost	$ 81	$ -	$ -	22	(2)	6	6	6	7	7	16	8	8	8	(2)	9	9	21	10	10	11	11	12	12	12	13	14
		Capital Revenue Requirements	$ 41.0	$ 0	$ 0	(1)	7	9	8	6	7	6	6	5	5	4	4	4	4	3	2	2	1	1	0	(0)	(1)	(2)	(3)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 88	$ -	$ -	7	5	8	8	8	8	9	12	10	10	10	7	11	12	15	13	13	14	14	15	16	16	18	19
		Project Costs (savings)	$ 35	$ 0	$ 0	(5)	7	9	8	5	7	6	(1)	5	5	4	11	4	4	(5)	2	2	1	1	0	(0)	(1)	(2)	(3)
		TOTAL CUSTOMER BENEFIT BY YEAR	$ 53	$ (0)	$ (0)	12	(2)	(1)	(0)	0	1	2	12	5	5	6	(4)	7	8	20	11	12	13	14	15	17	17	19	21
		PV ($2013)		$ (0)	$ (0.4)	10	(2)	(1)	(0)	0	1	1	6	2	2	2	(1)	2	2	5	3	3	3	3	3	3	2	3	3
		Cumulative PV		$ (0)	$ (0)	10	8	7	7	7	8	9	15	17	19	21	20	22	25	30	32	35	38	40	43	45	48	50	53

Case 8

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,021	$ 980	$ 41
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,470	$ 1,384	$ 87
	Production Revenue	$ (1,993)	$ (1,812)	$ (180)
	Capacity Value	$ (219)	$ (215)	$ (4)
	Net Customer Cost (Benefit)	**$ 453**	**$ 515**	**$ (62.1)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (1,993)																										
		Capacity Value	$ (219)	$ -	$ -	-	(26)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)
		Variable Production Cost	$ 1,470																										
		Capital Revenue Requirements	$ 1,021	$ 32	$ 80	82	90	94	98	130	127	122	118	115	111	107	104	101	98	95	92	88	86	83	81	79	78	74	60
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	16	16	16	17	24	18	19	19	20	20	21	21	22	23	33	24	30
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,812)																										
		Capacity Value	$ (215)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,384																										
		Capital Revenue Requirements	$ 980	$ 32	$ 80	82	83	86	90	123	120	116	113	110	106	103	100	97	94	92	90	87	85	82	81	79	79	76	62
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	16	16	17	17	18	19	27	20	20	21	21	22	23	33	24	30
	DELTA Project less Alternative	Energy Revenue	$ (180)	$ -	$ -	(29)	(4)	(14)	(15)	(15)	(16)	(17)	(26)	(18)	(19)	(20)	(6)	(22)	(22)	(35)	(24)	(25)	(27)	(27)	(29)	(31)	(35)	(34)	(35)
		Capacity Value	$ (4)	$ -	$ -	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 87	$ -	$ -	22	(1)	6	7	7	7	8	17	8	8	9	(2)	10	10	22	11	11	12	12	13	13	13	14	15
		Capital Revenue Requirements	$ 41.0	$ 0	$ 0	(1)	7	8	8	8	7	6	6	5	5	4	4	4	4	3	2	2	1	1	0	(0)	(1)	(2)	(3)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(8)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 97	$ -	$ -	7	5	8	9	9	8	10	13	11	11	12	9	13	13	17	14	15	15	16	17	18	18	20	21
		Project Costs (savings)	$ 35	$ 0	$ 0	(5)	7	9	8	8	7	6	(1)	5	5	4	11	4	4	(5)	2	2	1	1	0	(0)	(1)	(2)	(3)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 62**	**$ (0)**	**$ (0)**	**12**	**(2)**	**(0)**	**1**	**1**	**2**	**3**	**13**	**6**	**7**	**8**	**(3)**	**9**	**9**	**22**	**12**	**13**	**14**	**15**	**17**	**18**	**19**	**21**	**23**
		PV ($2013)		$ (0)	$ (0.4)	10	(1)	(0)	0	1	1	2	6	2	3	3	(1)	3	3	6	3	3	3	3	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	10	8	8	9	10	11	12	19	21	24	27	26	28	31	37	39	42	45	48	51	54	56	59	62

Case 9 **Appendix B, Schedule 5 - Economic Modeling Output Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,021	$ 980	$ 41
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,449	$ 1,384	$ 65
	Production Revenue	$ (1,994)	$ (1,812)	$ (151)
	Capacity Value	$ (218)	$ (215)	$ (3)
	Net Customer Cost (Benefit)	**$ 460**	**$ 515**	**$ (54.4)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (1,994)	[redacted]																									
		Capacity Value	$ (218)	$ -	$ -	-	(26)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)
		Variable Production Cost	$ 1,449	[redacted]																									
		Capital Revenue Requirements	$ 1,021	$ 32	$ 80	82	90	94	98	130	127	122	118	115	111	107	104	101	98	95	92	88	86	83	81	79	78	74	69
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	16	16	16	17	24	18	19	19	20	20	21	21	22	23	33	24	30
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,812)	[redacted]																									
		Capacity Value	$ (215)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,384	[redacted]																									
		Capital Revenue Requirements	$ 980	$ 32	$ 80	82	83	86	90	120	120	116	113	110	106	103	100	97	94	92	90	87	85	82	81	79	79	76	62
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	16	16	17	17	18	19	27	20	20	21	21	22	23	33	24	30
	DELTA Project less Alternative	Energy Revenue	$ (151)	$ -	$ -	(28)	(2)	(12)	(12)	(13)	(13)	(14)	(26)	(15)	(16)	(16)	(3)	(18)	(18)	(34)	(20)	(21)	(22)	(22)	(24)	(25)	(25)	(27)	(29)
		Capacity Value	$ (3)	$ -	$ -	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		Variable Production Cost	$ 65	$ -	$ -	22	(3)	4	4	5	5	5	14	6	6	6	(4)	7	7	19	7	8	8	8	9	9	9	10	10
		Capital Revenue Requirements	$ 41.0	$ 0	$ 0	(1)	7	9	8	8	7	8	6	5	5	4	4	4	4	3	2	2	1	1	0	(0)	(1)	(2)	(3)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 89	$ -	$ -	7	5	8	8	8	8	8	12	10	10	11	8	12	12	15	13	13	14	15	16	17	16	18	19
		Project Costs (savings)	$ 35	$ 0	$ 0	(5)	7	9	8	8	7	6	(1)	5	5	4	11	4	4	(5)	2	2	1	1	0	(0)	(1)	(2)	(3)
		TOTAL CUSTOMER BENEFIT BY YEAR	$ 54	$ (0)	$ (0)	12	(2)	(1)	(0)	1	1	2	12	5	6	7	(4)	8	8	21	11	12	13	14	15	17	17	20	21
		PV ($2013)		$ (0)	$ (0.4)	10	(2)	(1)	(0)	0	1	1	6	2	2	2	(1)	2	2	5	3	3	3	3	3	3	2	3	3
		Cumulative PV		$ (0)	$ (0)	10	8	7	7	8	8	10	16	18	20	22	21	23	26	31	34	36	39	42	44	47	49	52	54

Case 10 **Appendix B, Schedule 5 - Economic Modeling Output Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,021	$ 980	$ 41
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,605	$ 1,522	$ 84
	Production Revenue	$ (2,176)	$ (1,994)	$ (182)
	Capacity Value	$ (219)	$ (215)	$ (3)
	Net Customer Cost (Benefit)	**$ 405**	**$ 472**	**$ (67.3)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (2,176)	[redacted]																									
		Capacity Value	$ (219)	$ -	$ -	-	(26)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)
		Variable Production Cost	$ 1,605	[redacted]																									
		Capital Revenue Requirements	$ 1,021	$ 32	$ 80	82	90	94	98	130	127	122	118	115	111	107	104	101	98	95	92	88	86	83	81	79	76	74	80
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	16	16	16	17	24	18	18	19	20	20	21	21	22	23	33	24	30
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,994)	[redacted]																									
		Capacity Value	$ (215)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,522	[redacted]																									
		Capital Revenue Requirements	$ 980	$ 32	$ 80	82	83	86	90	123	120	116	113	110	106	103	100	97	94	92	90	87	85	82	81	79	78	76	82
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	16	16	17	17	18	19	27	20	20	21	21	22	23	33	24	30
	DELTA Project less Alternative	Energy Revenue	$ (182)	$ -	$ -	(32)	(3)	(14)	(15)	(15)	(16)	(17)	(30)	(18)	(19)	(20)	(5)	(22)	(22)	(40)	(24)	(25)	(27)	(27)	(29)	(31)	(30)	(34)	(33)
		Capacity Value	$ (3)	$ -	$ -	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		Variable Production Cost	$ 84	$ -	$ -	25	(2)	6	6	6	7	7	17	8	8	8	(3)	8	9	23	10	10	11	11	12	12	12	13	14
		Capital Revenue Requirements	$ 41.0	$ 0	$ 0	(1)	7	8	8	8	7	6	6	5	5	4	4	4	4	3	2	2	1	1	0	(0)	(1)	(2)	(3)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 102	$ -	$ -	7	6	9	9	9	10	10	13	11	12	12	9	13	14	18	15	15	16	17	18	19	19	21	22
		Project Costs (savings)	$ 35	$ 0	$ 0	(5)	7	9	8	8	7	6	(1)	5	5	4	11	4	4	(5)	2	2	1	1	0	(0)	(1)	(2)	(3)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 57**	**$ (0)**	**$ (0)**	**13**	**(1)**	**0**	**1**	**2**	**3**	**4**	**14**	**6**	**7**	**8**	**(2)**	**9**	**10**	**23**	**13**	**14**	**15**	**16**	**18**	**19**	**19**	**22**	**24**
		PV ($2013)		$ (0)	$ (0.4)	11	(1)	0	1	1	1	2	7	3	3	3	(1)	3	3	8	3	3	3	3	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	10	9	9	10	11	13	15	21	24	27	30	29	32	35	40	43	47	50	53	56	59	61	64	67

Case 11 **Appendix B, Schedule 5 - Economic Modeling Output Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,021	$ 980	$ 41
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,314	$ 1,245	$ 68
	Production Revenue	$ (1,780)	$ (1,631)	$ (149)
	Capacity Value	$ (215)	$ (215)	$ (3)
	Net Customer Cost (Benefit)	**$ 508**	**$ 558**	**$ (49.3)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (1,780)	[redacted]																									
		Capacity Value	$ (219)	$ -	$ -	-	(26)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)
		Variable Production Cost	$ 1,314	[redacted]																									
		Capital Revenue Requirements	$ 1,021	$ 32	$ 80	82	80	94	98	130	127	122	118	115	111	107	104	101	98	95	92	88	86	83	81	78	76	74	60
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	11	13	13	14	15	15	16	16	16	17	24	18	19	19	20	20	21	21	22	23	33	24	30
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,631)	[redacted]																									
		Capacity Value	$ (215)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,245	[redacted]																									
		Capital Revenue Requirements	$ 980	$ 32	$ 80	82	83	88	90	123	120	116	113	110	106	103	100	97	94	92	90	87	85	82	81	79	79	76	62
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	16	16	17	17	18	19	27	20	20	21	21	22	23	33	24	30
	DELTA Project less Alternative	Energy Revenue	$ (149)	$ -	$ -	(26)	(3)	(12)	(12)	(13)	(13)	(14)	(24)	(15)	(16)	(16)	(4)	(18)	(18)	(32)	(20)	(21)	(22)	(22)	(24)	(25)	(25)	(27)	(29)
		Capacity Value	$ (3)	$ -	$ -	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		Variable Production Cost	$ 68	$ -	$ -	20	(2)	5	5	5	5	6	14	9	6	7	(3)	7	8	18	8	9	9	9	10	10	10	11	11
		Capital Revenue Requirements	$ 41.0	$ 0	$ 0	(1)	7	9	8	8	7	0	6	5	5	4	4	4	8	3	2	2	1	1	0	(0)	(1)	(2)	(3)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(6)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 84	$ -	$ -	6	5	7	8	8	8	6	11	9	10	10	7	11	11	14	12	13	13	14	15	16	15	17	18
		Project Costs (savings)	$ 35	$ 0	$ 0	(5)	7	9	8	8	7	0	(1)	5	5	4	11	4	4	(5)	2	2	1	1	0	(0)	(1)	(2)	(3)
		TOTAL CUSTOMER BENEFIT BY YEAR	$ 49	$ (0)	$ (0)	11	(2)	(1)	(0)	0	1	2	12	4	5	6	(4)	7	8	20	10	11	12	13	15	16	16	19	20
		PV (\$2013)		$ (0)	$ (0.4)	9	(2)	(1)	(0)	0	1	1	5	2	2	2	(1)	2	2	5	2	2	2	2	2	2	2	2	2
		Cumulative PV		$ (0)	$ (0)	9	7	6	6	6	7	8	13	15	17	19	18	20	22	27	30	32	35	37	40	42	44	47	49

Case 12

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,021	$ 980	$ 41
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,459	$ 1,384	$ 76
	Production Revenue	$ (1,978)	$ (1,812)	$ (166)
	Capacity Value	$ (437)	$ (431)	$ (7)
	Net Customer Cost (Benefit)	**$ 238**	**$ 300**	**$ (61.7)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (1,978)	[redacted]																									
		Capacity Value	$ (437)	$ -	$ -	-	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)
		Variable Production Cost	$ 1,459	[redacted]																									
		Capital Revenue Requirements	$ 1,021	$ 32	$ 80	82	90	94	98	130	127	122	116	115	111	107	104	101	99	95	92	88	86	83	81	79	76	74	80
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	16	16	16	17	24	18	18	19	20	20	21	21	22	23	33	24	30
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,812)	[redacted]																									
		Capacity Value	$ (431)	$ -	$ -	-	(53)	(53)	(53)	(53)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)
		Variable Production Cost	$ 1,384	[redacted]																									
		Capital Revenue Requirements	$ 980	$ 32	$ 80	82	83	85	99	123	120	116	113	110	106	103	100	97	94	92	90	87	85	82	81	78	79	76	62
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	16	16	17	17	18	18	27	20	20	21	21	22	23	33	24	30
	DELTA Project less Alternative	Energy Revenue	$ (166)	$ -	$ -	(28)	(3)	(13)	(13)	(14)	(14)	(15)	(27)	(17)	(17)	(18)	(5)	(20)	(20)	(38)	(22)	(23)	(24)	(25)	(27)	(28)	(27)	(30)	(32)
		Capacity Value	$ (7)	$ -	$ -	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		Variable Production Cost	$ 76	$ -	$ -	22	(2)	5	6	6	6	6	15	7	7	7	(3)	8	8	20	8	10	10	10	11	11	11	12	12
		Capital Revenue Requirements	$ 41.0	$ 0	$ 0	(1)	7	9	8	8	7	6	6	5	5	4	4	4	4	3	2	2	1	1	0	(0)	(3)	(2)	(3)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 97	$ -	$ -	7	5	9	8	9	9	10	13	11	11	12	9	12	13	16	14	15	15	16	17	18	17	19	20
		Project Costs (savings)	$ 35	$ 0	$ 0	(5)	7	9	8	8	7	6	(1)	5	5	4	11	4	4	(5)	2	2	1	1	0	(0)	(1)	(2)	(3)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 62**	**$ (0)**	**$ (0)**	**12**	**(2)**	**0**	**1**	**1**	**2**	**3**	**13**	**6**	**7**	**7**	**(3)**	**9**	**9**	**22**	**12**	**13**	**14**	**16**	**17**	**18**	**18**	**21**	**23**
		PV ($2013)		$ (0)	$ (0.4)	10	(1)	0	1	1	1	2	6	2	3	3	(1)	3	3	6	3	3	3	3	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	10	8	8	9	10	11	13	19	21	24	27	26	28	31	37	39	42	45	48	51	54	56	59	62

Case 13 **Appendix B, Schedule 5 - Economic Modeling Output Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,021	$ 980	$ 41
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,459	$ 1,384	$ 76
	Production Revenue	$ (1,978)	$ (1,812)	$ (166)
	Capacity Value	$ -	$ -	$ -
	Net Customer Cost (Benefit)	**$ 675**	**$ 730**	**$ (54.8)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (1,978)	[redacted]																									
		Capacity Value	$ -	$ -	$ -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Variable Production Cost	$ 1,459	[redacted]																									
		Capital Revenue Requirements	$ 1,021	$ 32	$ 80	82	90	94	98	130	127	122	118	115	111	107	104	101	98	95	92	88	86	83	81	79	76	74	60
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	16	16	16	17	24	18	19	19	20	20	21	21	22	23	33	24	30
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,812)	[redacted]																									
		Capacity Value	$ -	$ -	$ -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Variable Production Cost	$ 1,384	[redacted]																									
		Capital Revenue Requirements	$ 980	$ 32	$ 80	82	83	86	90	123	120	116	113	110	106	103	100	97	94	92	90	87	85	82	81	79	78	76	62
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	18	16	17	17	18	19	27	20	20	21	21	22	23	33	24	30
	DELTA Project less Alternative	Energy Revenue	$ (166)	$ -	$ -	(29)	(3)	(13)	(13)	(14)	(14)	(15)	(27)	(17)	(17)	(18)	(5)	(20)	(20)	(36)	(22)	(23)	(24)	(25)	(27)	(28)	(27)	(30)	(32)
		Capacity Value	$ -	$ -	$ -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Variable Production Cost	$ 76	$ -	$ -	22	(2)	5	6	6	6	6	15	7	7	7	(3)	8	8	20	9	10	10	10	11	11	11	12	12
		Capital Revenue Requirements	$ 41.0	$ 0	$ 0	(1)	7	9	8	8	7	6	6	5	5	4	4	4	4	3	2	2	1	1	0	(0)	(1)	(2)	(3)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 90	$ -	$ -	7	5	8	8	8	8	9	12	10	10	11	8	12	12	16	13	14	14	15	16	17	17	19	19
		Project Costs (savings)	$ 35	$ 0	$ 0	(5)	7	9	8	8	7	6	(1)	5	5	4	11	4	4	(5)	2	2	1	1	0	(0)	(1)	(2)	(3)
		TOTAL CUSTOMER BENEFIT BY YEAR	$ 55	$ (0)	$ (0)	12	(2)	(1)	(0)	1	1	2	12	5	6	7	(4)	8	8	21	11	12	13	14	16	17	17	20	22
		PV ($2013)		$ (0)	$ (0.4)	10	(1)	(1)	(0)	0	1	1	6	2	2	2	(1)	2	2	5	3	3	3	3	3	3	2	3	3
		Cumulative PV		$ (0)	$ (0)	10	8	8	7	8	8	10	16	18	20	22	21	23	25	31	34	36	39	42	44	47	50	52	55

Case 14 **Appendix B, Schedule 5 - Economic Modeling Output Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Draft Capital Inputs Also in Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,021	$ 980	$ 41
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,459	$ 1,384	$ 76
	Production Revenue	$ (2,473)	$ (2,266)	$ (207)
	Capacity Value	$ (219)	$ (215)	$ (3)
	Net Customer Cost (Benefit)	**$ (38)**	**$ 62**	**$ (99.7)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (2,473)																										
		Capacity Value	$ (219)	$ -	$ -	-	(26)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)
		Variable Production Cost	$ 1,459																										
		Capital Revenue Requirements	$ 1,021	$ 32	$ 80	82	90	94	98	106	127	122	118	115	111	107	104	101	96	95	92	88	86	83	81	79	78	74	69
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	16	16	16	17	24	18	19	19	20	20	21	21	22	23	33	24	30
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (2,266)																										
		Capacity Value	$ (215)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,384																										
		Capital Revenue Requirements	$ 980	$ 32	$ 80	82	83	86	90	123	120	118	113	110	106	103	100	97	94	92	90	87	85	82	81	79	79	76	62
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	16	16	17	17	18	19	27	20	20	21	21	22	23	33	24	30
	DELTA Project less Alternative	Energy Revenue	$ (207)	$ -	$ -	(36)	(4)	(16)	(17)	(17)	(18)	(19)	(34)	(21)	(22)	(23)	(6)	(25)	(26)	(45)	(28)	(29)	(30)	(31)	(33)	(35)	(34)	(38)	(40)
		Capacity Value	$ (3)	$ -	$ -	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		Variable Production Cost	$ 76	$ -	$ -	22	(2)	5	0	6	6	6	15	7	7	7	(3)	8	8	20	9	10	10	10	11	11	11	12	12
		Capital Revenue Requirements	$ 41.0	$ 0	$ 0	(1)	7	9	8	8	7	6	6	5	5	4	4	4	4	3	2	2	1	1	0	(0)	(1)	(2)	(3)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 135	$ -	$ -	14	6	11	12	12	12	13	19	15	15	16	0	17	18	25	19	20	21	21	23	24	24	27	28
		Project Costs (savings)	$ 35	$ 0	$ 0	(5)	7	9	8	8	7	6	(1)	5	5	4	11	4	4	(5)	2	2	1	1	0	(0)	(1)	(2)	(3)
		TOTAL CUSTOMER BENEFIT BY YEAR	$ 100	$ (0)	$ (0)	19	(1)	3	4	5	5	7	20	10	10	12	(2)	13	14	30	17	18	20	21	23	25	25	28	30
		PV ($2013)		$ (0)	$ (0.4)	16	(1)	2	2	3	3	3	9	4	4	4	(1)	4	4	8	4	4	4	4	4	4	4	4	4
		Cumulative PV		$ (0)	$ (0)	16	15	17	19	22	25	28	38	42	46	50	49	53	57	65	69	73	77	81	85	89	92	96	100

Case 15 **Appendix B, Schedule 5 - Economic Modeling Output Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,021	$ 980	$ 41
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,459	$ 1,384	$ 76
	Production Revenue	$ (1,484)	$ (1,359)	$ (124)
	Capacity Value	$ (219)	$ (215)	$ (0)
	Net Customer Cost (Benefit)	**$ 951**	**$ 968**	**$ (16.8)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (1,484)																										
		Capacity Value	$ (219)	$ -	$ -	-	(26)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)
		Variable Production Cost	$ 1,459																										
		Capital Revenue Requirements	$ 1,021	$ 32	$ 80	82	99	94	98	130	127	122	118	115	111	107	104	101	98	96	92	88	86	83	81	76	76	74	60
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	18	16	16	17	24	18	19	18	20	20	21	21	22	23	33	24	30
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,359)																										
		Capacity Value	$ (215)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,384																										
		Capital Revenue Requirements	$ 980	$ 32	$ 80	82	83	86	90	123	120	116	113	110	106	103	100	97	94	92	90	87	85	82	81	79	79	76	62
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	16	16	17	17	18	19	27	20	20	21	21	22	23	33	24	30
	DELTA Project less Alternative	Energy Revenue	$ (124)	$ -	$ -	(22)	(2)	(10)	(10)	(10)	(11)	(11)	(20)	(13)	(13)	(14)	(3)	(15)	(15)	(27)	(17)	(17)	(18)	(19)	(20)	(21)	(20)	(23)	(24)
		Capacity Value	$ (3)	$ -	$ -	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		Variable Production Cost	$ 76	$ -	$ -	22	(2)	5	8	6	6	5	15	7	7	7	(3)	8	8	20	9	10	10	10	11	11	11	12	12
		Capital Revenue Requirements	$ 41.0	$ 0	$ 0	(1)	7	9	8	8	7	6	6	5	5	4	4	4	4	3	2	2	1	1	0	(0)	(1)	(2)	(3)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 52	$ -	$ -	(1)	4	5	5	5	5	6	5	6	6	7	7	7	7	7	8	8	9	9	10	10	10	11	12
		Project Costs (savings)	$ 35	$ 0	$ 0	(5)	7	9	8	8	7	6	(1)	5	5	4	11	4	4	(5)	2	2	1	1	0	(0)	(1)	(2)	(3)
		TOTAL CUSTOMER BENEFIT BY YEAR	$ 17	$ (0)	$ (0)	5	(3)	(4)	(3)	(2)	(2)	(1)	6	1	2	2	(4)	3	4	12	6	7	8	8	9	11	11	13	14
		PV ($2013)		$ (0)	$ (0.4)	4	(2)	(3)	(2)	(1)	(1)	(0)	3	0	1	1	(1)	1	1	3	1	1	2	2	2	2	2	2	2
		Cumulative PV		$ (0)	$ (0)	3	1	(1)	(3)	(5)	(6)	(6)	(3)	(3)	(2)	(1)	(3)	(2)	(1)	3	4	5	7	9	10	12	13	15	17

Case 16	Appendix B, Schedule 5 - Economic Modeling Output Tables Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,021	$ 980	$ 41
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,799	$ 1,706	$ 94
	Production Revenue	$ (1,978)	$ (1,812)	$ (166)
	Capacity Value	$ (219)	$ (215)	$ (3)
	Net Customer Cost (Benefit)	**$ 797**	**$ 837**	**$ (40.6)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (1,978)	[redacted]																									
		Capacity Value	$ (219)	$ -	$ -	-	(26)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)
		Variable Production Cost	$ 1,799	[redacted]																									
		Capital Revenue Requirements	$ 1,021	$ 32	$ 80	82	90	94	98	130	127	122	118	115	111	107	104	101	98	95	92	88	86	83	81	79	76	74	60
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	16	16	18	17	24	18	19	18	20	20	21	21	22	23	33	24	30
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,812)	[redacted]																									
		Capacity Value	$ (215)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,706	[redacted]																									
		Capital Revenue Requirements	$ 980	$ 32	$ 80	82	83	86	90	123	120	116	113	110	106	103	100	97	94	92	89	87	85	82	81	79	79	76	62
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	18	16	17	17	18	19	27	20	20	21	21	22	23	33	24	30
	DELTA Project less Alternative	Energy Revenue	$ (166)	$ -	$ -	(29)	(3)	(13)	(13)	(14)	(14)	(15)	(27)	(17)	(17)	(18)	(5)	(20)	(20)	(36)	(22)	(23)	(24)	(25)	(27)	(28)	(27)	(30)	(32)
		Capacity Value	$ (3)	$ -	$ -	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		Variable Production Cost	$ 94	$ -	$ -	28	(3)	7	7	7	8	8	19	8	9	9	(4)	10	10	25	11	12	12	13	13	14	13	15	15
		Capital Revenue Requirements	$ 41.0	$ 0	$ 0	(1)	7	9	8	8	7	6	6	5	5	4	4	4	4	3	2	2	1	1	0	(0)	(1)	(2)	(3)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 76	$ -	$ -	2	6	7	7	7	7	8	9	9	9	9	9	10	10	11	11	12	12	13	14	15	14	16	17
		Project Costs (savings)	$ 35	$ 0	$ 0	(5)	7	9	8	8	7	6	(1)	5	5	4	11	4	4	(5)	2	2	1	1	0	(0)	(1)	(2)	(3)
		TOTAL CUSTOMER BENEFIT BY YEAR	$ 41	$ (0)	$ (0)	7	(1)	(2)	(1)	(0)	0	1	9	4	4	5	(2)	6	7	16	9	10	11	12	14	15	15	18	20
		PV ($2013)		$ (0)	$ (0.4)	6	(1)	(1)	(1)	(0)	0	1	4	2	2	2	(1)	2	2	4	2	2	2	2	2	2	2	2	2
		Cumulative PV		$ (0)	$ (0)	5	4	3	2	2	2	3	7	9	11	13	12	14	16	20	22	25	27	29	31	34	36	38	41

Case 17

Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,021	$ 980	$ 41
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,120	$ 1,061	$ 58
	Production Revenue	$ (1,978)	$ (1,812)	$ (166)
	Capacity Value	$ (219)	$ (215)	$ (3)
	Net Customer Cost (Benefit)	**$ 117**	**$ 193**	**$ (75.9)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (1,978)																										
		Capacity Value	$ (219)	$ -	$ -	-	(26)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(26)	(27)	(27)	(27)	(27)	(27)	(27)
		Variable Production Cost	$ 1,120																										
		Capital Revenue Requirements	$ 1,021	$ 32	$ 80	82	90	94	98	100	127	122	118	115	111	107	104	101	98	95	92	88	86	83	81	79	78	74	60
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	16	16	16	17	24	18	19	19	20	20	21	21	22	23	33	24	30
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,812)																										
		Capacity Value	$ (215)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,061																										
		Capital Revenue Requirements	$ 980	$ 32	$ 80	82	83	86	90	123	120	116	113	110	106	103	100	97	94	92	90	87	85	82	81	79	79	76	62
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	16	16	17	17	18	19	27	20	20	21	21	22	23	33	24	30
	DELTA Project less Alternative	Energy Revenue	$ (166)	$ -	$ -	(29)	(3)	(13)	(13)	(14)	(14)	(15)	(27)	(17)	(17)	(18)	(5)	(29)	(20)	(36)	(22)	(23)	(24)	(25)	(27)	(28)	(27)	(30)	(32)
		Capacity Value	$ (3)	$ -	$ -	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		Variable Production Cost	$ 58	$ -	$ -	17	(2)	4	4	5	5	5	12	5	6	6	(2)	6	6	16	7	7	8	8	8	8	8	9	10
		Capital Revenue Requirements	$ 41.0	$ 0	$ 0	(1)	7	9	8	8	7	6	6	5	5	4	4	4	4	3	2	2	1	1	0	(0)	(1)	(2)	(3)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 111	$ -	$ -	12	5	9	10	10	10	11	16	12	12	13	7	14	14	21	16	16	17	18	19	20	20	22	23
		Project Costs (savings)	$ 35	$ 0	$ 0	(5)	7	9	8	8	7	6	(1)	5	5	4	11	4	4	(5)	2	2	1	1	0	(0)	(1)	(2)	(3)
		TOTAL CUSTOMER BENEFIT BY YEAR	$ 76	$ (0)	$ (0)	17	(2)	1	2	2	3	4	16	7	8	9	(4)	10	11	26	14	15	16	17	19	20	20	23	25
		PV ($2013)		$ (0)	$ (0.4)	14	(2)	1	1	1	2	2	8	3	3	3	(1)	3	3	7	3	3	3	3	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	14	12	13	14	15	17	19	27	30	33	36	35	38	41	48	51	54	57	61	64	67	70	73	76

Case 18 **Appendix B, Schedule 5 - Economic Modeling Output Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Grey

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,029	$ 976	$ 53
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,613	$ 1,535	$ 78
	Production Revenue	$ (1,326)	$ (1,223)	$ (103)
	Capacity Value	$ -	$ -	$ -
	Net Customer Cost (Benefit)	**$ 1,490**	**$ 1,467**	**$ 22.7**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (1,326)	[redacted]																									
		Capacity Value	$ -	[redacted]																									
		Variable Production Cost	$ 1,613	[redacted]																									
		Capital Revenue Requirements	$ 1,029	$ 37	$ 80	82	81	96	98	132	128	123	119	116	112	108	105	102	99	95	92	89	80	84	82	80	79	75	60
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	16	16	16	17	24	18	19	18	20	20	21	21	22	23	33	24	30
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,223)	[redacted]																									
		Capacity Value	$ -	$ -	$ -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Variable Production Cost	$ 1,535	[redacted]																									
		Capital Revenue Requirements	$ 976	$ 31	$ 80	82	83	85	90	123	119	115	112	109	106	103	100	97	94	92	89	86	84	82	80	78	76	73	66
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	16	16	17	17	18	19	27	20	20	21	21	22	23	33	24	30
	DELTA Project less Alternative	Energy Revenue	$ (102)	$ -	$ -	(20)	(1)	(8)	(8)	(8)	(9)	(9)	(17)	(10)	(11)	(11)	(2)	(12)	(12)	(23)	(13)	(14)	(15)	(15)	(16)	(17)	(17)	(19)	(19)
		Capacity Value	$ -	$ -	$ -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Variable Production Cost	$ 78	$ -	$ -	35	(3)	5	6	6	6	6	16	7	7	8	(4)	8	8	22	9	10	10	10	11	11	11	12	13
		Capital Revenue Requirements	$ 52.6	$ 0	$ 1	(0)	8	10	10	9	8	8	7	6	6	5	5	5	5	4	3	3	2	2	1	1	0	(0)	(1)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 24	$ -	$ -	(5)	4	3	3	3	3	2	1	3	3	4	6	4	4	1	4	4	5	5	5	6	6	6	7
		Project Costs (savings)	$ 47	$ 0	$ 1	(5)	6	10	10	9	8	8	1	6	6	5	12	5	5	(4)	3	3	2	2	1	1	0	(0)	(1)
		TOTAL CUSTOMER BENEFIT BY YEAR	$ (23)	$ (0)	$ (1)	(1)	(4)	(8)	(7)	(6)	(6)	(5)	0	(3)	(3)	(2)	(6)	(1)	(1)	5	1	2	2	3	4	5	5	7	8
		PV ($2013)		$ (0)	$ (0.5)	(0)	(3)	(5)	(5)	(4)	(3)	(3)	0	(1)	(1)	(1)	(2)	(0)	(0)	1	0	0	0	1	1	1	1	1	1
		Cumulative PV		$ (0)	$ (1)	(1)	(4)	(10)	(14)	(18)	(22)	(24)	(24)	(25)	(26)	(27)	(29)	(30)	(30)	(29)	(28)	(28)	(27)	(27)	(26)	(25)	(25)	(24)	(23)

Case 19 **Appendix B, Schedule 5 - Economic Modeling Output Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,013	$ 983	$ 29
	Fixed O&M Revenue Requirements	$ 175	$ 179	$ (6)
	Variable Production Cost	$ 1,236	$ 1,167	$ 69
	Production Revenue	$ (2,740)	$ (2,492)	$ (248)
	Capacity Value	$ (436)	$ (431)	$ (5)
	Net Customer Cost (Benefit)	**$ (755)**	**$ (592)**	**$ (163.4)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (2,740)	[redacted]																									
		Capacity Value	$ (436)	$ -	$ -	-	(53)	(54)	(54)	(54)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)	(53)
		Variable Production Cost	$ 1,236	[redacted]																									
		Capital Revenue Requirements	$ 1,013	$ 32	$ 80	81	88	93	97	129	125	121	117	114	110	107	104	100	97	94	91	88	85	83	81	79	77	74	59	38
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	16	16	16	17	24	18	19	19	20	20	21	21	22	23	33	24	30	
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (2,492)	[redacted]																									
		Capacity Value	$ (431)	$ -	$ -	-	(53)	(53)	(53)	(53)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)	(52)
		Variable Production Cost	$ 1,167	[redacted]																									
		Capital Revenue Requirements	$ 983	$ 32	$ 80	82	84	86	90	123	120	116	113	110	107	104	101	98	95	93	90	87	85	83	81	80	80	78	63	38
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	18	18	17	17	18	19	27	20	20	21	21	22	23	33	24	30	
	DELTA Project less Alternative	Energy Revenue	$ (248)	$ -	$ -	(40)	(6)	(20)	(20)	(21)	(22)	(23)	(40)	(25)	(26)	(27)	(8)	(30)	(31)	(52)	(33)	(35)	(38)	(38)	(40)	(42)	(41)	(46)	(48)	
		Capacity Value	$ (5)	$ -	$ -	-	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	
		Variable Production Cost	$ 69	$ -	$ -	19	(1)	5	5	5	6	6	14	6	7	7	(2)	7	8	18	6	8	9	9	10	10	10	11	11	
		Capital Revenue Requirements	$ 29.2	$ (0)	$ 0	(1)	5	7	7	8	5	5	4	4	3	3	3	3	2	1	1	0	0	(0)	(1)	(1)	(2)	(3)	(4)	
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-	
	SUMMARY	Net Market Benefits (costs)	$ 187	$ -	$ -	21	7	18	16	17	17	18	27	20	21	22	12	23	24	35	26	27	28	28	31	33	32	36	38	
		Project Costs (savings)	$ 23	$ (0)	$ 0	(5)	9	7	7	9	5	5	(2)	4	3	3	10	3	2	(6)	1	0	0	(0)	(1)	(1)	(2)	(3)	(4)	
		TOTAL CUSTOMER BENEFIT BY YEAR	$ 163	$ 0	$ (0)	27	2	9	10	11	12	13	29	16	18	18	2	21	22	42	25	27	28	30	32	34	35	39	42	
		PV ($2013)		$ 0	$ (0.3)	23	1	6	6	6	7	7	14	7	7	7	1	6	6	11	6	6	6	6	5	5	5	5	5
		Cumulative PV		$ 0	$ (0)	22	23	30	36	43	49	56	69	76	83	90	91	97	103	114	120	126	132	137	143	148	153	158	163

Case 20 **Appendix B, Schedule 5 - Economic Modeling Output Tables**
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Gray

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,021	$ 980	$ 41
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,868	$ 1,771	$ 97
	Production Revenue	$ (2,344)	$ (2,145)	$ (199)
	Capacity Value	$ (219)	$ (215)	$ (3)
	Net Customer Cost (Benefit)	**$ 499**	**$ 570**	**$ (70.7)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (2,344)																										
		Capacity Value	$ (219)	$ -	$ -	-	(26)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)
		Variable Production Cost	$ 1,868																										
		Capital Revenue Requirements	$ 1,021	$ 32	$ 80	82	90	94	98	130	127	122	118	115	111	107	104	101	98	95	92	88	86	83	81	79	78	74	60
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	16	16	16	17	24	18	19	19	20	20	21	21	22	23	33	24	30
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (2,145)																										
		Capacity Value	$ (215)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,771																										
		Capital Revenue Requirements	$ 980	$ 32	$ 80	82	83	86	90	123	120	116	113	110	106	103	100	97	94	92	90	87	85	82	81	79	78	76	62
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	16	16	17	17	18	19	27	20	20	21	21	22	23	33	24	30
	DELTA Project less Alternative	Energy Revenue	$ (199)	$ -	$ -	(29)	(3)	(13)	(13)	(14)	(14)	(15)	(35)	(21)	(22)	(24)	(6)	(26)	(27)	(48)	(30)	(32)	(33)	(35)	(37)	(40)	(39)	(44)	(46)
		Capacity Value	$ (3)	$ -	$ -	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		Variable Production Cost	$ 97	$ -	$ -	22	(2)	5	6	6	6	6	21	10	10	11	(4)	12	13	31	14	15	16	16	17	18	18	21	22
		Capital Revenue Requirements	$ 41.0	$ 0	$ 0	(1)	7	9	8	8	7	6	6	5	5	4	4	4	4	3	2	2	1	1	0	(0)	(1)	(2)	(3)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 106	$ -	$ -	7	5	8	8	9	9	9	14	12	13	13	11	15	15	18	17	17	16	19	20	22	21	24	25
		Project Costs (savings)	$ 35	$ 0	$ 0	(5)	7	9	8	8	7	6	(1)	5	5	4	11	4	4	(5)	2	2	1	1	0	(0)	(1)	(2)	(3)
		TOTAL CUSTOMER BENEFIT BY YEAR	**$ 71**	**$ (0)**	**$ (0)**	**12**	**(2)**	**(0)**	**0**	**1**	**2**	**3**	**15**	**7**	**8**	**9**	**(0)**	**11**	**12**	**23**	**15**	**16**	**17**	**18**	**20**	**22**	**22**	**25**	**28**
		PV ($2013)		$ (0)	$ (0.4)	10	(1)	(0)	0	1	1	1	7	3	3	3	(0)	3	3	6	3	3	3	3	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	10	8	8	8	9	10	11	18	21	24	28	28	31	34	40	44	47	51	54	57	61	64	67	71

Case 21 Appendix B, Schedule 5 - Economic Modeling Output Tables
Columbia Unit 2 Turbine and Mill Upgrade Analysis

Confidential Information is Highlighted in Blue

	Present Value (PV) (discounted to end of year 2013)	PROJECT 2013 Technology	ALTERNATIVE 1970 Technology	DELTA Project less Alternative
UNIT 2 SUMMARY	Capital Revenue Requirements	$ 1,021	$ 980	$ 41
	Fixed O&M Revenue Requirements	$ 173	$ 179	$ (6)
	Variable Production Cost	$ 1,815	$ 1,721	$ 94
	Production Revenue	$ (2,168)	$ (1,985)	$ (183)
	Capacity Value	$ (219)	$ (215)	$ (3)
	Net Customer Cost (Benefit)	**$ 622**	**$ 679**	**$ (57.3)**

			PV Discounted to end of year 2013	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
UNIT 2	PROJECT WITH UPGRADES	Energy Revenue	$ (2,168)	[redacted]																									
		Capacity Value	$ (219)	$ -	$ -	-	(26)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)	(27)
		Variable Production Cost	$ 1,815	[redacted]																									
		Capital Revenue Requirements	$ 1,021	$ 32	$ 80	82	80	94	98	130	127	122	118	115	111	107	104	101	98	95	92	88	86	83	81	79	78	74	60	
		Fixed O&M Revenue Requirements	$ 173	$ 13	$ 12	12	13	13	13	14	15	15	16	16	16	17	24	18	19	19	20	20	21	21	22	23	33	24	30	
	ALTERNATIVE WITHOUT UPGRADES	Energy Revenue	$ (1,985)	[redacted]																									
		Capacity Value	$ (215)	$ -	$ -	-	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)	(26)
		Variable Production Cost	$ 1,721	[redacted]																									
		Capital Revenue Requirements	$ 980	$ 32	$ 80	82	83	86	90	123	120	116	113	110	106	103	100	97	94	92	90	87	85	82	81	78	79	76	62	
		Fixed O&M Revenue Requirements	$ 179	$ 13	$ 12	17	13	13	13	14	15	15	22	16	16	17	17	18	19	27	20	20	21	21	22	23	33	24	30	
	DELTA Project less Alternative	Energy Revenue	$ (183)	$ -	$ -	(29)	(3)	(13)	(13)	(14)	(14)	(15)	(30)	(19)	(20)	(21)	(5)	(23)	(24)	(42)	(26)	(28)	(29)	(31)	(33)	(35)	(34)	(38)	(41)
		Capacity Value	$ (3)	$ -	$ -	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		Variable Production Cost	$ 94	$ -	$ -	22	(2)	5	6	6	6	6	20	9	10	10	(4)	11	12	29	13	14	15	16	17	18	17	20	21
		Capital Revenue Requirements	$ 41.0	$ 0	$ 0	(1)	7	9	8	8	7	8	6	5	5	4	4	4	4	3	2	2	1	1	0	(0)	(1)	(2)	(3)
		Fixed O&M Revenue Requirements	$ (6.0)	$ -	$ -	(4)	0	-	-	-	-	-	(6)	-	-	-	7	-	-	(8)	-	-	-	-	-	-	-	-	-
	SUMMARY	Net Market Benefits (costs)	$ 92	$ -	$ -	7	5	8	8	9	9	9	10	10	10	11	10	12	12	13	13	14	15	15	17	16	17	19	20
		Project Costs (savings)	$ 35	$ 0	$ 0	(5)	7	9	8	8	7	6	(1)	5	5	4	11	4	4	(5)	2	2	1	1	0	(0)	(1)	(2)	(3)
		TOTAL CUSTOMER BENEFIT BY YEAR	$ 57	$ (0)	$ (0)	12	(2)	(0)	0	1	2	3	11	5	6	7	(1)	8	9	19	12	13	14	15	16	18	18	21	23
		PV ($2013)		$ (0)	$ (0.4)	10	(1)	(0)	0	1	1	1	5	2	2	2	(0)	2	2	5	3	3	3	3	3	3	3	3	3
		Cumulative PV		$ (0)	$ (0)	10	8	8	8	9	10	11	16	18	21	23	23	25	28	33	35	38	41	44	46	49	52	55	57

APPENDIX B, SCHEDULE 6 (six) - Economic Modeling Sensitivity Analysis Matrices

Turbine and Mill Economic Analysis:

		Unit 1 Results of Sensitivity Analysis			Unit 2 Results of Sensitivity Analysis			Total Plant Results of Sensitivity Analysis		
Case #	Description	The Project PVRR 2013 Technology	The Alternative PVRR 1970's Technology	Delta (The Project - The Alternative)	The Project PVRR 2013 Technology	The Alternative PVRR 1970's Technology	Delta (The Project - The Alternative)	The Project	The Alternative	Delta* (Project less Alternative)
1 (base)	Reference/Base Case	198	243	(45)	457	515	(58)	655	758	(103)
2	Higher Cost of the Project by 10%	206	243	(37)	465	515	(50)	670	758	(88)
3	Lower Cost of the Project by 10%	190	243	(52)	449	515	(66)	639	758	(119)
4	Higher Cost of the Alternative by 10%	198	246	(48)	457	519	(62)	655	765	(110)
5	Lower Cost of the Alternative by 10%	198	240	(41)	457	511	(54)	655	751	(96)
6	Higher Heat Rate Improvement by 10%	193	243	(50)	451	515	(64)	644	758	(113)
7	Lower Heat Rate Improvement by 10%	203	243	(40)	462	515	(53)	665	758	(93)
8	Higher ICAP and UCAP Increase by 10%	195	243	(48)	453	515	(62)	648	758	(110)
9	Lower ICAP and UCAP Increase by 10%	201	243	(42)	460	515	(54)	661	758	(96)
10	Higher Operating Factor by 10%	151	204	(53)	405	472	(67)	556	676	(120)
11	Lower Operating Factor by 10%	245	282	(37)	508	558	(49)	753	840	(86)
12	Capacity Value equal to CONE	(8)	42	(50)	238	300	(62)	230	342	(111)
13	Capacity Value equal to $0	404	444	(40)	675	730	(55)	1,079	1,174	(95)
14	Higher MISO Market Energy Price by 25%	(252)	(173)	(79)	(38)	62	(100)	(290)	(111)	(179)
15	Lower MISO Market Energy Price by 25%	648	658	(10)	951	968	(17)	1,599	1,626	(27)
16	Higher Delivered Fuel Price by 25%	511	541	(31)	797	837	(41)	1,307	1,378	(71)
17	Lower Delivered Fuel Price by 25%	(115)	(56)	(59)	117	193	(76)	2	137	(135)

* A negative delta means that the Project is a lower cost option for customers

Case #	Description	The Project PVRR 2013 Technology	The Alternative PVRR 1970's Technology	Delta (The Project - The Alternative)	The Project PVRR 2013 Technology	The Alternative PVRR 1970's Technology	Delta (The Project - The Alternative)	The Project	The Alternative	Delta* (Project less Alternative)
18	combined in Favor of the Alternative	1,148	1,122	26	1,490	1,467	23	2,637	2,589	48
19	Upper and Lower Bound with all sensitivities combined in Favor of the Project	(914)	(779)	(135)	(756)	(592)	(163)	(1,670)	(1,372)	(299)

* A negative delta means that the Project is a lower cost option for customers

APPENDIX C – STEAM TURBINE UPGRADING ARTICLE IN POWER MAGAZINE - VOL 150 NO 3

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PLANT LIFE EXTENSION

Steam turbine upgrading: Low-hanging fruit

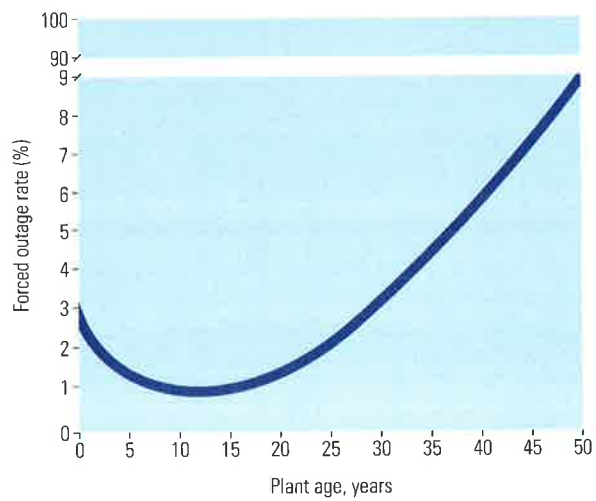
The thermodynamic performance of the steam turbine, more than any other plant component, determines overall plant efficiency. Upgrading steam path components and using computerized design tools and manufacturing techniques to minimize internal leaks are two ways to give your tired steam turbine a new lease on life. Here are three case studies that illustrate how to do that.

By Dr. Robert Peltier, PE

In 1500, Leonardo Da Vinci drew sketches of a device that rotated when hot air going up a chimney passed through a set of fan-like blades. Leonardo called his invention a "chimney jack," and although it only turned a roasting skewer, it gave birth to the idea of mounting blades on a shaft to convert thermal energy into mechanical energy. Sir Charles Parsons' improvements on the concept led to a patent on the first multistage reaction turbine in 1884 and a 4-kW prototype the following year. A century later, the technology has been refined to the point where modern ultra-supercritical plant efficiencies are approaching the magic 50% barrier.

In the U.S., market forces have driven some plant owners to continue to operate units whose heat rates are considered mediocre. Some 50-year-old best-of-class steam plants, which sported heat rates in the 9,000 Btu/kWh range when commissioned, continue to operate at similar efficiency today to supply a short-term need. The kicker, of course, is that the cost of operating a plant rises as it ages and becomes less reliable (Figure 1).

1. Senior moments. A typical steam plant's nominal forced outage rate will increase over time. *Source: POWER magazine*



Keeping any plant on-line and profitable requires continuous investment. Not the mandatory sort—such as installing or upgrading emissions-control systems to meet stricter standards—but discretionary investment. It only seems reasonable to invest in areas where the return on investment will be biggest—such as upgrading a plant's workhorse, its steam turbine (Figure 2). The dollars are significant: Improving a baseloaded 500-MW coal plant's heat rate by 100 Btu/kWh could save as much as $10 million dollars annually in fuel costs alone.

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Forward . . . thinking

Dairyland Power Cooperative (DPC) and Siemens Power Generation (Orlando, Fla.) recently completed a retrofit of the high-pressure (HP), intermediate-pressure (IP), and low-pressure (LP) steam paths of Unit 1 of Dairyland's J.P. Madgett Station in Alma, Wis. Madgett Station is a coal-fired subcritical steam plant that entered service in 1979 with a nominal rating of 365 MW. Retiring the unit wasn't an option, because DPC resource planners realized they need its capacity now and for another 30 years. Modernizing the steam turbine was the only feasible strategy. DPC initiated the retrofit project with three aggressive goals: improve the efficiency of the plant across the load range, boost unit capacity, and lengthen the turbine's maintenance period to 10 years.

Siemens provided a retrofit upgrade package that included new rotors, inner casings, and high-efficiency rotor and stator blades, as well as design and installation services. A 50-day outage was scheduled in the fall of 2004 to complete the retrofit work in parallel with major boiler maintenance, upgrading the control system to a modern distributed control system, and replacing the main transformer to handle the expected higher power output.

Siemens' BB44FA (full arc) HP/IP turbine retrofit package targets the existing fleet of Westinghouse building-block (BB) 44 turbines with inlet pressures up to 2,400 psig and an inlet temperature of 1,000F. BB44 turbines range in size between 350 MW and 680 MW. By using the package, engineers can add a full arc to the admission inlet section, eliminate the 180-degree steam turnaround to the HP blade path, eliminate the impulse control stage, add a fully integral inner casing, and improve steam sealing (Figure 2).

All internal stationary components were put within a single, fully integral casing—a design that minimizes parts count and decreases installation time and the duration of future outages. The BB44FA design duplicates the mating-flanges profile of existing units, enabling reuse of the outer casing and all the anchor points. This exemplifies Siemens' design philosophy for the retrofit package: to make it completely "plug-and-play."

The design of the HP/IP rotor design features fully integral, no-bore forging to shorten start-up times and lengthen fatigue life. Like the outer casing and anchor points, bearings can be reused because the new rotor matches the weight of the old one, reducing cost and installation time. Blade designs featuring integral shrouds were selected to optimize thermodynamic performance. The shroud design has two advantages: The shroud creates a circumferential boundary for the steam path, enabling the retrofit of more-efficient seals, and it provides individual blade tip supports between adjacent blades. The designs of the first-stage HP and IP blades reduce rotor inlet temperatures while providing favorable downstream flow conditions.

Unit 1's old, five-stage LP turbine was replaced with a new, seven-stage design that eliminates riveted shrouds on the front-end blading and riveted shrouds and lashing wires on the larger LP blades (Figure 3). A single inner casing with moisture removal features is included in the retrofit package. The LP turbine was designed to be a "drop-in" replacement to allow the reuse of many inner-to-outer cylinder connection points. Other features of the package include a monoblock rotor forging

2. On the half-shell. Dairyland replaced an entire high-pressure/intermediate-pressure turbine at its J.P. Madgett Station to improve the plant's performance and reliability. *Courtesy: Dairyland Power Cooperative, John P. Madgett Station*

3. New lease on life. Siemens Power Generation's replacement low-pressure turbine uses improved blade design and increased exhaust annulus area to improve performance. *Courtesy: Dairyland Power Cooperative, John P. Madgett Station*

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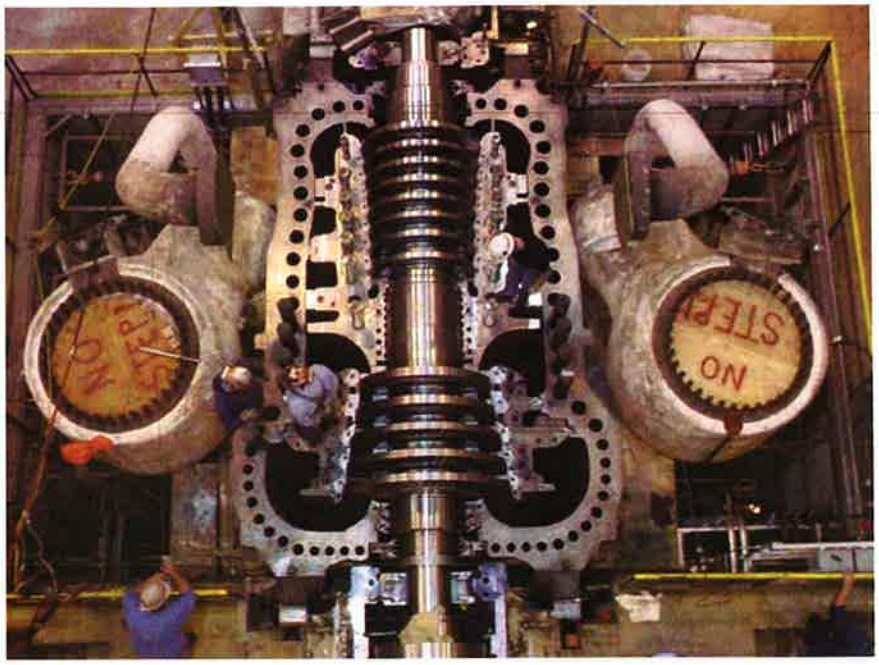
without thru-bore, reaction front-end blades with integral shrouds, 37.7-in freestanding last-row blades, and a single inner casing with an improved exhaust diffuser.

The upgraded turbine was successfully installed during the scheduled 50-day outage of J.P. Madgett Station. Test results were exceptional: The efficiency of the HP turbine increased by 8% to 10% over the load range while that of the IP section rose 2% to 4%. Total plant output went up 20 to 27 MW. Much of the measured 7- to 8-MW performance gain in the LP section was attributed to the improved front end blade design, the 25% increase in annulus area, and the more-efficient last three stages of the LP section.



4. Bird's eye view. Labadie Unit 3's high-pressure/intermediate-pressure turbine rotor-finishing assembly. *Courtesy: AmerenUE*

5. You make the call. Compare Labadie Unit 3 and 4's new and old high-pressure (HP) turbines. The old HP section (left) has two fewer rows than the new one (right). Testing found the new design to be 7% more efficient. *Courtesy: AmerenUE*

Show me—the improvements

AmerenUE's Labadie Plant, 35 miles west of St. Louis, has been recognized by the U.S. EPA and the State of Missouri for its exceptional environmental performance. But plant management is equally well known for its commitment to continuously improving the production statistics of Labadie's four 600-MW (nominal) coal-fired units.

Over the past few years, plant staff—with the help of Alstom Power (Windsor, Conn.)—has raised maximum unit capacity by at least 10% (from 580 MW to 630 MW) while simultaneously increasing their availability (POWER, July/August 2003, pp. 58–61). Beyond boiler improvements necessitated by its switch to Powder River Basin (PRB) coal in the late 1990s, the Labadie plant also installed low-NO_x burners, an overfire air system, and advanced computer controls to improve unit performance and significantly reduce emissions.

One of Labadie's greatest performance gains came from the upgrading of all four of its steam turbines. The four units were designed in the late 1960s and began commercial operation between 1971 and 1974. Westinghouse supplied the BB44-design turbine-generators of Units 1 and 2; General Electric followed up with a G-2 design for Units 3 and 4. Each turbine-generator is a tandem-compound unit with two double-flow LP sections. The upgrade program spanned several years; the HP/IP turbines of the Westinghouse units were replaced in 2002, and new HP/IP and LP turbines for the GE units were put in a year later.

The HP/IP performance records of Units 1 and 2 over their first 30 years of service were disappointing. Major-maintenance intervals remained stubbornly at around four years, unit efficiency continued to inch downward, start-up times kept rising, and operational problems grew in number and severity. Turbine efficiency would improve after maintenance overhauls but never returned to design levels and degraded rapidly between overhauls. Internal turbine problems such as thumbnail chipping of the nozzle block and steam seal degradation proved difficult to correct permanently. Other mechanical problems included non-uniform creep of rotors, causing them to bow and further extending start-up times and outage intervals. The end result—fewer megawatt-hours sold—dictated nothing less than replacement of both units' HP/IP turbines.

AmerenUE chose to replace the turbines as modules, with the new units featuring low-reaction (impulse) blading with full arc admission. Doing so cost more but gave engineers more freedom to maximize performance unconstrained by the units' existing outer casing (although the outer casing also was replaced during the retrofit to eliminate other maintenance problems). The modular approach also simplified the arrangement of the stages. Because the inlets of the new HP/IP sections are at the center of the turbine (along with single-flow HP and IP expansions), a large balance piston is no longer needed to offset the axial thrust that the old, reaction-design turbine used to produce. Removing the piston reduced the number of internal leakage paths from five to one.

A further performance improvement resulted from the revised steam sealing arrangement, which does more than significantly reduce leakage. It also uses cold reheat steam—rather than main steam—to seal the turbine. The beneficial trickle-down effect extends to reduction of gland steam spillover and reduction of the condenser's heat load.

Both turbine retrofits have produced the desired results. Units 1 and 2 (where only

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the HP/IP turbines were replaced) saw an increase in HP efficiency of 7% and LP efficiency of 5%. The total increase in the capacity of each unit was demonstrated at 27 MW, due to efficiency increases alone.

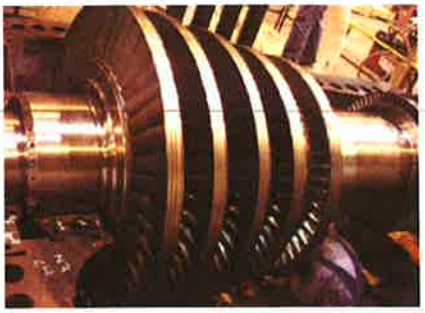
The aforementioned O&M issues also drove Ameren to do wholesale replacements of the turbines of Units 3 and 4. In this case, the goals were to improve unit efficiency and plant output and to lengthen the turbine's maintenance interval (Figure 4). The tandem-compound HP/IP turbine was replaced with a similar low-reaction turbine design (Figures 5 and 6). Replacement of the outer casing was not necessary, which saved capital cost and reduced piping and insulation rework.

The two double-flow LP turbines with 30-inch L-0 blades were replaced because stress corrosion cracking of the L-1 wheel dovetail area had accelerated enough to warrant either a major repair job or the blades' replacement. After running the numbers, Ameren chose the replacement option, which entailed the use of modern, 34-inch L-0 blades and a smaller blade path (Figure 7). This increased unit capacity by 10 of 14 MW.

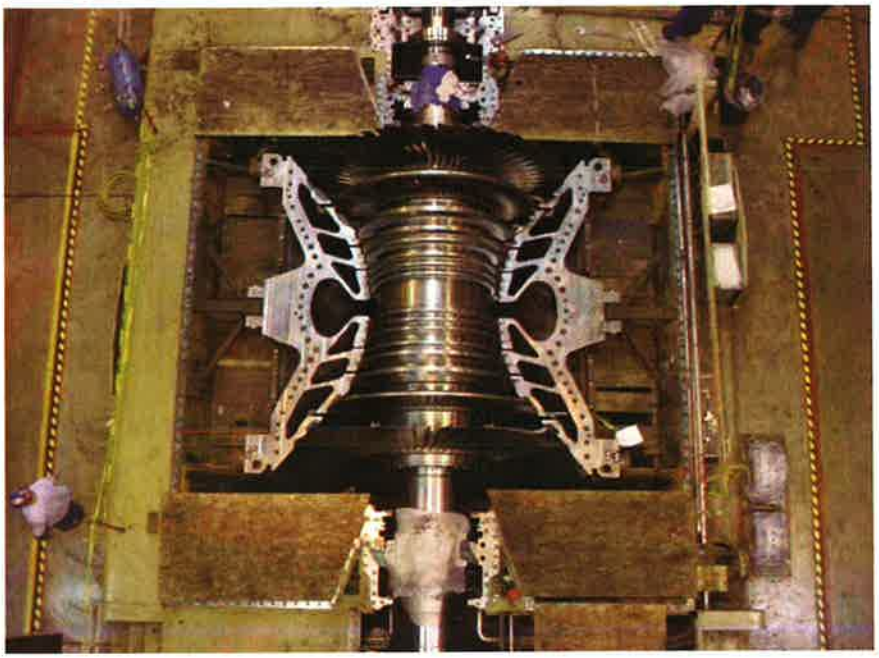
Perhaps the most significant lesson Ameren learned was the need to consider upgrade projects holistically and coordinate their execution with other planned plant changes. Within a unit, any change made to any system almost always produces changes elsewhere. For example, putting in a new economizer and air preheater lowers the gas path pressure drop, decreasing the level of fan power needed. At Labadie, doing so saved 3 to 6 MW and created an ancillary benefit: improved precipitator performance due to the lower entering gas temperature. Similarly, modifying the superheater division panels eliminated a number of gas flow restrictions and fatigue-related tube failures, enabling operators to increase unit maximum power by another 12 MW. AmerenUE engineers made sure the new steam turbine had the margin to take advantage of other plant performance improvements.

Excelsior—ever upward with capacity

A project similar to the upgrade of Labadie Plant was recently completed at KeySpan Corp.'s four-unit, 1,520-MW Northport Power Station on Long Island. Northport has 1960s- and 1970s-vintage steam turbines from General Electric. In the fall of 2004, it was the 375-MW Unit 3's turn for rejuvenation. The main reliability problem of Unit 3's turbine was internal seal leakage that was reducing the unit's peak output and increasing its heat rate.



6. Which would you want? On the left is the old intermediate-pressure turbine blade/shroud design of Units 3 and 4. At right is the modern design. *Courtesy: AmerenUE*



7. Almost finished. Lengthening the blades of Unit 3's low-pressure turbine from 30 to 34 inches increased the low-pressure section's efficiency by 5%. *Courtesy: AmerenUE*

KeySpan typically tests its units regularly and overhauls them about every seven years. Northport Unit 3 hadn't gotten a facelift since 1997. Before its scheduled turbine overhaul in 2004, Unit 3 hadn't been performing up to snuff. For example, tests indicated that the unit was load-limited by 15-MW with the main boiler feed pump at maximum speed throughout 2003 and early 2004. Main steam temperature also was limited—by increasing hot reheat temperatures since the unit's last overhaul. Due to these issues—and many others—Unit 3's corrected load had dropped 20 to 30 MW below the other three units at the site. All signs pointed to increased HP/IP leakage of an unacceptable level.

When the 2004 overhaul began, operators noted that the two horizontal joint studs on the right side of the HP inner shell were completely relaxed when the shell was removed. Both washers were split and removed without removing the nuts. A contact check of the inner shell half joint in the HP to IP mid-span area revealed a significant leakage path. Based on the contact check, GE estimates the leakage at over 18,000 lb/hr, penalizing capacity by 470 kW and heat rate by 7.9 Btu/kWh.

Pre-overhaul estimates promised recovery of 4 MW and a heat rate reduction of 257 Btu/kWh by improving turbine stage efficiency and reducing HP to IP leakage from 11% to 4% of steam flow. The first step was to send the turbine shell out to have the mating joint machined down by 0.031 inch to bring the flatness into design specs.

The steam seal optimization package KeySpan chose came from TurboCare Inc. (Chicopee, Mass.). In it were standard labyrinth packaging rings, retractable packing rings, brush seals, and conventional blade and brush-tip seals—all sized for Unit 3's turbine. Seal rubbing is not uncommon in steam turbines, and it is par-

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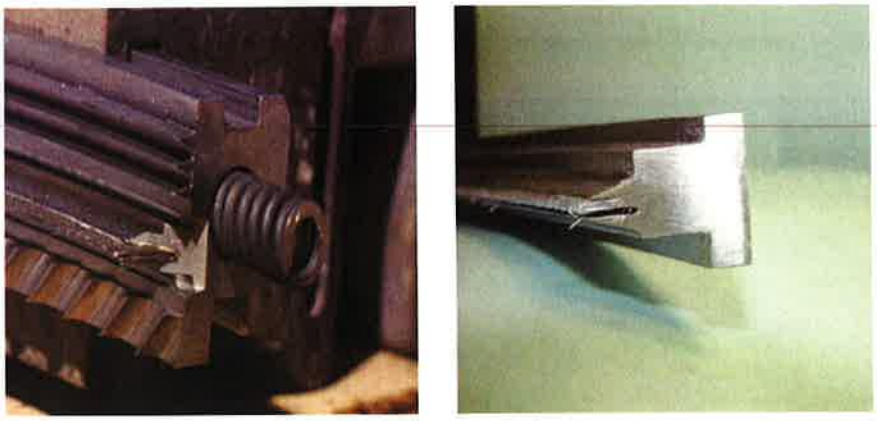
ticularly common with single-casing HP/IP designs that use a packing box to seal the flow between the HP and IP sections.

A relatively long bearing span often initiates a rub in the mid-span seal area. Conventional packing can open after the first few turbine starts, leaving blade-tip seals with as much as 0.025 to 0.040 inch of clearance for years after the first few restarts after an overhaul. The retractable packing included in the TurboCare package maintains a 0.015-in. clearance by using springs to force the packing ring segments away from the shaft during start-up. For the shaft seals between stages, brush seals were added to the body of the retractable packing, reducing clearance to nearly zero (Figure 8).



8. Sealed up tight. Installing a new brush seal (left) and brush-tip seal (right) significantly reduced steam seal leakage within the turbine of Northport Unit 3. *Courtesy: TurboCare Inc.*

Steam seal design is as much art as science. On Unit 3's turbine, the brush seals were analyzed over a wide range of operating conditions to determine the effect of wear on them. Good turbine design practice requires the HP rotor to withstand twice the expected destabilizing force from seals as the worst-case stability condition. Because the original seals did not meet this condition, the new seals incorporated three anti-swirl design features in the HP mid-span seal (N2 rings) and in stages 2 and 3 of the HP section. The new design now can withstand 2.3 times the worst-case destabilizing force. Overall, it was estimated that improved sealing alone was responsible for a 2.3-MW boost in capacity.

Perhaps the most significant lesson Ameren learned was the need to consider upgrade projects holistically and coordinate their execution with other planned plant changes.

Northport Unit 3 was returned to service in March 2005 with its heat rate lower by 465 Btu/kWh (net)—with 317 Bta/kWh being attributed to the turbine, even great than the predicted 257 Btu/kWh gain. Similarly, capacity was up 14.1 MW (gross)—more than triple the 4-MW gain predicted before the overhaul. Bottom line for KeySpan: This was a very successful overhaul, indeed. ■

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APPENDIX D – UNIT 2 TURBINE CONDITION ASSESSMENT REPORT

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Condition Assessment

LPA & LPB Turbine
L-1 Dovetail Attachments

Columbia Unit 2

Submitted to:
Alliant Energy Generating Station

April 2013

Condition Assessment

LPA and LPB Turbine
L-1 Dovetail Attachments

Alliant Energy Generating Station
Columbia Unit 2

Submitted to:
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SI Project Number 1201345.00

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Associate

April 2013

Signature & Review

Condition Assessment

LPA and LPB Turbine
L-1 Dovetail Attachments

Alliant Energy Generating Station
Columbia Unit 2

Written by: Date: April 2013

Clifford Lange / Associate

Reviewed by: Date: April 2013

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Approved by: Date: April 2013

Clifford Lange / Associate

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Condition Assessment

LPA and LPB Turbine
L-1 Dovetail Attachments

Alliant Energy Generating Station
Columbia Unit 2

Executive Summary

The L-1, L-2, and L-3 disk-side dovetail attachment rows on the turbine and generator ends of the Columbia Unit 2 LPA and LPB turbine rotors were inspected in April 2013 by Structural Integrity Associates using phased array inspection technology. The inspections detected crack-like indications in the dovetails on the L-1 stages of both LPA and LPB rotors. To assist Alliant Energy in assessing the service life of these rotors, defects identified as life-limiting are evaluated using the EPRI LPRimLife code to assess the potential for attachment failure with continued unit operation.

The analyses performed consist of probabilistic fracture mechanics based crack growth calculations that assume stress corrosion cracking is the dominate degradation mechanism. A review of the inspection data shows that the worst location of defect alignment and depth is in the LPA L-1 attachments. LPRimLife analyses of this location produce failure probabilities of 1% and 2.5% for 22,663 and 28,838 hours of operation respectively with the unit overspeed trip levels set at 105 percent. Longer operating intervals can be justified for the LPB rotor for the same probabilities of failure. Further reductions in failure probability can be realized through lowering of the unit overspeed trip level, reduced operating hours or proposed repair options.

1.0 Introduction

In January 2013 Alliant Energy contracted with Structural Integrity Associates, Inc. (SI) to perform phased array inspections of the L-1, L-2, and L-3 disk-side dovetail attachments rows on the LPA and LPB rotors of the Columbia Unit 2 Power Station. The results of those inspections are provided in SI report 1201345.401 and list significant indications in the dovetails on the L-1 stages of LPA and LPB. The goal of this project is to assess the remaining service life of the LPA and LPB L-1 dovetail attachments and assist Alliant Energy in selecting a suitable operating interval for these rotors.

Evaluations of the subject dovetails are performed using the EPRI LPRimLife code. LPRimLife performs fracture mechanics based life evaluations on disc attachments where stress corrosion cracking is the dominant damage mechanism. Stresses in the dovetail hook regions are determined by finite element analysis based on measurement of a Unit 2 L-1 blade provided by Alliant Energy.

The analyses performed during this project are based in large part on data provided by Alliant Energy. Because this data has not independently verified by SI, the results and conclusions presented in this report may change if any of this information is altered or found to be inappropriate for the Columbia Power Unit 2 LPA or LPB rotors.

An overview of the methodology used in the LPRimLife Code is provided in Section 2 with details of the rotor loads (stresses) and material data discussed in Section 3. Section 4 presents the attachment-specific stress analysis of the L-1 dovetails performed for the Unit 2 rotors. A summary of SI's inspection results is given in Section 5 and is used to define the matrix of indications selected for the life assessment calculations. The remaining life calculations are presented in Section 6. A summary of the work performed is given in Section 7.

2.0 LPRimLife Methodology

The LPRimLife code was developed by SI under EPRl sponsorship to provide the electric generating industry a tool for evaluating remaining lifetimes of LP rim-attachments experiencing SCC [1-4]. A flow diagram for the LPRimLife Code is shown in Figure 2-1, illustrating the use of dovetail geometry, loading, material properties and inspection data to predict rim attachment lifetimes. These parameters are discussed briefly in the remainder of this section and the definitions of specific values for the Unit 2 LP's at Columbia Unit 2 are detailed in Section 3.

2.1 Geometry/Stresses

Figure 2-2 is a photograph of typical dovetail cracking observed in the final stages of LP rotors. This photograph is useful in that it shows both the general geometry of a 'straddle-mount' attachment (the type applicable to Columbia's Unit 2 LP's), and the crack patterns produced by SCC. The stresses along these crack planes are obtained from finite element stress analyses of specific rim attachment geometries (See Section 4) and the results imported to LPRimLife. Alternatively pre-configured attachment geometries from the LPRimLife library can be applied. These library files represent GE straddle mount and Westinghouse axial-entry configurations from other units that include geometry and stress inputs. The geometry and loading data from these library files can be modified using scale factors within the program to include effects of over speed and rim attachment modifications (e.g. repair scenarios).

2.2 Material Properties

Two fundamental properties needed for the lifetime calculations are the crack initiation and crack growth laws. Details of each and an overview of the LPRimLife input parameters are discussed below.

2.2.1 Crack Initiation

Defect initiation via SCC in the phase transition zone (PTZ) is the result of complex interactions between chemical conditions of the steam, deposits and electrolytic films, passivity breakdown and nucleation of stable pits, pit propagation, pit repassivation, and transition from pits to cracks. Quantitative treatment of these processes is not resident within LPRimLife and time-to-initiation is a user input characterized using a cumulative probability distribution function (PDF). For deterministic calculations, cracks initiate at the average time (50 percentile) of the input distribution function. For probabilistic calculations, a Monte Carlo procedure is applied, selecting initiation times randomly from the PDF. In both analyses, the sizes of an initiated defect (both depth and length) are user inputs.

2.2.1 Crack Growth

In LPRimLife, SCC is identified as the dominant damage mechanism in dovetail cracking [5] and is modeled using the following equation;

$$\ln(da/dt) = C_1 - (7302/T) + 0.0278S_y \qquad (1)$$

where;

	da/dt	=	crack growth rate (inches/hour),
	C_1	=	constant (μ = -4.968; σ = 0.587),
	T	=	operating temperature °R (°F+460), and,
	S_y	=	disk material yield strength (ksi).

The dependency of SCC growth rates on temperature is characterized by the data plotted in Figure 2-3. Note that Figure 2-3 also shows that the crack growth rate is <u>independent</u> of the applied stress intensity (K_I, for $K_I > K_{1SCC}$) which is a function of the applied stress levels and crack geometry. The 1995 survey of LP rim-attachment cracking [6] showed that this equation provides a reasonable representation of crack growth rates in disk rim attachments.

The parameters C_1 (μ & σ), T and S_y are inputs to the LPRimLife and are used to define the SCC growth rate for the LP rim attachment under consideration.

2.2.2 SCC Threshold

Laboratory test results [7] shown in Figure 2-3 indicate a stress intensity factor threshold (K_{1SCC}) in the range of 10 to 20 MPa√m (9.1 to 18.2 ksi√inch) before the plateau region defined by Equation 1 is reached. As crack growth in the dovetail region progresses, and loads redistribute, the applied stress intensity factor may drop below the threshold and growth will cease. This threshold effect becomes influential in stages with smaller blades and consequently lower rim loading. In these stages the likelihood of cracks propagating after initiation is very low because a minimum K_1 value of 10 ksi√inch is needed to overcome threshold effects.

2.3 Inspection Data

Inspection data is collected using several different techniques including eddy current, linear phased array and magnetic particle. All of these techniques require that the signals or raw data from each method be analyzed and reduced to crack depth and lengths at specific rim locations (e.g. top, middle or bottom hooks) for use in LPRimLife.

2.4 Failure Criterion

As shown in Figure 2-1, there are three failure criteria used in LPRimLife to assess attachment life; brittle fracture, stress overload, and user defined maximum crack depth. A brief discussion of each mode follows.

2.4.1 Brittle fracture

LPRimLife uses a semi-elliptic surface-connected crack model to determine defect stress intensity as a function of applied stress, defect depth, and defect length. A schematic of this crack model is shown in Figure 2-4. Brittle fracture occurs when the applied stress intensity factor (K_I) exceeds the fracture toughness (K_{IC}) of the material. Fracture toughness is a temperature-dependent material property that increases significantly at temperatures above the Fracture Appearance Transition Temperature (FATT). Default fracture toughness data versus excess temperature (T-FATT) for 3.5NiCrMoV rotor steels configured in LPRimLife is shown in Figure 2-5.

2.4.2 Overload

Overload occurs when the remaining ligament of a cracked attachment hook is loaded beyond the material's plastic limit. For rectangular cross-sections and assuming a Von Mises flow rule, the net-section ligament stress is calculated using a limit-load approach [8].

$$(S_m)^2 + (S_b/1.5)^2 + (2\tau)^2 = (S_f)^2 \qquad (2)$$

In Equation 2, S_m, S_b and τ are the membrane, bending and shear stress components, respectively, acting on the remaining hook ligament. The material flow stress, S_f, is the average of the yield and tensile strength, and represents the material's plastic limit. The factor of 1.5 in Equation 2 is included to account for the limit load capacity of a fully-plastic rectangular section in bending.

2.4.3 User Defined Maximum Depth

If a user-specified maximum crack depth is reached then failure is predicted (this feature was not used for the Columbia Unit 2 LP calculations).

2.5 Remaining Lifetime Calculations

The sequential elements of the LPRimLife lifetime calculations, shown schematically in Figure 2-1, employ the following steps.

1. Estimate initiation time (if cracking was not detected)

2. Calculate growth of initiated and detected cracks due to SCC, checking for failure in each hook during the crack growth analysis.
3. Failure of a hook causes the load carried by that hook to be redistributed to the remaining hooks and the crack growth calculations continue for those hooks with increased loads.
4. Remaining life is the sum of initiation time (if applicable) and time to reach critical size for the last hook to fail. The crack growth portion of the remaining life in LPRimLife is determined using the following equation:

$$t_{rem} = \frac{a_{cr} - a_i}{da/dt} \tag{3}$$

where, t_{rem} is remaining life, a_{cr} is critical crack size, a_i is initial or detected crack size and da/dt is the crack growth rate.

It should be noted that in LPRimLife the crack growth rate determined is constant for a constant operating temperature (per Equation 1) and typically does not change when load redistribution occurs.

When performing deterministic analyses, average values of the input parameters are used in the calculations and a single value for the remaining lifetime is produced for each indication. Safety factors or risk levels are then inferred by comparing the desired operating time with the calculated remaining lifetime.

For probabilistic evaluations, the calculation sequence listed above is repeated many times (simulations, a user input) and the calculated lifetimes compared against a target lifetime. Calculated lifetimes that do not exceed the target are recorded as fails. After all trials are completed, the failure probability for that target lifetime is the number of fails divided by the total number of trials performed. The calculations are performed over a range of target lifetimes (a user input) and plots of failure probability versus time produced.

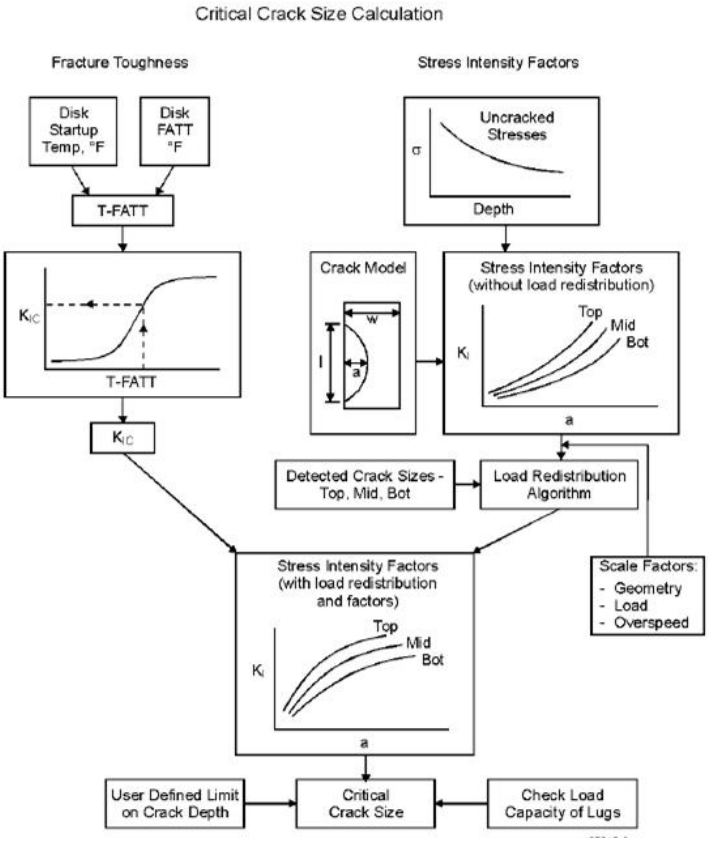


Figure 2-1: Flow diagram for LPRimLife methodology

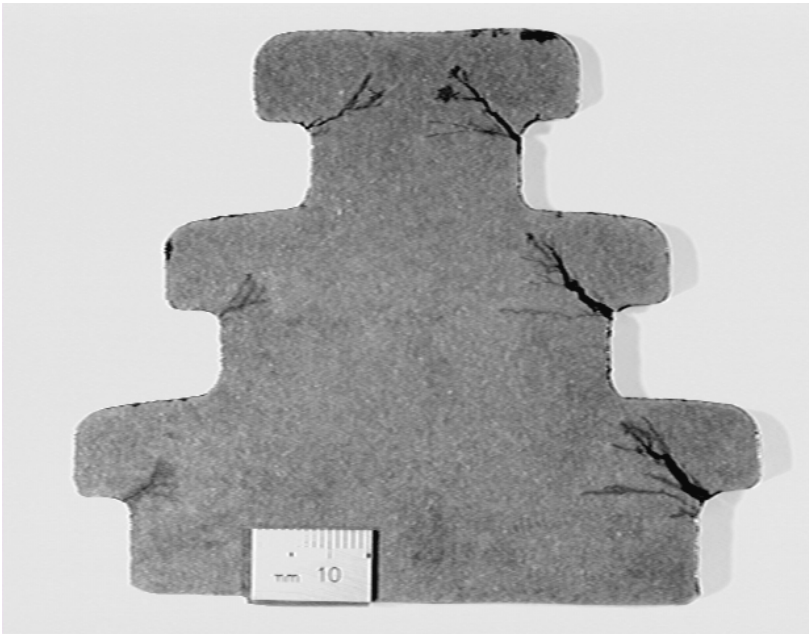


Figure 2-2: Typical dovetail cracking in LP turbines, straddle-mount configuration.

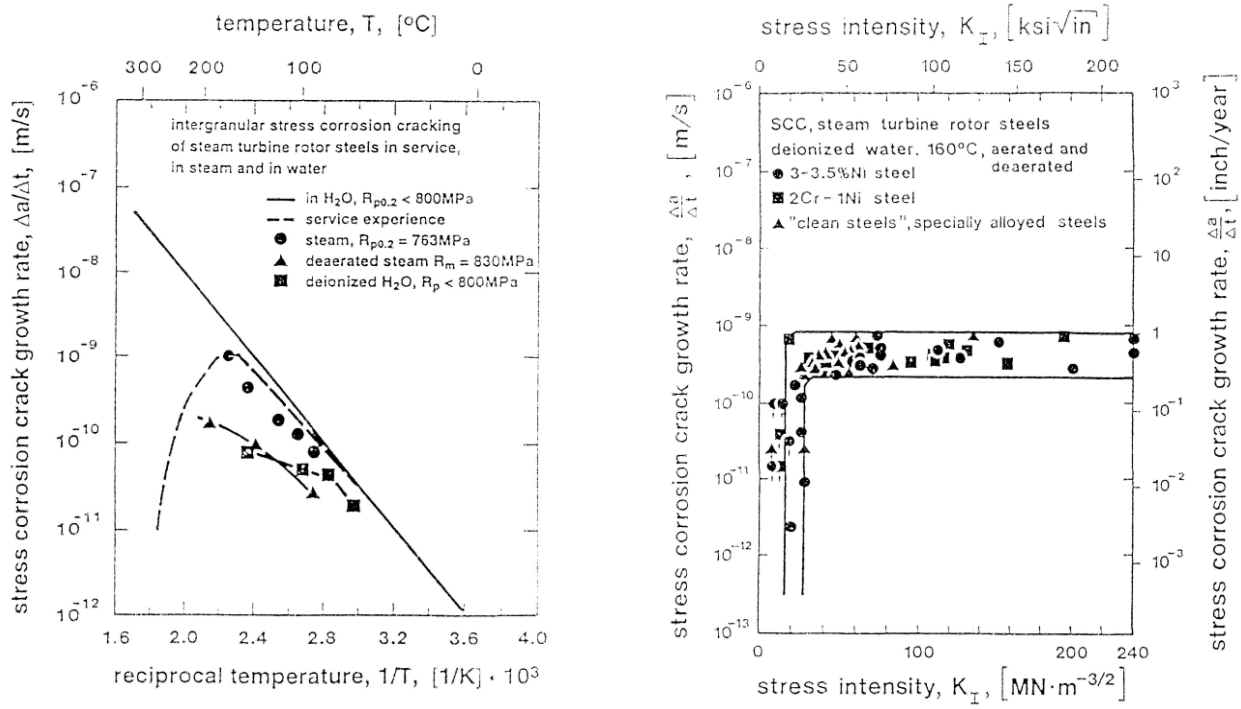


Figure 2-3: SCC crack growth data.

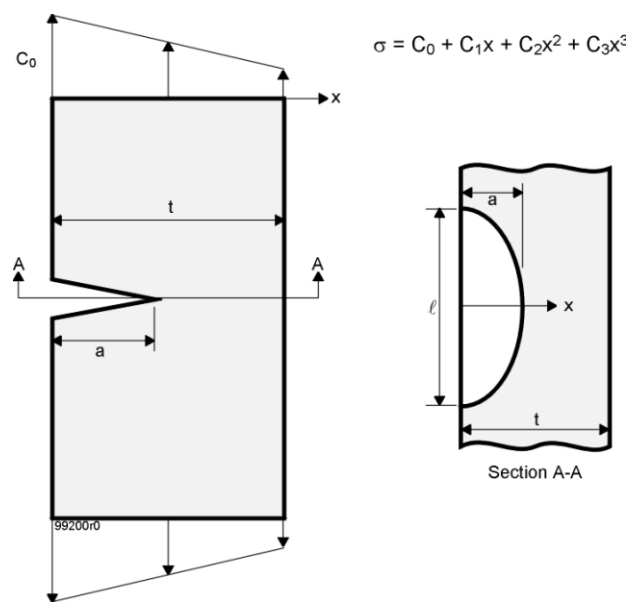


Figure 2-4: Semi-elliptic surface-connected crack model used to compute stress intensity factors.

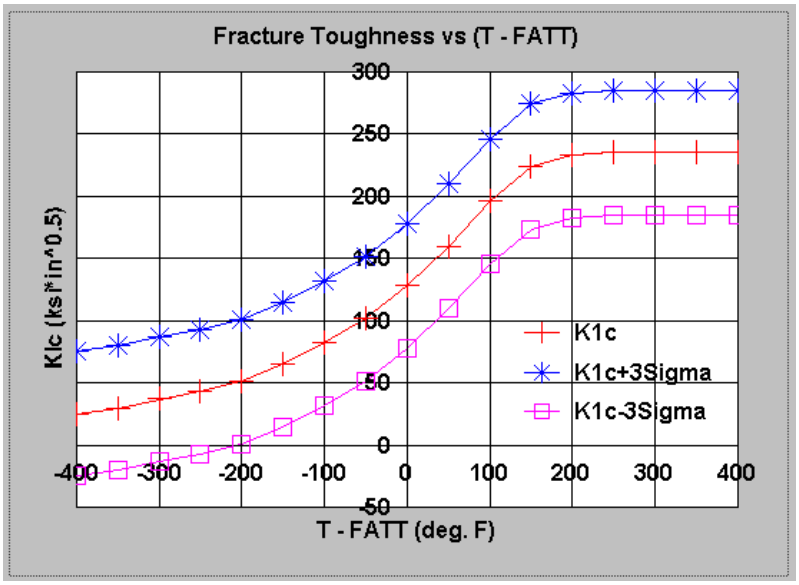


Figure 2-5 Default fracture toughness data for 3.5NiCrMoV rotor steels in LPRimLife.

3.0 Rotor-Specific Load and Material Data

In this section the specific values for load/stresses and material data used to perform the remaining life calculations for the Columbia Unit 2 LP's are discussed. For those inputs treated as random variables in the probabilistic analyses, appropriate levels of uncertainty are assigned in the form of a normal distribution with mean and standard deviation. References are provided when available to document the sources of each parameter.

3.1 Load Related Inputs

The primary loading in the rim attachments is the angular velocity (RPM) and the temperature of the dovetail region. As indicated in Section 2, finite element (FE) stress analyses of the Unit 2 L-1 attachments are used to characterize the stress distribution associated with each attachment hook as a function of angular velocity. The details of the analyses performed for each attachment row is provided in Section 4. This section describes the user-selected factors in LPRimLife to account for load variations due to bucket position (e.g. notch proximity) and overspeed conditions. Details of the temperature inputs for start-up and steady state operation are also discussed.

3.1.1 Load Scale Factor

The load scale factor is a random variable used to uniformly scale the stress distributions assigned to each crack plane in the top, middle and bottom attachment hooks. The most common application of the load scale factor is to model increased load (stress) applied to attachment hooks that carry buckets adjacent to the notch region. For a notch-bucket, the applied load is assumed to be equally shared by two adjacent buckets and a load scale factor of 1.5 would be used, assuming consistent materials between notch and non-notch blades.

For the Columbia Unit 2 rotors none of the recorded indications are located near the notch region and therefore it is not necessary to make use of the Load Scale Factor. No variability is included in the near-notch load effect. At all other bucket locations a load scale factor of 1.0 is used with a 10 percent standard deviation.

3.1.2 Overspeed Factor

Overspeed testing records provided by Alliant Energy for the Columbia Unit 2 Station [9] indicate that the average overspeed test is performed at 109 percent, or 3924 rpm. In the analyses performed, overspeed is conservatively treated as a random variable with a mean value of 110 percent with a standard deviation of 1 percent. Subsequent evaluations are performed using alternate overspeed settings of 100 and 105 percent.

3.1.3 Startup Temperature

The startup temperature is conservatively set at room temperature (70°F) with zero standard deviation. Actual dovetail metal temperatures during startup are expected to be higher than 70°F by the time the rotor reaches rated speed. For evaluation of the Columbia LP's this input is inconsequential since the rotor material fracture toughness has been assumed to be independent of temperature, See Section 3.2.2.

3.1.4 Steady-State Temperature

The steady state temperature is an important LPRimLife input parameter as it directly influences the *da/dt* crack growth rates (see Eqn. 1) used in the lifetime calculations. A transient thermal analysis is performed of the Columbia Station LP rotors using the SAFER Code [10] to determine the steady state operating temperature of the L-1 wheel dovetails. The LP rotor is a dual-flow design with seven (7) stages on each side of the inlet flow region. The SAFER analysis takes advantage of this symmetry assuming that the flow conditions through each side of the turbine are identical making it necessary to model only 1 side of the LP rotor.

Dimensional data is obtained from SI who compiled a detailed set of as measured dimensions for both the LPA and LPB rotors [11, 12, 13]. Comparisons of these measurements show no appreciable differences between the two rotors that would need to be included in the thermal analyses so that the results from a single model can be used for both rotors. A schematic of the LP rotor showing all pertinent dimensions created from this data is shown in Figure 3-1. The blade weight calculations are summarized in Table 3-1 and the SAFER-PC Finite Element (FE) model based on the provided dimensions is shown in Figure 3-2.

For the thermal analysis using SAFER-PC, steady state steam temperature and pressure conditions at the inlet and outlet of the rotor are obtained from the rotor heat balance diagrams [14]. A conservative idealization of a cold start transient required for input to the SAFER code is shown in Figure 3-3.

The steady state operating temperature profile calculated by SAFER-PC with the temperature of the L-1 stage identified is shown in Figure 3-4. Comparisons of this temperature with steam temperature data at extraction points located in the rotor [15] show that these data are consistent with each other and a conservative estimate of blade steady state operating temperature of 197.6°F is used for the lifetime calculations. A standard deviation of 10°F is used to include uncertainty in the temperature estimate.

3.2 Material Related Inputs

The material properties used in LPRimLife can be segregated into tensile properties and those associated with the fracture mechanics aspect of the lifetime calculations. The tensile properties (S_y and S_{ult}) are important when the dominate failure mode is stress overload as their relative values determine the material's plastic limit (e.g. flow stress, S_f). In addition, the yield stress directly influences the crack growth rate per Equation 1. The fracture mechanics properties include the crack initiation, crack growth and fracture toughness. Values utilized for these inputs are discussed below.

3.2.1 Yield and Ultimate Strength

Rotor-specific yield and ultimate strength data for the Columbia Unit 2 LP's is not available for this analysis. However, hardness measurements collected on the L-1 disks from LPA rotor [16] following the phased array inspection activity is used to provide reasonable estimates of these material properties. The average of all measurements taken is a Rockwell C Hardness of 30.0. Using published conversions [17] the Rockwell C hardness values translate to ultimate and yield strength values of 140 ksi and 109 ksi respectively. The corresponding standard deviations for each of these parameters are 18.1 ksi and 14.2 ksi respectively also based on the published data in [17].

3.2.2 Fracture Toughness and FATT

As discussed in Section 2.4.1, fracture toughness is a temperature-dependent material property that increases significantly at temperatures above the Fracture Appearance Transition Temperature (FATT). In this analysis FATT and K_{IC} data for the subject rotors were obtained from Reference [18]. This study presents data for a wide range of manufacturing procedures and chemical compositions. For 3.5NiCrMoV rotor steel an FATT in the range of 0 to -60°C for yield strengths of 100 ksi were reported. Corresponding plots of fracture toughness versus excess temperature (similar to Figure 2.5) showed fracture toughness values in excess of 200 ksi√in at operating temperatures of 200°F. To ensure sufficient conservatism for application to the Columbia rotors the fracture toughness of each LP was assumed to be independent of temperature with a mean value of 100 ksi√in and standard deviation 17.5 ksi√in.

3.2.3 SCC Initiation Time

For those attachment locations with no reportable indications, an algorithm is used in LPRimLife to simulate the potential for flaw initiation as a function of unit operating time. For this evaluation the initiation probability density function used ranges from 0 to 18,000 hrs with a mean value (50% probability of initiation) at 8760 hours, Figure 3-5. This distribution of

initiation times introduces cracks into the lifetime calculations in those attachments that do not have indications assigned to them at the beginning of the analyses (t equal zero).

It should be recognized that LP attachment life from SCC is predominately initiation-driven. This is the result of the SCC growth rates predicted; since once cracking begins it progresses (for stresses above threshold which at the attachments are the norm) at a constant rate which proves to be relatively fast. Therefore, if cracking does not occur, then operation can continue indefinitely.

3.2.4 SCC Growth Rate

The SCC growth rate relationship described in Section 2.1.1, Equation 1, is used with the appropriate values for operating temperature (197°F –Section 3.1.4) and yield stress (109 ksi – Section 3.2.1) to give a mean *da/dt* crack growth rates of approximately 0.016 in/year for L-1. Variability in this value will be influenced by the standard deviations of C_1, operating temperature, T, and the yield stress, S_y.

3.2.5 SCC Growth Threshold

The threshold stress intensity factor K_{1SCC} used in the analyses of each stage was set to a mean value of 10 ksi√in with a standard deviation of 3 ksi√in. These values are consistent with the SCC data shown in Figure 2.3 for LP rotor steels.

Table 3-1: Summary of Blade Weight Data

Stage	Radius to Blade Base (in.)	Airfoil Length (in.)	Blade Width (in.)		Mass Factor	Row Weight (lb.)
			Base	Tip		
L6	26.0	3.0	1.5	1.4	0.45	96
L5	26.0	4.0	1.5	1.2	0.45	121
L4	26.0	5.0	2.0	1.3	0.40	167
L3	26.0	7.0	3.0	1.6	0.40	338
L2	26.0	11.0	3.5	1.5	0.35	539
L1	25.0	16.5	5.0	1.5	0.30	951
L0	26.0	26.0	6.0	1.6	0.25	1713

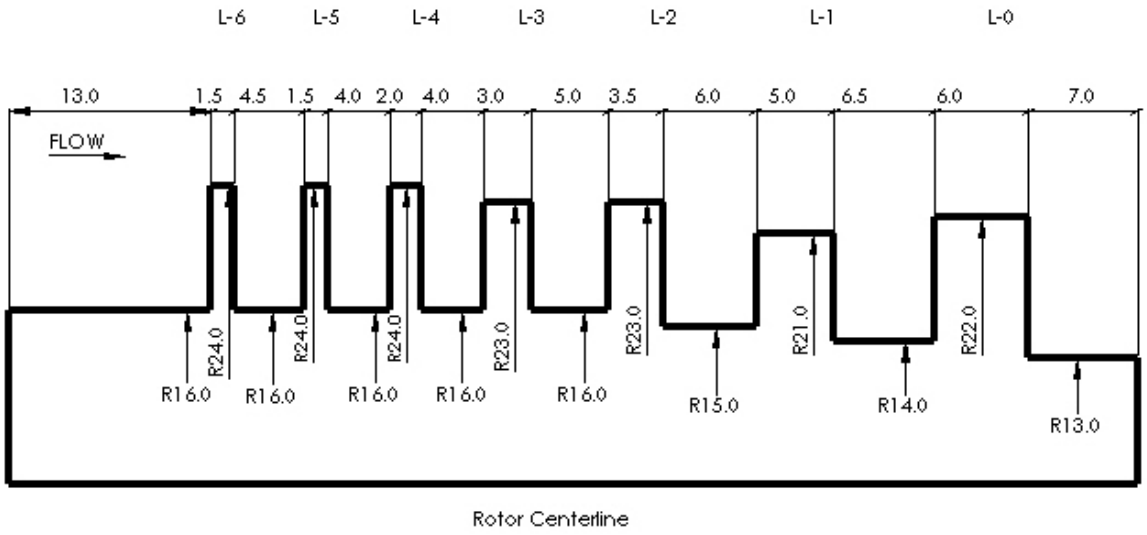


Figure 3-1: Schematic of Columbia LP Section with Dimensions (in inches)

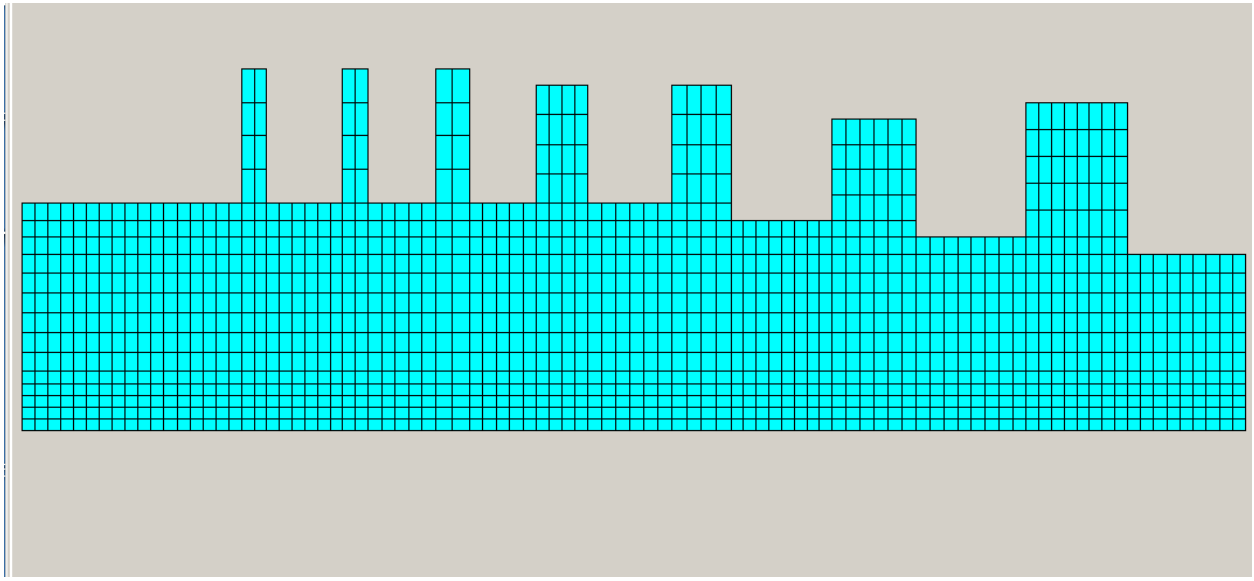


Figure 3-2: Columbia LP Rotor SAFER-PC Finite Element Model

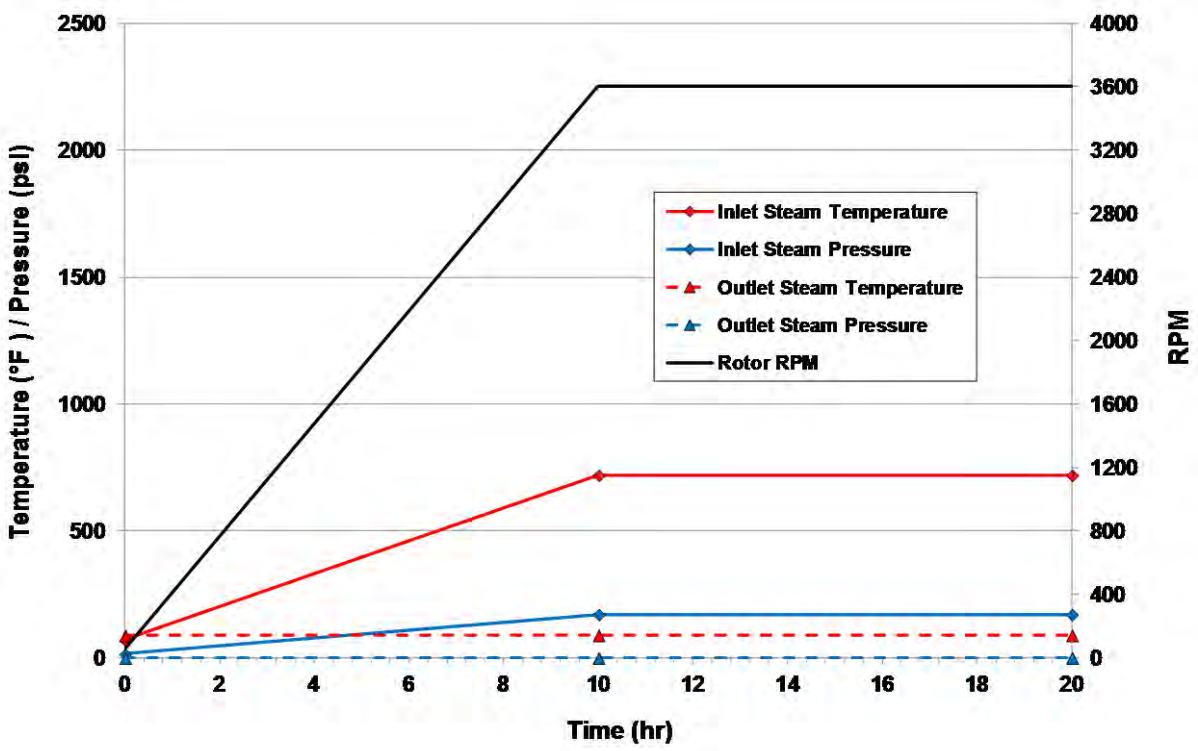


Figure 3-3: Idealized Steam Temperature and Pressure Cold Startup Conditions used in SAFER Transient Thermal Stress Analysis

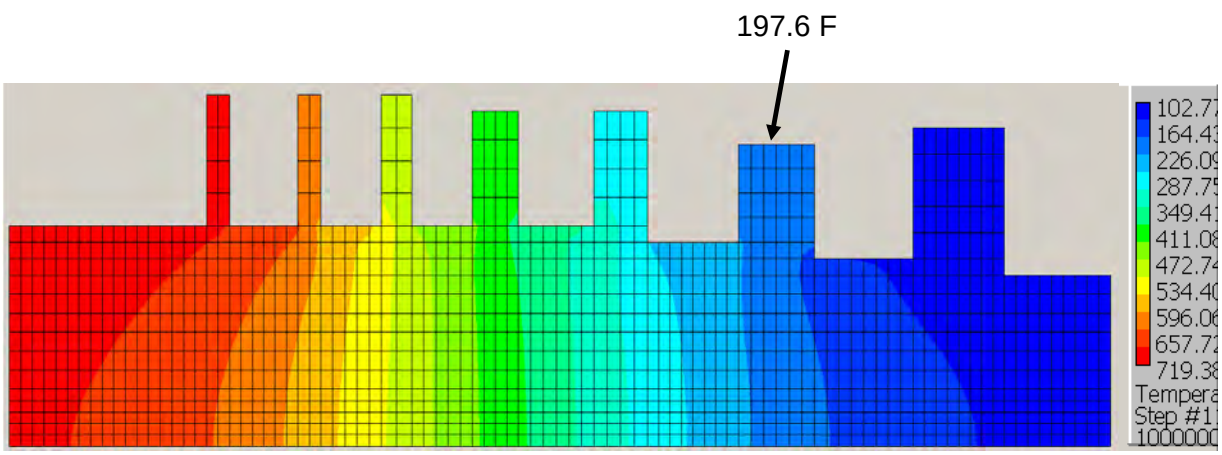


Figure 3-4: Contour Plot Showing the distribution of Metal Temperatures in the LP Section at Steady State

Figure 3-5: Assumed Distribution used to Represent the Potential SCC Initiation

4.0 Dovetail Finite Element Analysis

To determine the stress distributions associated with each attachment hook a finite element stress analysis of the L-1 disc-side attachments is performed. The analysis is performed using the ANSYS v11.0 [19] finite element code based on dimensions of blade-side dovetail profiles shown in Figure 4-1. These dimensions are obtained by direct measurement of a L-1 blade made available to SI by Alliant Energy.

Modeling the attachment is accomplished in ANSYS using Plane 42 elements. This is an 4-node element with two degrees of freedom per node: translations in the nodal x and y directions. In this application the element is used in an axi-symmetric formulation with modeling spanning from the rotor centerline radially outward to the outer edge of the attachment (Figure 4-2). Each model includes the blade-side attachment with contact and friction elements simulating the interaction between the dovetail hooks and blade, but does not include the blade airfoil. Two load-cases are analyzed as described below:

1. The disc-side rotor dovetail is subject to a rotational velocity of 376.992 radians/sec, simulating operation at 3600 rpm. This load case is performed without blade contribution to determine the disc-side response to centrifugal loads.

$$\text{Omega\_Global Y} = \left(2 * \pi * \frac{RPM}{60}\right) = 376.992 \text{ radians/sec}$$

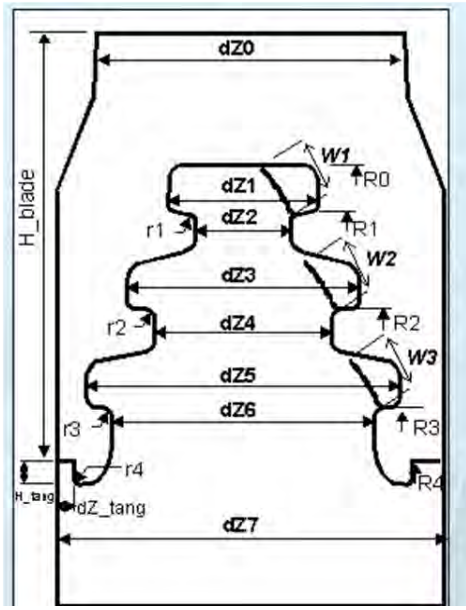
   The normal stresses along the assumed crack planes from each attachment hook are extracted and retained for summation with load case #2.

2. The contribution of the blade forces applied to the dovetails is determined using the entire model. The blade traction force is modeled as pressure load applied at the end of the modeled blade section, illustrated in Figure 4-3. The applied pressure is calculated as a function of applied rim load:

$$\text{Blade Pressure Load} = \frac{Rim\_Load}{\left(2 * \pi * R_{BLD} * Ax\_Width\right)}$$

   Where: *Rim_Load* is the centrifugal load of the blades calculated as the stage blade weight, W, multiplied by R_{CM}, the distance from the blade center of mass to the neutral axis of the rotor as shown in Figure 4-3. *Ax_Width* is the axial width (admission-to-discharge face) of the modeled blade end and R_{BLD} is the radial distance from the rotor centerline to the end of the modeled blade section.

Figure 4-4 shows the locations of the assumed crack planes, along which stresses are extracted. The sum of the normal stresses from each load case (Blade Traction Force Load-Case + Angular Velocity Load-Case) are used in the LPRimLife analysis to calculate stress intensity versus crack size and net-section dovetail stresses used in the life calculations. Plots of the combined stresses for each hook are shown in Figure 4-4 for the L-1 attachment.



dZ0	3.300
dZ1	1.750
dZ2	1.000
dZ3	2.688
dZ4	2.000
dZ5	3.688
dZ6	3.000
dZ7	4.750
H_blade	4.400
H_tang	0.250
dZ_tang	0.563

R0	24.250
R1	23.625
R2	22.538
R3	21.311
R4	20.750
r1	0.080
r2	0.080
r3	0.080
r4	0.080

Figure 4-1: Dimensional drawing and reference data for the Columbia Unit 2 LPA/LPB L-1 dovetail geometry.

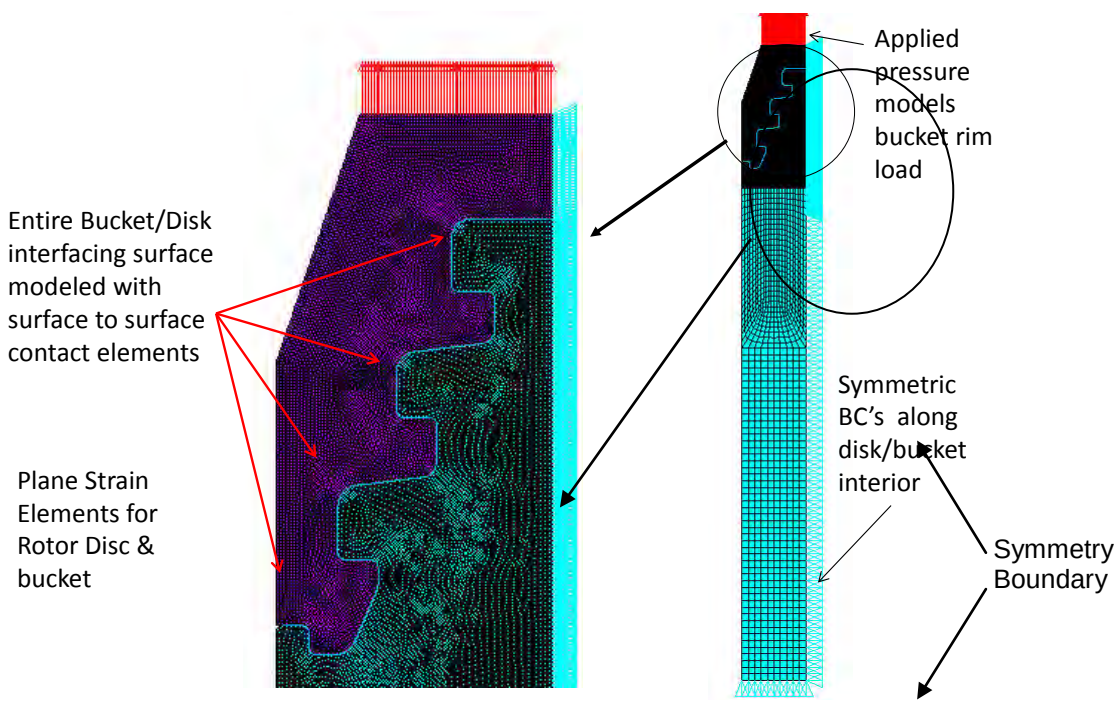


Figure 4-2: Finite element model of the L-1 attachment showing boundary conditions and applied loads.

Blade c.g.	As measured (in)	6.9375
Rad. to Blade c.g. (in)	R_tang + Blade c.g.	27.6875
Blade weight (lbs)	As measured (lbs)	12
# of blades	83	83
Total Blade Wt. (lbs), W	# blades * Blade wt	996
RPM	3600	3600
Omega (rad/sec)	RPM*2*pie/60	376.99
Rim Load (kips) =	W/g *Rcg*Omega^2	**10154**
FEA Pressure (ksi)	Rim Load/(2*pie*R*t)	**19.279**

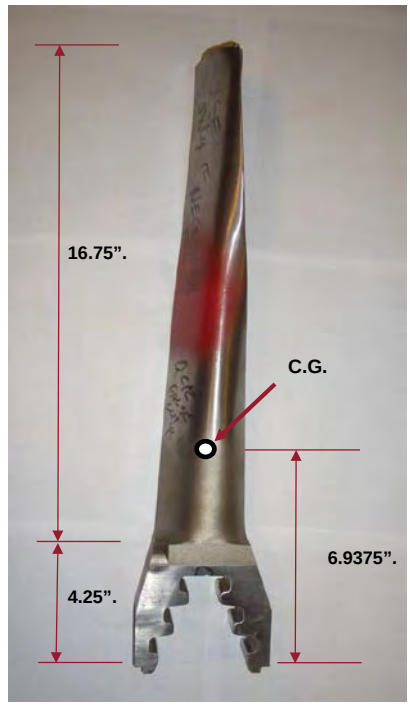


Figure 4-3: Photograph and L-1 dimensional data for rim load calculations.

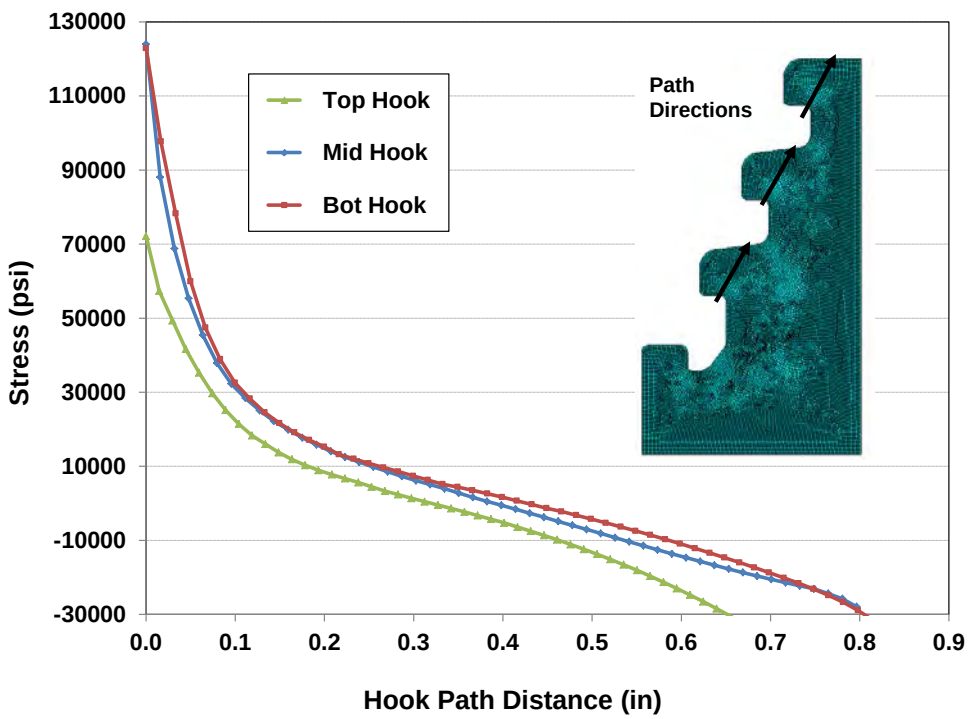


Figure 4-4: Normal stress versus distance along the assumed crack planes for the top, middle and bottom hooks of the L-1 dovetail attachment at 3600 rpm.

5.0 Inspection Data Evaluation

Structural Integrity Associates performed a volumetric "Phased Array" ultrasonic inspection of the dovetail regions of the C LPA & LPB rotors in April 2013. The results of that inspection are documented in Reference [20] and reported crack-like indications in the L-1 dovetail attachments of both LPA and LPB turbine rotors as listed in Table 5-1.

Table 5-1: Columbia Unit 2 LPA/LPB Inspection Summary

Rotor	Stage	Number of 'Crack-Like' Indications	Maximum Reported Depth (in.)
LPA	L-1	21	0.26
	L-2	0	
	L-3	0	
LPB	L-1	11	0.18
	L-2	0	
	L-3	0	

Further interrogation of the inspection data was performed to identify those locations that would be "life-limiting" for each rotor. To this end, a visual comparison of indication characterization (pitting or crack-like, and extent), circumferential position (distance along the scan path), hook position (top, mid, bottom) and attachment orientation (admission or discharge) is performed. Tables 5-2 and 5-3 identify the most critical defect locations for the LPA and LPB rotors respectively. Each table shows the critical location for each side (Admission/Discharge) of both L-1 disks (TE & GE).

On the LPA rotors, flaws 12 and 24 are locations where aligned indications are present in multiple hooks. Since flaw 24 is also the deepest flaw on both L-1 stages these stacked defects will be the life limiting location for the LPA rotor. All other defect locations are on single hooks and cracks will not grow in the remaining hooks until the initiation routine in LPRimLife initiates cracks in those locations consistent with the crack initiation model described in Section 3.2.3. Since the LPB rotor has no stacked defects the limiting lifetime will be controlled by the deepest flaw location and will be somewhat longer than the limiting flaw on the LPA rotor. This highlights the importance initiation time plays in predicting attachment failure.

Each of the flaws identified in Tables 5-2 and 5-3 were evaluated using LPRimLife to establish the potential for attachment failure in each rotor. The results of these calculations are presented in the following section.

Table 5-2: Potential Life-Limiting Defect Areas, LPA

Rotor	Defect ID	Location	Defect ID*	Hook ID	Indication Size (in)		Notch Effect
					Depth	Length	
LPA	Generator End	Discharge Side	12 & 24	Lower	0.13	0.62	No
				Middle	0.26	2.80	No
				Upper	-	-	No
		Admission Side	32	Lower	0.22	0.40	No
				Middle	-	-	No
				Upper	-	-	No
	Turbine End	Discharge Side	56	Lower	0.18	0.90	No
				Middle	-	-	No
				Upper	-	-	No
		Admission Side	64	Lower	0.18	0.70	No
				Middle	-	-	No
				Upper	-	-	No

Table 5-3: Potential Life-Limiting Defect Areas, LPB

Rotor	Defect ID	Location	Defect ID*	Hook ID	Indication Size (in)		Notch Effect
					Depth	Length	
LPB	Generator End	Discharge Side	36	Lower	-	-	No
				Middle	0.18	0.60	No
				Upper	-	-	No
		Admission Side	41	Lower	-	-	No
				Middle	0.12	0.40	No
				Upper	-	-	No
	Turbine End	Discharge Side	7	Lower	-	-	No
				Middle	0.15	0.50	No
				Upper	-	-	No
		Admission Side	No Crack-like Indications	Lower	-	-	No
				Middle	-	-	No
				Upper	-	-	No

6.0 Remaining Life Evaluation

To assess the potential for dovetail attachment failure with continued operation of each rotor, deterministic and probabilistic crack growth calculations are performed using the LPRimLife code. The rotor-specific inputs for these calculations discussed in Section 3 are applied in combination with the flaw regions identified in Section 5. Calculations are performed for each flaw with the results summarized in Tables 6-1 and 6-2. In both tables operating hours are converted to years assuming 8000 operating hours/year. Historical operating data provided by Alliant Energy [21] shows that over the past 22 years the Columbia Unit 2 station has averaged 7800 operating hours /year.

In the deterministic calculations the mean value of each input is used to perform the life calculation a single time. Therefore, these results represent the 50th percentile of expected time to failure. For the probabilistic calculations, a Monte Carlo procedure is applied wherein each input variable is selected 'randomly' at the start of each simulation based on its specified mean and standard deviation. For the Columbia calculations 50,000 simulations are performed evaluating each flaw, therefore, the lowest probability of failure that could be determined from this analysis is 1 in 50,000 or approximately 0.002 percent. A summary of the statistical parameters for all random variables used in the probabilistic calculations is summarized in Table 6-3.

For all results, it is noted that in the evaluation of each flaw if a hook does not have a crack at the start of the analysis (time t=0) then the initiation potential curve discussed in Section 3 will be applied. Specifically, any hook without a defect at t=0 would be assumed to have cracking present (initiation potential of 100 percent) after 18,000 hours of simulated operation.

The stacked defects 12 and 24 on the LPA rotor (Table 6-1) are the limiting location for both rotors. To further understand different operating scenarios and associated risk levels additional deterministic and probabilistic LPRimLife evaluations are completed for this location. Specifically, overspeed levels of 0, 5 and 10 percent are applied. Recall that overspeed level effects blade rim loads which define the critical crack size in each hook for determining failure from a fracture mechanics perspective, and the level of tensile/shear stresses in each hook that define hook limit-load failure. Also operating lifetimes associated with a 2.5% failure probability are calculated. All of these results are summarized in Table 6-4.

Graphical representations of these results are provided in Figure 6-1. The cumulative probability of failure as a function of accumulated operating time (since the units return to service following

the 2013 inspection) for the three overspeed conditions are shown. This figure shows the resulting failure probabilities for increasing operating times

Table 6-1: Probability of Failure Results Summary - Unit 2 LPA

Defect ID	Hook ID	Indication Size (in)		Notch Effect	Deterministic Lifetime Hours/Years*	Probabilistic Lifetime @ 1% Hours/Years*
		Depth	Length			
12 & 24	Lower	0.13	0.62	No	82,200 / 10.26	18,770 / 2.35
	Middle	0.26	2.80	No		
	Upper	-	-	No		
32	Lower	0.22	0.40	No	94,000 / 11.75	29,095 / 3.64
	Middle	-	-	No		
	Upper	-	-	No		
56	Lower	0.18	0.90	No	98,600 / 12.33	29,140 / 3.64
	Middle	-	-	No		
	Upper	-	-	No		
64	Lower	0.18	0.70	No	98,600 / 12.33	29,140 / 3.64
	Middle	-	-	No		
	Upper	-	-	No		

Table 6-2: Probability of Failure Results Summary - Unit 2 LPB

Defect ID	Hook ID	Indication Size (in)		Notch Effect	Deterministic Lifetime Hours/Years	Probabilistic Lifetime @ 1% Hours/Years
		Depth	Length			
36	Lower	-	-	No	115,500 / 14.44	32,862 / 4.11
	Middle	0.18	0.60	No		
	Upper	-	-	No		
41	Lower	-	-	No	125,800 / 15.73	34,952 / 4.37
	Middle	0.12	0.40	No		
	Upper	-	-	No		
7	Lower	-	-	No	121,600 / 15.20	33,846 / 4.23
	Middle	0.15	0.50	No		
	Upper	-	-	No		
No Crack-like Indications	Lower	-	-	No	- / -	- / -
	Middle	-	-	No		
	Upper	-	-	No		

Table 6-3: Statistical Parameters of the LPRimLife Random Variables

LPRimLife Variable		LPA & LPB	
		μ	σ
Load Scale Factor		1.0	0.025
Overspeed		1.1	0.005
Startup Temp		70	0
Steady State Temp		197.6	10
Crack Depth	Top	0.02	0.02
	Middle	0.26	0.03
	Bottom	0.13	0.03
Crack Length	Top	0.05	0.01
	Middle	2.80	0.05
	Bottom	0.62	0.05
Yield Strength (ksi)		109.0	14.5
Ultimate Stress (ksi)		142.0	18.1
FATT (deg F)		0	0
K1c		110	17.5
Initiation Time yrs		0 (min)	2 (max)
SCC Rate, log(C1)		-4.968	0.587
K1C SCC Threshold		10	3

Table 6-4: Probability of Failure Results Summary - Unit 2 LPA

Defect ID	Hook ID	Indication Size (in)		Over speed	Deterministic Lifetime	Probabilistic Lifetime (Hours / Years*)	
		Depth	Length	(%)	(Hours / Years*)	1% Failure Probability	2.5% Failure Probability
12 & 24	Lower	0.13	0.62	10	82,200 / 10.26	18,770 / 2.35	24,387 / 3.05
	Middle	0.26	2.80				
	Upper	-	-				
12 & 24	Lower	0.13	0.62	5	93,700 / 11.71	22,663 / 2.83	28,838 / 3.60
	Middle	0.26	2.80				
	Upper	-	-				
12 & 24	Lower	0.13	0.62	0	105,000 / 13.13	26,081 / 3.26	32,951 / 4.12
	Middle	0.26	2.80				
	Upper	-	-				

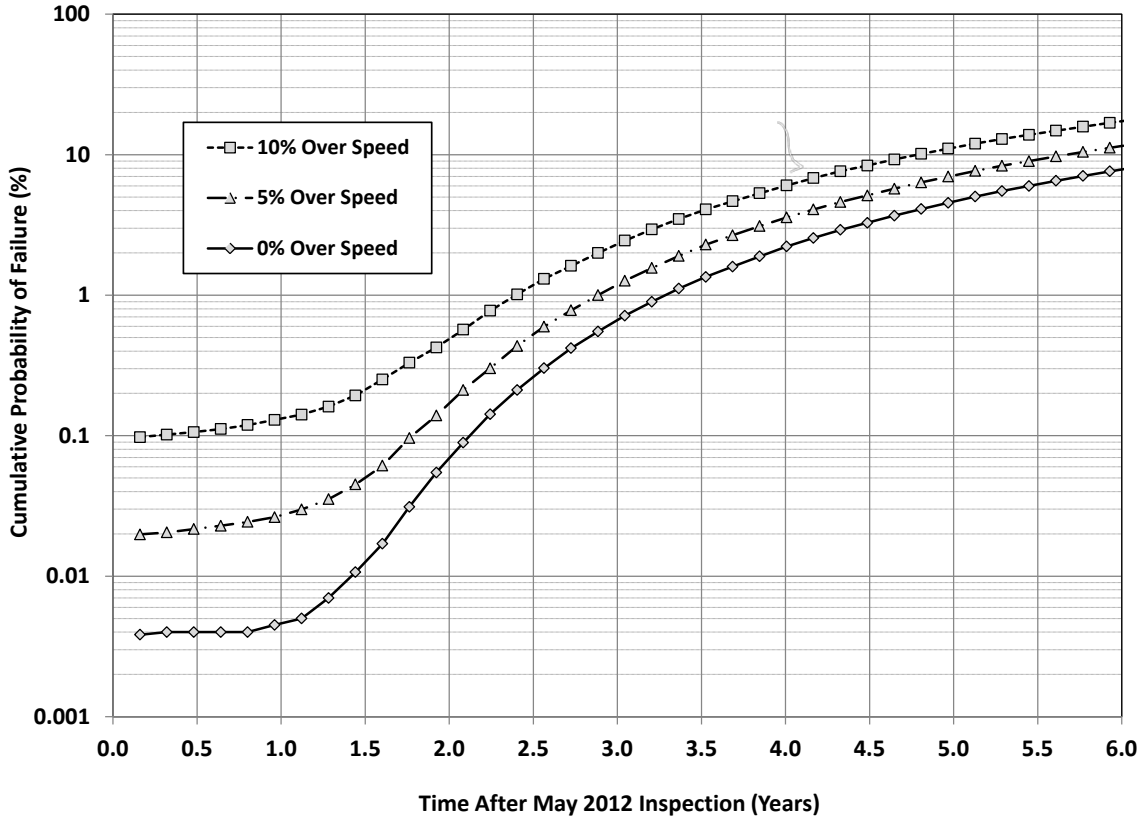


Figure 6-1: Cumulative probability of failure versus operating time results for LPA L-1 and L-2 attachments for 5-percent overspeed trip level.

7.0 Proposed Repair Remaining Life Evaluation

Alliant Energy has requested that SI evaluate a repair option that involves removal of a single blade at the stacked defect location. This type of repair reduces the stresses acting on the disk attachment hooks at this location on the L-1 stage resulting in longer lifetime estimates. The analysis of the repair requires that a revised rim blade load be calculated, the hook stress distributions be updated and additional LPRimLife evaluations be completed to demonstrate the effectiveness of the repair. As this repair leaves only single hook defect geometries, these single defect locations will need to be evaluated in LPRimLife to establish the most limiting lifetime for the rotor. Additionally Alliant Energy will need to complete an identical repair to the blade diametrically opposite the stacked defect location to maintain proper rotor balance.

The proposed repair involves the removal of the airfoil portion of the blade leaving the base of the blade intact to serve as a spacer for the remaining blades on the disk. Figure 7-1 shows the revised rim load calculations. To simplify the calculations it is assumed that only that portion of the airfoil outboard of the center of gravity (C.G.) is removed. This assumption permits easy calculation of a revised C.G. and reduced blade weight as shown in Figure 7-1. The reduced rim load due to the centrifugal force of the reduced blade mass is 43.7% of the original rim load calculation shown in Figure 4-3. The resulting attachment hook stress profiles calculated via finite elements for the L-1 blades (see Figure 4-4) are reduced by 43.7 % and used in the LPRimLife program to calculate attachment lifetime for the repair location.

This analysis is considered to be very conservative. The removed blade airfoil is likely to include more mass that that assumed removed with the assumption of the cut made at the blade C.G. Therefore the total mass will be less than that assumed as well as the distance to the C.G. resulting in a higher load than that resulting from the repair.

The results are shown in Table 7-1 and show that the stacked defect location when subjected to reduced loads from the repair has a lifetime of 8.62 years for a 1% failure probability of blade attachments. Additionally the LPRimLife evaluation of the remaining single defect #24 which at 2.80 inches long extends into the adjacent blade has lifetimes of 3.47 years and 3.92 years for a 1% failure probability of blade attachments for overspeed conditions of 10% and 5% respectively

Table 7-1: Probability of Failure Results – Proposed Repair

Defect ID	Hook ID	Indication Size (in)		Over speed (%)	Deterministic Lifetime Hours/Years*	Probabilistic Lifetime @ 1% Hours/Years*
		Depth	Length			
12 & 24**	Lower	0.13	0.62	10	>1,000,000 / >125	68,923 / 8.62
	Middle	0.26	2.80			
	Upper	-	-			
24***	Lower	-	-	10	98,900 / 12.36	27,745 / 3.47
	Middle	0.26	2.80			
	Upper	-	-			
24***	Lower	-	-	5	109,900 / 13.74	31,323 / 3.92
	Middle	0.26	2.80			
	Upper	-	-			

*Based on 8,000 operating hours /year
**Lifetimes based on reduced loads estimated for repair option
***Single defect lifetimes based on 100% rim load & blade stress profiles

Blade c.g. (in)	6.9375 (as measured)	3.4688
Rad. to Blade c.g. (in)	R_tang + Blade c.g.	24.2188
Blade weight (lbs)	As measured (lbs)	6
# of blades	1	1
Total Blade Wt. (lbs), W	# blades * Blade wt	6
RPM	3600	3600
Omega (rad/sec)	RPM*2*pie/60	376.99
Rim Load (kips) =	W/g *Rcg*Omega^2	**54**
FEA Pressure (ksi)	Rim Load/(2*pie*R*t)	**8.432**

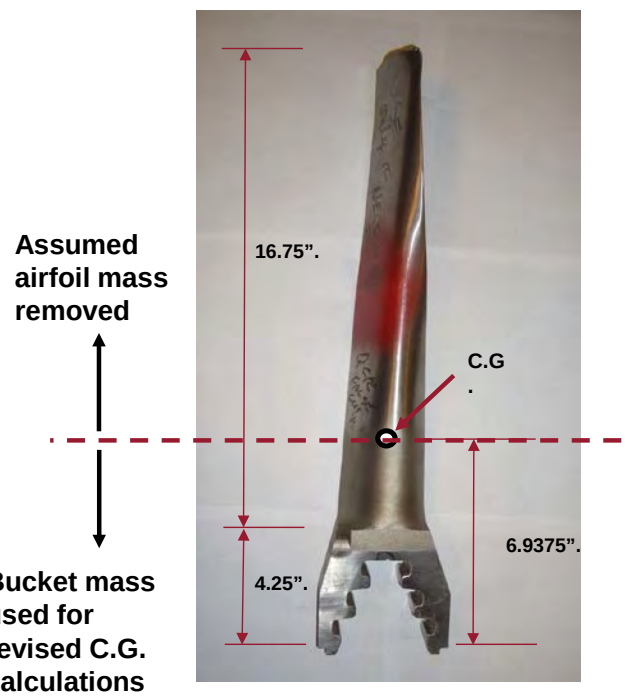


Figure 7-1: Revised Rim Load Calculations for the Proposed Repair.

8.0 Summary and Recommendations

Evaluations of the Columbia Unit 2 LPA and LPB rotor L-1 dovetails are performed using the EPRI LPRimLife code. The code assumes that stress corrosion cracking (SCC) is the dominant damage mechanism and predicts the potential for initiation and propagation of indications under the influence of operating stresses to determine crack size as a function of operating time. Fracture mechanics and limit-load failure criteria are applied to assess attachment failure as a function of accumulated operating time.

Stress distributions in the L-1 dovetail attachments are determined by finite element stress analyses based on measurements of a L-1 blade provided by Alliant Energy. Volumetric inspections of each attachment performed by SI in April 2013, revealed the presence of numerous areas of pitting and crack-like indications of significant length and depth. Review of the inspection results showed several areas considered life-limiting for each rotor. The results of the inspections are used to specify initial defect sizes used in the attachment life evaluations performed.

Results of analyses performed show that for a probability of failure of 1% the operating intervals for the LPA and LPB rotors (following the units return to service after the 2013 inspection) are 2.35 years and 4.11 years respectively. These results are based on a 10% overspeed condition. The limiting flaw location for both rotors is the stacked defects #12 and # 24 on the LPA rotor. Results of that defect location for a 5% overspeed condition show that for failure probabilities of attachment failure of 1% and 2.5% the operating intervals are 2.83 and 3.60 years respectively.

Based on the results of the calculations described in this report it is concluded that continued service of the LPA and LPB rotors (without repair) can be justified for 3.60-years of operating time, without development of significant failure potentials for overspeed allowances of 5 percent or less. While every attempt to introduce *reasonable* conservatism into the calculations has been made, the dynamic nature of steam turbine operation and, more pointedly, the ability to predict and control steam quality and other operational characteristics that affect SCC initiation and rates of growth, preclude the ability to provide justifiable, extended service prediction times without the acceptance of greater risk.

Recognizing that the probabilistic analysis methodology implemented in LPRimLife will, in general, result in predictions that over-estimate failure potentials, the question remains; what is considered an 'acceptable' level of risk? SI considers that for fossil LP rotor attachments P_f limits in the range of 1-to-2 ½ percent represent reasonable risk limits for high-severity events with no personnel-safety implications (i.e. blade loss). Therefore, for the Columbia LPA and

LPB rotors operation to a 3.60-year operating interval would be a limited risk. At that point, reinspection of the L-1, -2, and -3 dovetail attachments of each rotor should be performed. Then, through comparison of the two inspection data sets, a reduction in the uncertainties associated with SCC growth rate and initiation potentials could be realized if desired.

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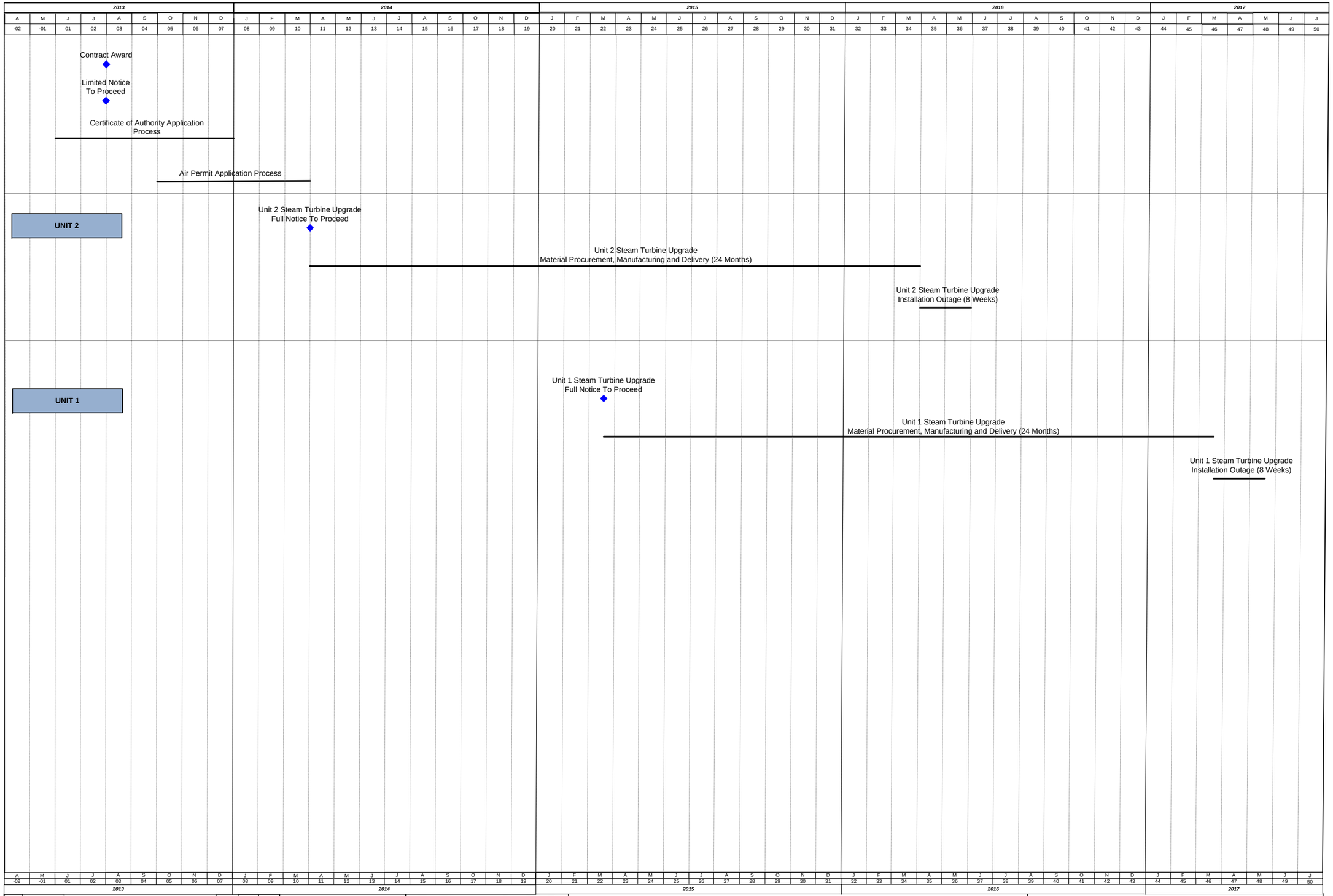
APPENDIX E – PRELIMINARY LEVEL 1 SCHEDULES



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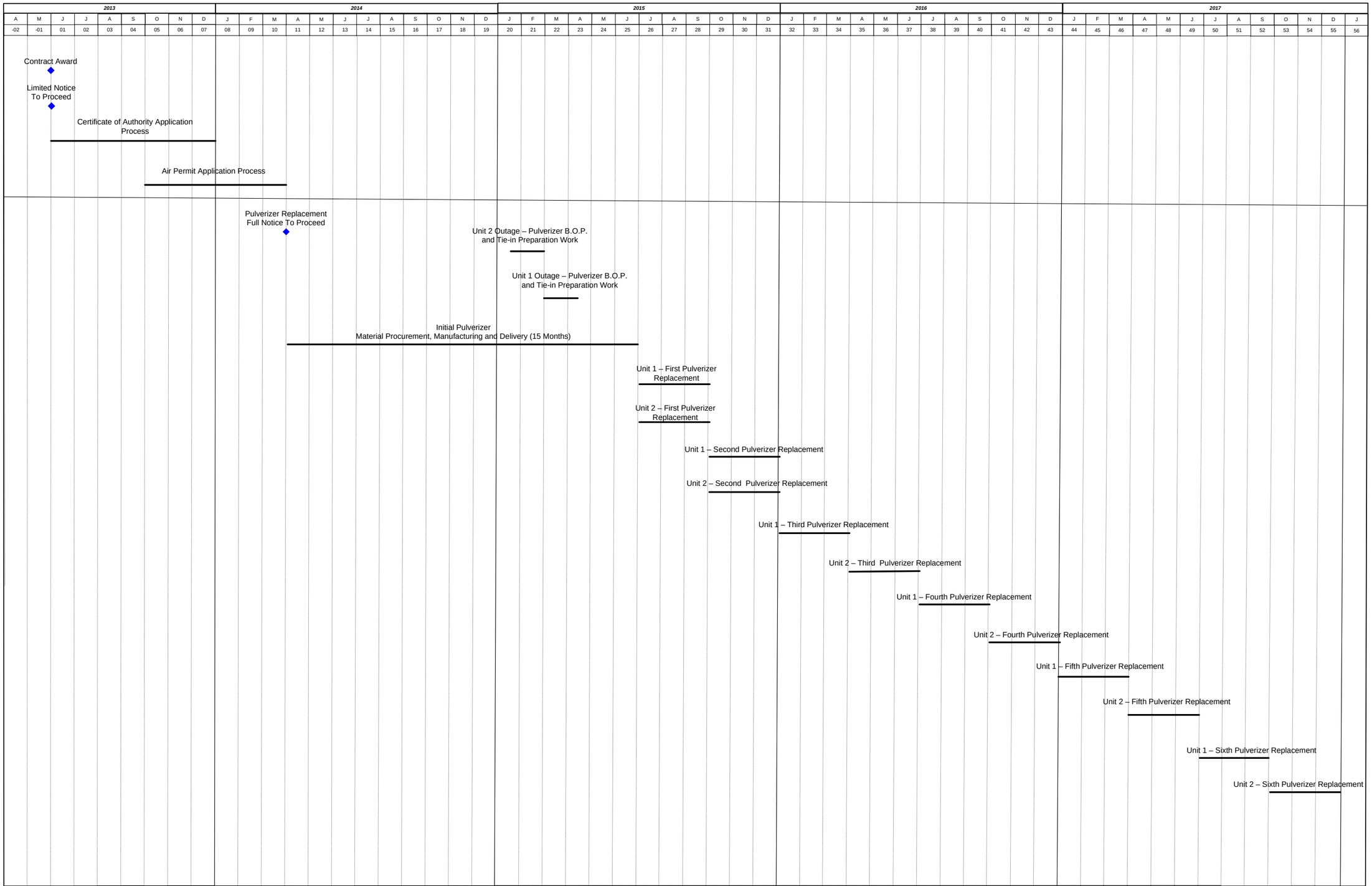

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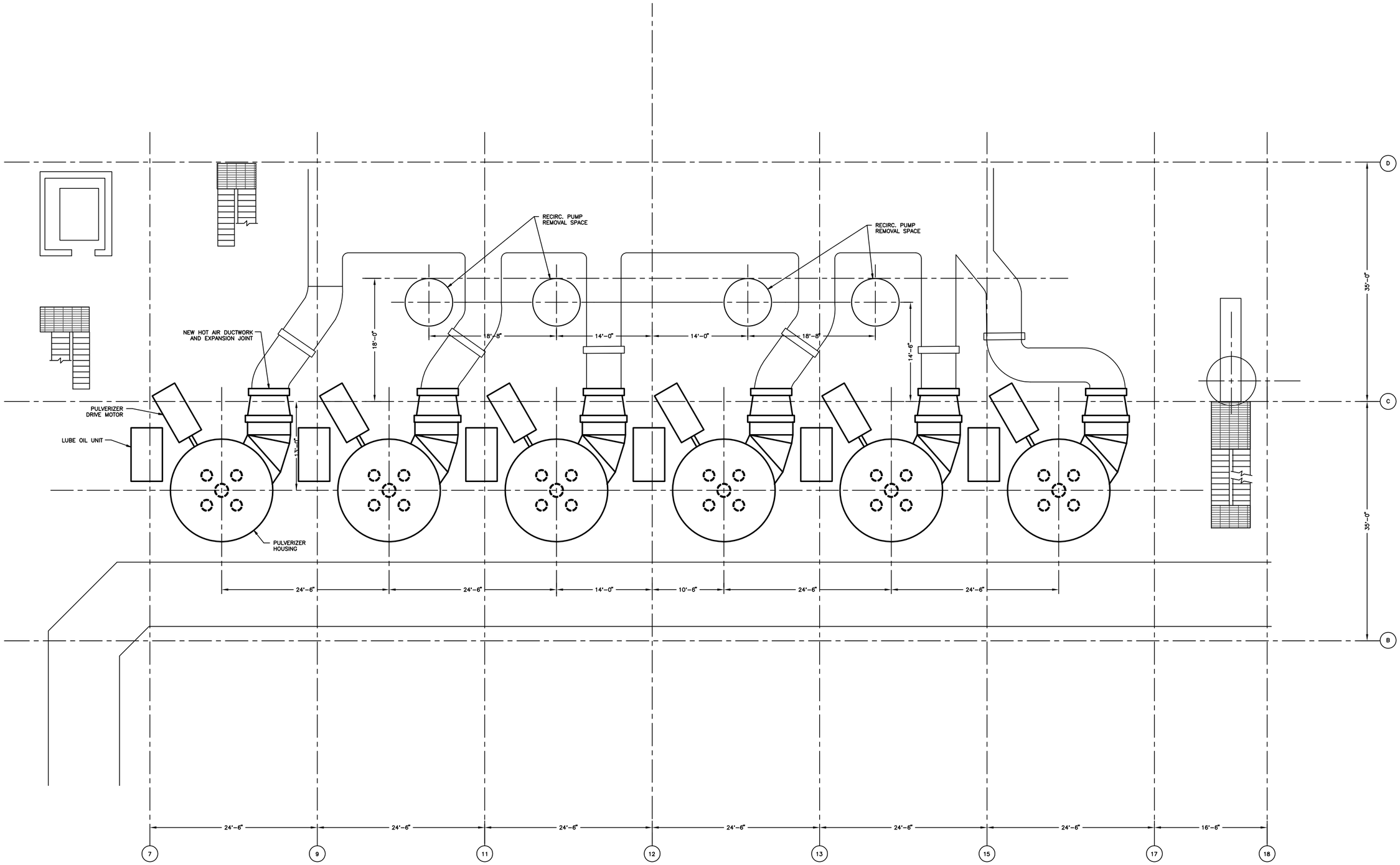
APPENDIX F – PRELIMINARY LAYOUT OF PULVERIZER BAY



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COLUMBIA CAMP PROJECT

GENERAL ARRANGEMENT
CONCEPTUAL PULVERIZER LAYOUT

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APPENDIX G – DRAFT BOILER MODELING ENGINEERING STUDY REPORT

Boiler Performance Evaluation For Turbine Upgrade

for

Black & Veatch, Alliant Energy, Columbia Generating Station

ES Contract 591-1011 (282Z)
May 7, 2013
DRAFT

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INTRODUCTION

This engineering study was undertaken by The Babcock & Wilcox Company (B&W) at the request of Black & Veatch to evaluate the effect of a turbine upgrade on boiler performance. The overall objective of this study is to identify future operating conditions and capabilities for a planned turbine HP/IP cylinder retrofit, with respect to economically feasible boiler modifications while firing a representative PRB and targeting 1005°F superheater and reheater outlet steam temperatures.

BACKGROUND

The Columbia Generating Station Units 1 and 2 are 520 MW steam generators with Controlled Circulation Radiant Reheat (CCRR), manufactured by Alstom (formerly called Combustion Engineering). The units are designed to fire sub-bituminous coal through tangential burners. The units' maximum continuous capacity is 3,800,000 lb/hr main steam flow at 2620 psig and 1005°F outlet conditions with reheat steam flow of 3,392,000 lb/hr at 554 psig and 1005°F outlet conditions.

Units 1 and 2 are designed with six pulverizers and six elevations of burners. Combustion air is supplied to the boiler by two forced draft (FD) fans and two primary air (PA) fans. The air discharged by the FD and PA fans passes through a Ljungstrom tri-sector air heater, where it is heated by the flue gas exiting the economizer. Primary air is supplied to the pulverizers and preheated secondary air is supplied to the windbox.

The units are balanced draft with furnace dimensions of 56'-2 1/2" wide and 49'-2 7/8" deep with a setting height of about 170' from the centerline of the lower furnace wall inlet headers to the furnace roof. The boiler convection pass section consists of a radiant reheat curtain wall (adjacent to the front wall), radiant superheater division panels, superheater pendant platen, reheater, finishing superheater, low temperature superheater and economizer. A sectional side view of Unit 2 is shown in Appendix 1.

Unit 1 and Unit 2 are duplicates except for the overfire air (OFA) systems. The economizer with additional nested low temperature superheater surface area was replaced in Unit 2 in 1999, under B&W contract 586-1233. In 2005, B&W contract 586-1521 supplied Unit 1 with a duplicate of the economizer with additional nested low temperature superheater surface area previously supplied in Unit 2. B&W contract 586-1521 also included the replacement of the superheater division panels in both units.

The turbine generator for Columbia Generating Station was originally designed and manufactured by General Electric Company. The nominal output of this turbine generator is 511 MW gross. The nominal conditions associated with Unit 2 at the guaranteed rating flow at 2400 psig throttle pressure per GE heat balance diagram, 443 HB 985, dated 9/10/75, are as follows:

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Throttle pressure and temperature	2400 psig / 1000°F
Throttle flow	3,408,062 lb/hr
Reheat pressure and temperature (IP valves)	486 psig / 1000°F
Reheater flow	3,051,939 lb/hr
Generator output	511,233 kW

The 5% overpressure heat balance diagram (398 HB 683, dated 10/20/71) for Columbia Generating Station indicates the following performance:

Throttle pressure and temperature	2520 psig / 1000°F
Throttle flow	3,768,974 lb/hr
Reheat pressure and temperature (IP valves)	536 psig / 1000°F
Reheater flow	3,362,876 lb/hr
Generator output	553,392 kW

SCOPE

This engineering study evaluates the boiler performance resulting from a turbine upgrade on Alliant Energy Columbia Generating Station. B&W developed and validated a model of Unit 2 and compared the model's performance characteristics to actual plant data. Black & Veatch supplied first draft turbine heat balances for ten cases of future operating conditions. These new turbine heat balances were incorporated into the boiler performance model and evaluated.

Alliant Energy Columbia Generating Station desires to maintain all key process parameters such as superheat and reheat steam outlet conditions. However, with a newer, more efficient turbine, parameters like superheat and reheat steam outlet conditions may not be achievable at all boiler loads studied. B&W will make recommendations for potential modifications in order to sustain superheat and reheat steam outlet conditions with the turbine upgrade.

The water/steam side terminal points for this evaluation are the economizer inlet and the superheater outlet, respectively.

BASIS

The design basis for this study is to determine if key performance parameters such as superheat and reheat steam outlet conditions can be maintained at the specified future operating conditions. As B&W is not the OEM of the boiler, the analysis carried out as described in this report is based on the information supplied by Black & Veatch. The thermal performance of the boiler takes into account the superheat, reheat and firing system modifications (circa 2000-2005) to the unit as identified by Black & Veatch. Furthermore, as B&W is not the OEM of the turbine and various integrated boiler components, the predicted performance for both the current conditions and the future conditions with the turbine upgrade are based on the turbine heat balances supplied by Black & Veatch (see Appendix 2 for the original turbine heat balances and Appendix 3 for the upgraded turbine heat balances).

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The results of this study are also based on the fuel analyses in Table 1. Black & Veatch supplied two coal analyses. Both were used for predicting performance results at specified scenarios.

Table 1: Fuel Analyses

ULTIMATE ANALYSIS	CORDERO-ROJO	BLACK THUNDER
% BY	WT	WT
ASH	5.43	5.41
MOISTURE	29.59	26.89
CARBON	49.22	51.25
HYDROGEN	3.41	3.46
NITROGEN	0.77	0.61
SULFUR	0.31	0.30
OXYGEN	11.26	12.08
TOTAL	100.00	100.00
HHV, BTU/LB	8,400	8,861

Current plant operating data for Unit 2 was received from Black & Veatch and incorporated into B&W's performance model. The data consisted of 5 minute averages spanning various time periods collected on various days for 8 different loads:

- 590 MW – August 29, 2012 from 10:00 am to 2:00 pm
- 545 MW – July 2, 2012 from 11:00 am to 10:00 pm
- 525 MW – February 7, 2012 from 7:00 am to 2:00 pm
- 520 MW – January 26, 2012 from 3:00 am to 7:00 am
- 400 MW – October 26, 2012 from 10:30 am to 1:00 pm
- 350 MW – August 9, 2012 from 8:30 am to 1:30 pm
- 270 MW – March 30, 2012 from 1:40 am to 9:20 am
- 200 MW – January 1, 2012 from 12:00 am to 4:00 am

The averaged operating data for all 8 load cases that was used to calibrate B&W's model of Unit 2 is in Table 2.

The data represents typical boiler operations at all of the different load cases except two, the 590 MW and the 270 MW. During the 590 MW test data, one of the top feedwater heaters in the first string (2G1) was out of service. This resulted in a lower than typical economizer feedwater inlet temperature and a higher than typical reheater flow. During the 270 MW test data, the unit was being started up so the operating pressures are lower than typical. While B&W's model of the unit is capable of validating these non-typical operating scenarios, they will not be used to characterize the model that will be used to evaluate the effects of the turbine upgrade on boiler performance.

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Table 2: Operating Data on Columbia Generating Station Unit 2

DATE OF OPERATING DATA				TAG NUMBERS	8/29/2012	7/2/2012	2/7/2012	1/26/2012	10/26/2012	8/9/2012	3/30/2012	1/1/2012
GENERATOR GROSS LOAD, MW					590	545	525	520	400	350	270	200
LOAD CONDITION, % ORIGINAL MCR					107%	103%	95%	87%	77%	65%	51%	36%
NUMBER OF MILLS IN SERVICE					6	5	5	5	5	5	3	3
BURNER TILT, DEG				2A1925.V	-8	-4	-8	-9	0	2	0	2
STEAM LEAVING SUPERHEATER 10^3lb/hr				2CI.MB.S00.A.V	4061	3919	3609	3289	2913	2467	1941	1358
STEAM LEAVING REHEATER [1], 10^3lb/hr				calculated	3968	3668	3448	3158	2673	2274	1798	1267
REHEAT SPRAY FLOW, 10^3lb/hr				2A1207F.V + 2A1208F.V	144.35	131.36	160.00	158.26	10.01	10.47	0.78	6.23
SUPERHEAT SPRAY FLOW, 10^3lb/hr					29.82	9.02	23.41	50.40	0.23	11.01	31.49	0.28
TEMPERATURE	DEG F	STEAM	STEAM AT SUPERHEATER OUTLET	2A1227.V, 2A1228.V	1002	1000	1005	1005	965	990	1004	1000
			STEAM AT SUPERHEATER PLATEN OUTLET	2A1903.V, 2A1906.V	906	911	907	907	894	920	936	951
			STEAM AT SUPERHEATER ATTEMPERATOR OUTLET	2A1224.V, 2A1226.V	811	816	806	803	804	821	826	827
			STEAM AT SUPERHEATER ATTEMPERATOR INLET	2A1223.V, 2A1225.V	815	815	825	838	801	819	892	846
			STEAM AT LOW TEMPERATURE SUPERHEATER OUTLET	2A1904.V, 2A1905.V	741	737	746	749	724	729	728	732
			STEAM AT REHEAT CURTAIN WALL OUTLET	2A1912.V - 2A1915.V	624	617	595	593	598	597	622	555
			STEAM AT REHEAT OUTLET	2A1231.V, 2A1232.V	1012	1008	1008	1008	957	973	977	955
			STEAM AT REHEAT ATTEMPERATOR INLET	2A1128.V	658	648	647	645	572	571	588	522
		WATER	ENTERING ECONOMIZER	2A1202.V	454	481	465	464	446	432	408	385
			LEAVING ECONOMIZER	2A1908.V - 2A1911.V	629	637	635	638	592	591	575	562
			SUPERHEAT & REHEAR SPRAY	2C1.TS.SFO.A.V	384	377	373	372	349	338	317	299
PRESSURE	PSIG		STEAM AT SUPERHEATER OUTLET	2A1221.V	2584	2477	2508	2501	2450	2440	1896	2419
			ENTERING ECONOMIZER	2A1201.V	2883	2778	2759	2744	2618	2569	1989	2477
			DRUM	2A1205.V	2828	2725	2705	2692	2581	2538	1967	2453
			STEAM AT REHEATER INLET	2C1.PB.C10.A.V	618	570	539	531	401	341	254	191
			STEAM AT REHEATER OUTLET	2C1.PB.H00.A.V	593	545	517	510	383	325	242	182
			REHEAT SPRAY	2A1206.V	1124	1073	1081	1073	1053	1019	811	958
			SUPERHEAT SPRAY	2A1211.V	2907	2793	2840	2816	2640	2587	2016	2492
TEMPERATURE	DEG F	AIR	ENTERING AIR HEATER	calculated [2]	97	111	70	71	90	81	92	126
			LEAVING AIR HEATER	2A1280.V, 2A1281.V	717	709	686	684	612	596	588	514
		GAS	LEAVING AIR HEATER (INCL LKG)	2A1288.V, 2A1289.V	332	330	295	294	268	260	252	229
			LEAVING AIR HEATER (EXCL LKG)	calculated	353	352	318	317	291	284	276	253
			LEAVING ECONOMIZER	2A1297.V, 2A1298.V	804	798	793	794	685	674	682	582
AIR HEATER LEAKAGE [3], %					10.0	10.6	10.8	10.9	13.5	13.7	16.1	23.8
ORSAT AT ECONOMIZER OUTLET, %				2A1944.S	2.5	3.2	3.0	3.1	3.8	4.6	5.0	5.4
EXCESS AIR AT ECONOMIZER OUTLET, %				calculated	16	21	19	20	26	33	36	40
FEEDWATER HEATER DATA			EXTRACTION TEMPERATURE, DEG F	2A1633.V	656	646	645	643	569	569	585	519
			EXTRACTION PRESSURE, PSIG	2A1632.V	621	566	538	531	400	342	256	195
			LEAVING FEEDWATER HEATER, DEG F	2A1636.V, 2A1637.V	457	482	467 [4]	466 [4]	446	434	410	387
			ENTERING FEEDWATER HEATER, DEG F	2A1634.V, 2A1635.V	419	411	401 [4]	400 [4]	384	373	352	332
			DRAIN TEMPERATURE, DEG F	2A1640.V	428	420	413	414	392	381	357	338

Footnotes:

1. Reheat flow calculation is based on the original turbine heat balances as supplied by Black & Veatch.
2. The air temperature entering the air heater was calculated using a weighted average of:
   0.80 * (2A1278.V, 2A1279.V) + 0.20 * (2A1305.V, 2A1306.V).
3. Air heater leakage was provided by Black & Veatch separately from the 2012 leakage test data.
4. Cases 525 and 520 MW: the top two feedwater heaters in the second string (2G2 and 2F2) are out of service due to tube leak repairs. The temperatures are from 2A1634.V and 2A1636.V only.

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METHODOLOGY

The methodology used in this engineering study to evaluate the current operating conditions and predict future capabilities of the Columbia Generating Station Unit 2 begins with boiler heat balance and efficiency calculations based upon the unit test data provided by Black & Veatch.

B&W analyzes boiler performance through the use of heat and material balance and heat transfer models. The heat and material balance model begins with the fuel analysis, boiler boundary conditions and furnace geometry to perform combustion and efficiency calculations in accordance with ASME Power Test Code 4 or 4.1. Boiler efficiency is calculated via the heat loss method and determines unit heat input, fuel rate, wet flue gas weight and air weight. Additional routines within the heat and material balance program determine furnace exit gas temperature (FEGT) and flue gas properties.

The heat transfer model utilizes the quantities determined in the heat and material balance and the geometric configuration (tube OD, tube spacing, tube routing, etc.) of each convection pass component (superheater, reheater, economizer and screen surface) to determine the heat absorbed by the convection pass surface, not including the air heater. The heat transfer model results in an economizer exit gas temperature (EEGT) at a specific gas weight that is entered into an air heater model. The three models are interdependent and a final solution to the heat balance is found when the models are iterated to converge to agreement.

Both the heat balance and heat transfer models utilize proprietary, empirically derived design factors based on years of B&W experience. The boiler performance models have the ability to use plant operating data to characterize the unit computer model to reflect how the boiler is currently operating, which results in more accurate performance predictions. Thus, the operational data is input into the heat transfer model where it is used to calculate the heat absorption of each convection pass component, starting with the EEGT. The calculated tube bank absorptions are compared to theoretical absorptions. This comparison results in performance factors for the boiler components. Performance factors represent the ratio of how each convection pass component is actually performing (absorbing) versus how it is predicted to operate (sometimes an indication of surface cleanliness).

The heat transfer model is also used to predict furnace exit gas temperature (FEGT). This is the average temperature across the plane entering the first convective tube bank. FEGT is back calculated starting with the economizer exit gas temperature. The calculated FEGT from the provided data is compared to B&W's unadjusted prediction. The difference between these numbers is used to adjust the heat transfer model of the unit to provide more accurate predicted performance. The predicted performance results from B&W's model (see Table 3) predict the same performance as the actual unit operating data (Table 2). Table 3 has been expanded to show the furnace exit gas temperature (FEGT) and the absorptions in the convective pass components.

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Table 3: Results from Calibrated Performance Model

DATE OF OPERATING DATA				8/29/2012	7/2/2012	2/7/2012	1/26/2012	10/26/2012	8/9/2012	3/30/2012	1/1/2012
GENERATOR GROSS LOAD, MW				590	545	525	520	400	350	270	200
LOAD CONDITION, % MCR				107%	103%	95%	87%	77%	65%	51%	36%
NUMBER OF MILLS IN SERVICE				6	5	5	5	5	5	3	3
EXCESS AIR LEAVING ECONOMIZER, %				16	21	19	20	26	33	36	40
FUEL INPUT, 10^6 BTU/HR				5965	5576	5303	4854	4079	3582	2901	2031
QUANTITY	10^3 LB/HR	STEAM LEAVING SUPERHEATER		4061	3919	3609	3289	2913	2467	1941	1358
		STEAM LEAVING REHEATER		3968	3668	3448	3158	2673	2274	1798	1267
		FUEL FLOW		710	664	631	578	486	426	345	242
		FLUE GAS LEAVING ECONOMIZER		5962	5786	5442	4992	4382	4035	3352	2403
		TOTAL AIR TO BURNING EQUIPMENT		5200	5074	4765	4372	3862	3578	2982	2144
PRESSURE	PSIG	STEAM AT SUPERHEATER OUTLET		2584	2477	2508	2501	2450	2440	1896	2419
		STEAM AT REHEATER INLET		618	570	539	531	401	341	254	191
		DROP	REHEATER	28	27	25	22	20	17	13	9
			ECONOMIZER	38	35	30	25	19	14	9	4
			DRUM TO SH OUTLET	240	223	189	157	123	89	55	27
TEMPERATURE	DEG F	STEAM	LEAVING SUPERHEATER	1002	1000	1005	1005	965	990	1004	1000
			ENTERING REHEATER	603	593	575	568	565	561	586	514
			LEAVING REHEATER	1012	1008	1008	1008	957	973	977	955
		WATER	WATER ENTERING ECONOMIZER	454	481	465	464	446	432	408	385
			WATER LEAVING ECONOMIZER	629	637	635	638	592	591	575	562
			SUPERHEAT & REHEAT SPRAY	384	377	373	372	349	338	317	299
		GAS	LEAVING FURNACE [1]	2455	2357	2414	2406	2056	1998	1885	1837
			LEAVING ECONOMIZER	806	797	795	794	685	675	683	583
			LEAVING AIR HEATER (EXCL. LKG)	353	352	318	317	291	284	276	253
		AIR	ENTERING AIR HEATER	97	111	70	71	90	81	92	126
			LEAVING AIR HEATER	663	666	662	665	573	555	583	519
ABSORPTION	10^6 BTU/HR	ECONOMIZER		875	780	761	693	507	463	362	267
		REHEATER		931	864	847	788	575	505	370	291
		PRIMARY SUPERHEATER		804	766	690	643	513	467	405	266
		SECONDARY SUPERHEATER		625	570	567	524	383	323	234	175
EFFICIENCY, %				85.01	85.22	84.95	84.99	86.03	85.68	86.13	87.85

Footnote:

1. The furnace exit gas temperature (FEGT) is defined by the plane of the leading edge face of the first convective heat transfer bank in direction of gas flow (superheater pendant platen).

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Some of the trends in the data shown in Table 3 do not track as expected. Of note is the data from 10/26/2012, as it is the only case where the superheater outlet temperature is significantly less than the design superheater outlet temperature, at 965°F. The 10/26/2012 case resulted in a clean furnace compared to other cases, thus, the FEGT is significantly lower compared to other cases. The clean furnace and resulting lower FEGT is the main reason that the superheater steam outlet temperature does not trend with other cases.

Predicted performance conditions with the new HP/IP turbine cylinder retrofit were supplied by Black & Veatch. The nominal output of the new turbine generator is 600 MW gross. The nominal conditions associated with Unit 2 at the guaranteed rating flow at 2400 psig throttle pressure per Black & Veatch heat balance diagram, Case 2, dated 11/01/11, are as follows:

Throttle pressure and temperature	2400 psig / 1000°F	
Throttle flow	3,874,000	lb/hr
Reheat pressure and temperature (IP valves)	562 psig / 1000°F	
Reheater flow	3,450,000	lb/hr
Generator output	600,003	kW

The performance conditions for 8 additional cases with the new turbine are shown below in Table 4. The Black & Veatch heat balance diagrams for all cases are attached in Appendix 3. The conditions in Table 4 represent a first iteration from Black & Veatch. The heat balances assume full superheat and reheat temperatures at the HP and IP turbines. Furthermore, all the heat balances assume 0 lb/hr superheat spray flow and 0 lb/hr reheat spray flow.

Table 4: Future Performance Conditions with New Turbine

CASE NUMBER			CASE 1	CASE 2a	CASE 2b	CASE 3	CASE 4	CASE 5	CASE 6	CASE 8	CASE 9	CASE 10
LOAD CONDITION, % MCR			VWOP	100%	100%	70%	50%	25%	17%	50%	44%	17%
LOAD CONDITION, GROSS MW			630	600	600	420	300	150	100	300	262	100
CONDITION			1% WBT	AVG AMB	AVG AMB	AVG AMB	AVG AMB	AVG AMB	AVG AMB	AVG AMB	AVG AMB	AVG AMB
OPERATION (TURBINE THROTTLE PRESSURE)			CONSTANT	CONSTANT	CONSTANT	CONSTANT	CONSTANT	CONSTANT	CONSTANT	SLIDING	SLIDING	SLIDING
FUEL			CORDERO-ROJO	BLACK THUNDER	CORDERO-ROJO	CORDERO-ROJO	CORDERO-ROJO	CORDERO-ROJO	CORDERO-ROJO	CORDERO-ROJO	CORDERO-ROJO	CORDERO-ROJO
NUMBER OF MILLS IN SERVICE			6	6	5	6	6	6	6	6	6	6
QUANT	LB/HR	SUPERHEATER STEAM FLOW	4,221,000	3,874,000	3,874,000	2,622,300	1,879,400	1,021,700	721,200	1,853,200	1,619,300	642,200
		COLD REHEAT STEAM FLOW	3,742,000	3,450,000	3,450,000	2,350,600	1,668,700	842,100	566,000	1,663,100	1,451,500	553,700
TEMPERATURE	DEG F	ENTERING ECONOMIZER	495	488	488	453	423	368	339	425	414	338
		LEAVING SUPERHEATER	1006	1006	1006	1004	1002	1002	1002	1004	1004	1002
		ENTERING REHEATER	632	628	628	586	568	574	575	647	649	607
		LEAVING REHEATER	1003	1003	1003	1002	1002	1002	1002	1002	1002	1002
PRESSURE	PSIG	STEAM AT SUPERHEATER OUTLET	2616	2485	2485	2440	2420	2406	2403	1189	1025	991
		STEAM AT REHEATER INLET	645	595	595	405	287	143	94	287	250	91
		STEAM AT REHEATER OUTLET	610	562	562	383	271	134	88	270	235	85

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RESULTS

The overall objective of this engineering study is to evaluate the current operating conditions and identify future operating conditions and capabilities for a planned turbine HP/IP cylinder retrofit, with respect to economically feasible boiler modifications while firing a representative PRB and targeting 1005°F superheater and reheater outlet steam temperatures. B&W analyzed the future conditions and metallurgy with the new turbine and existing boiler arrangement. Not all the future conditions achieved 1005 °F superheater and reheater outlet steam temperatures. As a result, B&W also analyzed the new turbine cases with adjustments made to current operating conditions and current boiler heating surfaces.

New Turbine with Existing Boiler B&W analyzed 10 cases corresponding to 9 turbine heat balance diagrams. Table 5 shows the predicted performance summary results with the current boiler arrangement, the current boiler condition and the new turbine.

Upon analysis of the 10 cases, there are 4 cases (Case 2a, 8, 9, 10) where superheater steam reached the design outlet temperature condition with superheat spray flow. There are 5 cases (Case 1, 2a, 2b, 8, 9) where the reheater steam reached the design outlet temperature condition with reheat spray flow.

Cases 8, 9 and 10 were analyzed for sliding pressure operation. Case 8, 9 and 10 are 3 out of the 4 cases where superheater steam reached the design outlet temperature condition with superheat spray flow. At a constant temperature, superheated steam has a higher enthalpy at a lower pressure. For that reason, sliding pressure operation, from the boiler side, requires overfiring; this results in higher fuel rates, higher flue gas weights, higher flue gas temperature leaving the furnace and, therefore, more superheater and reheater absorption. Designing the turbine retrofit for sliding pressure is a viable option to help the boiler achieve design steam outlet temperatures.

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Table 5: Predicted Performance with New Turbine

FUEL AS FIRED				PERFORMANCE PARAMETERS				INPUT [1]	PREDICTED PERFORMANCE									
				CASE NUMBER					CASE 1	CASE 2a	CASE 2b	CASE 3	CASE 4	CASE 5	CASE 6	CASE 8	CASE 9	CASE 10
				LOAD CONDITION, % MCR					VWOP	100%	100%	70%	50%	25%	17%	50%	44%	17%
				LOAD CONDITION, GROSS MW					630	600	600	420	300	150	100	300	262	100
				CONDITION					1% WBT	AVG AMB	AVG AMB	AVG AMB	AVG AMB	AVG AMB	AVG AMB	AVG AMB	AVG AMB	AVG AMB
				OPERATION (TURBINE THROTTLE PRESSURE)					CONSTANT	CONSTANT	CONSTANT	CONSTANT	CONSTANT	CONSTANT	CONSTANT	SLIDING	SLIDING	SLIDING
		Cordero-Rojo	Black Thunder	FUEL				X	Cordero-Rojo	Cordero-Rojo	Black Thunder	Cordero-Rojo	Cordero-Rojo	Cordero-Rojo	Cordero-Rojo	Cordero-Rojo	Cordero-Rojo	Cordero-Rojo
PROXIMATE ANALYSIS	% BY	WT	WT	NUMBER OF MILLS IN SERVICE				X	6	5	6	5	4	3	2	4	3	2
	TOTAL MOISTURE	29.59	26.89	BURNER TILT, DEG				X	-6	-6	-6	1	0	2	2	0	0	2
	VOLATILE MATTER	30.91	34.62	EXCESS AIR LEAVING ECONOMIZER, %				X	20	24	20	27	34	49	58	34	37	58
	FIXED CARBON	33.85	33.27	FUEL INPUT, 10^6 BTU/HR					5837	5637	5405	3520	2583	1532	1055	2802	2527	1003
	ASH	5.43	5.22	QUANTITY	10^3 LB/HR		STEAM LEAVING SUPERHEATER	X	4221	3874	3874	2622	1879	1022	721	1853	1619	642
	TOTAL	99.78	100.00	QUANTITY	10^3 LB/HR		STEAM ENTERING REHEAT ATTEMPERATOR	X	3742	3450	3450	2351	1669	842	566	1663	1452	554
				QUANTITY	10^3 LB/HR		SUPERHEAT SPRAY FLOW		0	33	0	0	0	0	0	57	124	14
				QUANTITY	10^3 LB/HR		REHEAT SPRAY FLOW		19	130	48	0	0	0	0	34	60	0
		Cordero-Rojo	Black Thunder	QUANTITY	10^3 LB/HR		FUEL FLOW		695	671	610	419	308	182	126	334	301	119
ULTIMATE ANALYSIS	% BY	WT	WT	QUANTITY	10^3 LB/HR		FLUE GAS LEAVING ECONOMIZER		6012	5979	5437	3801	2938	1918	1393	3181	2932	1325
	ASH	5.43	5.41	QUANTITY	10^3 LB/HR		TOTAL AIR TO BURNING EQUIPMENT		5267	5259	4780	3330	2568	1652	1179	2781	2559	1122
	MOISTURE	29.59	26.89	PRESSURE	PSIG		STEAM AT SUPERHEATER OUTLET	X	2616	2485	2485	2440	2420	2406	2403	1174	1025	991
	CARBON	49.22	51.25	PRESSURE	PSIG		STEAM AT REHEATER INLET	X	645	595	595	405	287	143	94	287	250	91
	HYDROGEN	3.41	3.46	PRESSURE	PSIG	DROP	REHEATER		31	27	27	12	13	7	4	13	11	4
	NITROGEN	0.77	0.61	PRESSURE	PSIG	DROP	ECONOMIZER		41	34	34	16	8	2	2	8	6	1
	SULFUR	0.31	0.30	PRESSURE	PSIG	DROP	DRUM TO SUPERHEATER OUTLET		260	218	218	100	51	15	7	50	38	6
	OXYGEN	11.27	12.08	TEMPERATURE	DEG F	STEAM	LEAVING SUPERHEATER		959	1006	984	903	905	992	943	1004	1004	1002
	TOTAL	100.00	100.00	TEMPERATURE	DEG F	STEAM	ENTERING REHEAT ATTEMPERATOR	X [2]	594	628	611	505	490	566	528	647	649	607
	HHV, BTU/LB	8,400	8,861	TEMPERATURE	DEG F	STEAM	ENTERING REHEATER		587	575	591	505	490	566	528	608	570	607
				TEMPERATURE	DEG F	STEAM	LEAVING REHEATER		1003	1003	1003	871	879	1000	940	1002	1002	973
				TEMPERATURE	DEG F	WATER	WATER ENTERING ECONOMIZER	X	495	488	488	453	423	368	339	425	414	338
NOTES:				TEMPERATURE	DEG F	WATER	WATER LEAVING ECONOMIZER		646	650	635	584	558	536	503	571	553	507
1. Unmarked performance parameters are outputs				TEMPERATURE	DEG F	WATER	SUPERHEAT & REHEAT SPRAY		375	369	369	342	320	282	260	321	313	256
2. Adjusted when main steam outlet temperature was low				TEMPERATURE	DEG F	GAS	LEAVING ECONOMIZER		810	809	786	676	619	551	496	642	629	490
				TEMPERATURE	DEG F	GAS	LEAVING AH (EXCL. LKG)		352	350	337	288	271	255	257	281	274	255
				TEMPERATURE	DEG F	AIR	ENTERING AIR HEATER	X	95	95	95	95	110	130	160	110	110	160
				TEMPERATURE	DEG F	AIR	LEAVING AIR HEATER		666	664	650	574	537	494	458	554	546	454
				HEAT LOSSES, %			DRY GAS		5.84	5.98	5.40	4.61	4.07	3.50	2.87	4.31	4.23	2.81
				HEAT LOSSES, %			H_2 AND H_2O IN FUEL		8.27	8.26	7.50	8.06	7.90	7.70	7.49	7.93	7.91	7.49
				HEAT LOSSES, %			MOISTURE IN AIR		0.14	0.14	0.13	0.11	0.10	0.08	0.07	0.10	0.10	0.07
				HEAT LOSSES, %			UNBURNED COMBUSTIBLE	X	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
				HEAT LOSSES, %			RADIATION		0.17	0.18	0.18	0.28	0.37	0.63	0.90	0.35	0.38	0.95
				HEAT LOSSES, %			UNACCOUNTED FOR & MANUFACTURER'S MARGIN	X	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
THE BABCOCK & WILCOX COMPANY				HEAT LOSSES, %			OTHER LOSSES		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
282Z				EFFICIENCY, %					83.78	83.64	84.99	85.14	85.76	86.29	86.87	85.51	85.58	86.88
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				Plant	Wisconsin Power & Light, Alliant Energy, Columbia Generating Station													

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The predicted turbine outputs in Table 5 are contingent on raising the superheater outlet temperature to achieve 1005 °F. There are two practical solutions to attain the design outlet steam temperature for more than 4 cases; the first is to adjust the current operating conditions and the second is to adjust the current boiler heating surface arrangement.

Adjusted Operating Conditions B&W's model was adjusted to reflect actual operating conditions by using the field test data and fuel analyses provided by Black & Veatch (Tables 1 and 2). The adjustments to the model take the form of a performance or heat transfer factor, known as a Kf factor. These adjusted Kf factors are determined by the model based on the test data. Kf factors are analogous to tuning parameters or calibration factors. These Kf factors are used primarily to compensate for the fouling and slagging of the existing heat transfer surfaces and can be considered cleanliness factors. Coal ash deposits on pressure part tubes can significantly alter the heat transfer characteristics and decrease heat absorption in furnace and/or convection pass surfaces.

The actual Kf factors determined from the test data for this study are incorporated into the boiler model so that the predicted results for future operating scenarios are in tune with the actual operating conditions that exist in the field. Upon updating the unit performance model the new expected turbine heat balances are then applied.

The results of the boiler cleanliness analysis show that the finishing superheater and reheater are the components that are considered "clean" (normal Kf factors). The economizer, low temperature superheater and the furnace are considered "dirty" (low Kf factors). The low Kf factors determined from the field data imply fouled surfaces. The consequences of fouled convection pass surfaces are decreased heat absorption and the potential for missed steam temperatures. Missed main steam and/or hot reheat steam temperatures means lost megawatt generation.

Cleaning the low temperature superheater and economizer banks through means of grit blasting and adding sootblower coverage is a workable solution as suggested by Alliant Energy. B&W analyzed the performance for the current turbine, the current boiler heating surface and clean low temperature superheater and economizer surface. This predicted performance can be compared to the performance for the current cleanliness of the low temperature superheater and economizer in Table 6.

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Table 6: Comparison of the Performance with Clean Low Temperature Superheater and Economizer versus Current Low Temperature Superheater and Economizer with the Existing Turbine and Boiler Heating Surface

FUEL AS FIRED			PERFORMANCE PARAMETERS				PREDICTED PERFORMANCE			
			SURFACE MODIFICATION SCENARIO				EXISTING	EXISTING	EXISTING	EXISTING
			SURFACE MODIFICATION SCENARIO				CLEAN	CURRENT	CLEAN	CURRENT
			CASE NUMBER				7/2/2012	7/2/2012	10/26/2012	10/26/2012
			LOAD CONDITION, % MCR				103%	103%	77%	77%
			LOAD CONDITION, GROSS MW				545	545	400	400
		Cordero-Rojo	FUEL				Cordero-Rojo	Cordero-Rojo	Cordero-Rojo	Cordero-Rojo
PROXIMATE ANALYSIS	% BY	WT	NUMBER OF MILLS IN SERVICE				5	5	5	5
	TOTAL MOISTURE	29.59	BURNER TILT, DEG				-4	-4	0	0
	VOLATILE MATTER	30.91	EXCESS AIR LEAVING ECONOMIZER, %				21	21	26	26
	FIXED CARBON	33.85	FUEL INPUT, 10^6 BTU/HR				5546	5576	4089	4079
	ASH	5.43	QUANTITY	10^3 LB/HR		STEAM LEAVING SUPERHEATER	3919	3919	2913	2913
	TOTAL	99.78				STEAM ENTERING REHEAT ATTEMPERATOR	3537	3537	2663	2663
						SUPERHEAT SPRAY FLOW	18	0	0	0
						REHEAT SPRAY FLOW	128	131	0	10
		Cordero-Rojo				FUEL FLOW	660	664	487	486
ULTIMATE ANALYSIS	% BY	WT				FLUE GAS LEAVING ECONOMIZER	5755	5786	4393	4382
	ASH	5.43				TOTAL AIR TO BURNING EQUIPMENT	5047	5074	3871	3862
	MOISTURE	29.59	PRESSURE	PSIG		STEAM AT SUPERHEATER OUTLET	2477	2477	2450	2450
	CARBON	49.22				STEAM AT REHEATER INLET	570	570	401	401
	HYDROGEN	3.41			DROP	REHEATER	25	25	18	18
	NITROGEN	0.77				ECONOMIZER	53	53	37	37
	SULFUR	0.31				DRUM TO SUPERHEATER OUTLET	248	248	131	131
	OXYGEN	11.27	TEMPERATURE	DEG F	STEAM	LEAVING SUPERHEATER	1000	994	973	962
	TOTAL	100.00				ENTERING REHEAT ATTEMPERATOR	648	648	578	572
	HHV, BTU/LB	8,400				ENTERING REHEATER	594	593	578	566
						LEAVING REHEATER	1005	1008	970	957
					WATER	WATER ENTERING ECONOMIZER	481	481	446	446
						WATER LEAVING ECONOMIZER	637	637	592	592
						SUPERHEAT & REHEAT SPRAY	377	377	349	349
					GAS	LEAVING ECONOMIZER	760	798	674	685
						LEAVING AH (EXCL. LKG)	340	352	287	291
					AIR	ENTERING AIR HEATER	111	111	90	90
						LEAVING AIR HEATER	633	709	565	612
			KF FACTORS	ACT ABS/ THEO ABS		ECONOMIZER	0.95	0.87	0.95	0.92
						LOW TEMPERATURE SUPERHEATER	0.85	0.72	0.85	0.76
						FINISHING SUPERHEATER	1.17	1.17	1.29	1.29
						REHEATER	0.99	0.99	1.02	1.02
						PENDANT PLATEN SUPERHEATER	0.56	0.56	0.67	0.67
						DIVISION PANEL SUPERHEATER	0.62	0.62	0.69	0.69
						RADIANT REHEATER	0.57	0.57	0.76	0.76
			HEAT LOSSES, %			DRY GAS	5.24	5.52	4.68	4.78
						H_2 AND H_2O IN FUEL	8.12	8.16	8.09	8.11
						MOISTURE IN AIR	0.12	0.13	0.11	0.11
						UNBURNED COMBUSTIBLE	0.30	0.30	0.30	0.30
						RADIATION	0.17	0.17	0.18	0.18
						UNACCOUNTED FOR & MANUFACTURER'S MARGIN	0.50	0.50	0.50	0.50
THE BABCOCK & WILCOX COMPANY						OTHER LOSSES	0.00	0.00	0.00	0.00
282Z			EFFICIENCY, %				85.55	85.22	86.14	86.02
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			Plant	Wisconsin Power & Light, Alliant Energy, Columbia Generating Station						

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In the 545 MW case in Table 6, the superheater steam outlet temperature of 1000°F is achieved with spray flow for the clean surface scenario. In the 400 MW case, the superheater steam outlet temperature increased about 10°F with the clean surface versus the current surface.

B&W then analyzed the performance for the new turbine with the current boiler heating surface and the clean low temperature superheater and economizer. Table 7 shows the performance of the clean surface compared to the performance of the dirty surface while considering the new turbine.

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Table 7: Comparison of the Performance with Clean Low Temperature Superheater and Economizer versus Current Low Temperature Superheater and Economizer with the Existing Boiler Heating Surface and the New Turbine

FUEL AS FIRED			
		Cordero-Rojo	Black Thunder
PROXIMATE ANALYSIS	% BY	WT	WT
	TOTAL MOISTURE	29.59	26.89
	VOLATILE MATTER	30.91	34.62
	FIXED CARBON	33.85	33.27
	ASH	5.43	5.22
	TOTAL	99.78	100.00
		Cordero-Rojo	Black Thunder
ULTIMATE ANALYSIS	% BY	WT	WT
	ASH	5.43	5.41
	MOISTURE	29.59	26.89
	CARBON	49.22	51.25
	HYDROGEN	3.41	3.46
	NITROGEN	0.77	0.61
	SULFUR	0.31	0.30
	OXYGEN	11.27	12.08
	TOTAL	100.00	100.00
	HHV, BTU/LB	8,400	8,861

PERFORMANCE PARAMETERS			PREDICTED PERFORMANCE					
SURFACE MODIFICATION SCENARIO			CLEAN LTSH & ECON			CURRENT LTSH & ECON		
CASE NUMBER			CASE 1	CASE 2b	CASE 3	CASE 1	CASE 2b	CASE 3
LOAD CONDITION, % MCR			VWOP	100%	70%	VWOP	100%	70%
LOAD CONDITION, GROSS MW			630	600	420	630	600	420
CONDITION			1% WBT	AVG AMB	AVG AMB	1% WBT	AVG AMB	AVG AMB
OPERATION (TURBINE THROTTLE PRESSURE)			CONSTANT	CONSTANT	CONSTANT	CONSTANT	CONSTANT	CONSTANT
FUEL			Cordero-Rojo	Black Thunder	Cordero-Rojo	Cordero-Rojo	Black Thunder	Cordero-Rojo
NUMBER OF MILLS IN SERVICE			6	6	5	6	6	5
BURNER TILT, DEG			-6	-6	1	-6	-6	1
EXCESS AIR LEAVING ECONOMIZER, %			20	20	27	20	20	27
FUEL INPUT, 10^6 BTU/HR			5907	5470	3544	5837	5405	3520
QUANTITY	10^3 LB/HR	STEAM LEAVING SUPERHEATER	4221	3874	2622	4221	3874	2622
		STEAM ENTERING REHEAT ATTEMPERATOR	3742	3450	2351	3742	3450	2351
		SUPERHEAT SPRAY FLOW	0	0	0	0	0	0
		REHEAT SPRAY FLOW	66	88	0	19	48	0
		FUEL FLOW	703	617	422	695	610	419
		FLUE GAS LEAVING ECONOMIZER	6084	5501	3827	6012	5437	3801
		TOTAL AIR TO BURNING EQUIPMENT	5330	4837	3352	5267	4780	3330
PRESSURE	PSIG	STEAM AT SUPERHEATER OUTLET	2616	2485	2440	2616	2485	2440
		STEAM AT REHEATER INLET	645	595	405	645	595	405
	DROP	REHEATER	31	27	12	31	27	12
		ECONOMIZER	41	34	16	41	34	16
		DRUM TO SUPERHEATER OUTLET	260	218	100	260	218	100
TEMPERATURE	DEG F	STEAM: LEAVING SUPERHEATER	981	1006	918	959	984	903
		STEAM: ENTERING REHEAT ATTEMPERATOR	612	628	517	594	611	505
		STEAM: ENTERING REHEATER	588	591	517	587	591	505
		STEAM: LEAVING REHEATER	1003	1003	885	1003	1003	871
		WATER: WATER ENTERING ECONOMIZER	495	488	453	495	488	453
		WATER: WATER LEAVING ECONOMIZER	647	636	585	646	635	584
		WATER: SUPERHEAT & REHEAT SPRAY	375	369	342	375	369	342
		GAS: LEAVING ECONOMIZER	780	758	655	810	786	676
		GAS: LEAVING AH (EXCL. LKG)	342	328	281	352	337	288
		AIR: ENTERING AIR HEATER	95	95	95	95	95	95
		AIR: LEAVING AIR HEATER	641	626	556	666	650	574
KF FACTORS	ACT ABS/ THEO ABS	ECONOMIZER	0.95	0.95	0.95	0.88	0.88	0.88
		LOW TEMPERATURE SUPERHEATER	0.85	0.85	0.85	0.71	0.71	0.71
		FINISHING SUPERHEATER	1.17	1.17	1.17	1.17	1.17	1.17
		REHEATER	0.97	0.97	0.97	0.97	0.97	0.97
		PENDANT PLATEN SUPERHEATER	0.57	0.57	0.57	0.57	0.57	0.57
		DIVISION PANEL SUPERHEATER	0.59	0.59	0.59	0.59	0.59	0.59
		RADIANT REHEATER	0.58	0.58	0.58	0.58	0.58	0.58
HEAT LOSSES, %		DRY GAS	5.61	5.20	4.45	5.84	5.40	4.61
		H_2 AND H_2O IN FUEL	8.24	7.47	8.04	8.27	7.50	8.06
		MOISTURE IN AIR	0.13	0.12	0.10	0.14	0.13	0.11
		UNBURNED COMBUSTIBLE	0.30	0.30	0.30	0.30	0.30	0.30
		RADIATION	0.17	0.18	0.28	0.17	0.18	0.28
		UNACCOUNTED FOR & MANUFACTURER'S MARGIN	1.50	1.50	1.50	1.50	1.50	1.50
		OTHER LOSSES	0.00	0.00	0.00	0.00	0.00	0.00
EFFICIENCY, %			84.05	85.23	85.33	83.78	84.99	85.14

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Customer Black & Veatch
Plant Wisconsin Power & Light, Alliant Energy, Columbia Generating Station

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For Case 2b in Table 7, the superheater steam outlet temperature of 1006°F is achieved for the clean surface scenario. In Cases 1 and 3, the superheater steam outlet temperature increased about 15-20°F with the clean low temperature superheater and economizer versus the current low temperature superheater and economizer. Therefore, cleaning the low temperature superheater and economizer better will help to achieve desired operating conditions.

Adjusting the Heating Surface B&W analyzed performance with an increase in heating surface in the finishing superheater bank (see Table 8). The additional heating surface is shown in Figure 1.

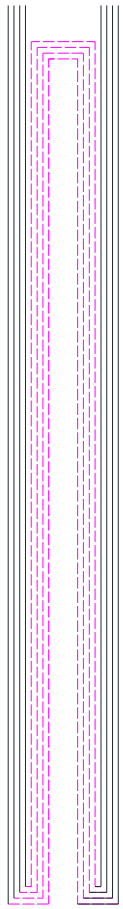

Figure 1. Additional heating surface (pink dotted lines) in the finishing superheater bank

Upon completion, both Cases 1 and 2b achieved the superheater steam outlet temperature of 1006°F with spray flow with the increased heating surface. In Case 3, the superheater steam outlet temperature increased about 40°F.

B&W also analyzed the same new turbine cases with the additional heating surface at a clean condition. These predicted performance results are in Table 8. Cases 1 and 2b resulted in higher spray flows. Although the spray flows increased, they are still within the capabilities of the existing attemperators. Case 3 resulted in about a 15 °F increase in superheater steam outlet temperature above the current cleanliness condition.

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Table 8: Comparison of the Performance with Clean Low Temperature Superheater and Economizer versus Current Low Temperature Superheater and Economizer with Additional Finishing Superheater Heating Surface and the New Turbine

FUEL AS FIRED			
		Cordero-Rojo	Black Thunder
PROXIMATE ANALYSIS	% BY	WT	WT
	TOTAL MOISTURE	29.59	26.89
	VOLATILE MATTER	30.91	34.62
	FIXED CARBON	33.85	33.27
	ASH	5.43	5.22
	TOTAL	99.78	100.00
		Cordero-Rojo	Black Thunder
ULTIMATE ANALYSIS	% BY	WT	WT
	ASH	5.43	5.41
	MOISTURE	29.59	26.89
	CARBON	49.22	51.25
	HYDROGEN	3.41	3.46
	NITROGEN	0.77	0.61
	SULFUR	0.31	0.30
	OXYGEN	11.27	12.08
	TOTAL	100.00	100.00
	HHV, BTU/LB	8,400	8,861

PERFORMANCE PARAMETERS			PREDICTED PERFORMANCE					
SURFACE MODIFICATION SCENARIO			FIGURE 1, CLEAN LTSH & ECON			FIGURE 1, CURRENT LTSH & ECON		
CASE NUMBER			CASE 1	CASE 2b	CASE 3	CASE 1	CASE 2b	CASE 3
LOAD CONDITION, % MCR			VWOP	100%	70%	VWOP	100%	70%
LOAD CONDITION, GROSS MW			630	600	420	630	600	420
CONDITION			1% WBT	AVG AMB	AVG AMB	1% WBT	AVG AMB	AVG AMB
OPERATION (TURBINE THROTTLE PRESSURE)			CONSTANT	CONSTANT	CONSTANT	CONSTANT	CONSTANT	CONSTANT
FUEL			Cordero-Rojo	Black Thunder	Cordero-Rojo	Cordero-Rojo	Black Thunder	Cordero-Rojo
NUMBER OF MILLS IN SERVICE			6	6	5	6	6	5
BURNER TILT, DEG			-6	-6	1	-6	-6	1
EXCESS AIR LEAVING ECONOMIZER, %			20	20	27	20	20	27
FUEL INPUT, 10^6 BTU/HR			6020	5472	3623	6034	5492	3604
QUANTITY	10^3 LB/HR	STEAM LEAVING SUPERHEATER	4221	3874	2622	4221	3874	2622
		STEAM ENTERING REHEAT ATTEMPERATOR	3742	3450	2351	3742	3450	2351
		SUPERHEAT SPRAY FLOW	110	141	0	47	88	0
		REHEAT SPRAY FLOW	122	83	0	125	91	0
		FUEL FLOW	717	618	431	718	620	429
		FLUE GAS LEAVING ECONOMIZER	6201	5504	3912	6215	5524	3892
		TOTAL AIR TO BURNING EQUIPMENT	5432	4839	3427	5444	4856	3409
PRESSURE	PSIG	STEAM AT SUPERHEATER OUTLET	2616	2485	2440	2616	2485	2440
		STEAM AT REHEATER INLET	645	595	405	645	595	405
		DROP REHEATER	31	27	12	31	27	12
		DROP ECONOMIZER	41	34	16	41	34	16
		DROP DRUM TO SUPERHEATER OUTLET	260	218	100	260	218	100
TEMPERATURE	DEG F	STEAM LEAVING SUPERHEATER	1006	1006	955	1006	1006	941
		STEAM ENTERING REHEAT ATTEMPERATOR	632	628	547	632	628	536
		STEAM ENTERING REHEATER	587	593	547	586	590	536
		STEAM LEAVING REHEATER	1003	1003	922	1003	1003	911
		WATER WATER ENTERING ECONOMIZER	495	488	453	495	488	453
		WATER WATER LEAVING ECONOMIZER	643	629	582	642	629	581
		WATER SUPERHEAT & REHEAT SPRAY	375	369	342	375	369	342
		GAS LEAVING ECONOMIZER	764	739	649	795	768	669
		GAS LEAVING AH (EXCL. LKG)	337	321	279	347	331	286
		AIR ENTERING AIR HEATER	95	95	95	95	95	95
		AIR LEAVING AIR HEATER	627	611	550	654	635	567
KF FACTORS	ACT ABS/ THEO ABS	ECONOMIZER	0.95	0.95	0.95	0.88	0.88	0.88
		LOW TEMPERATURE SUPERHEATER	0.85	0.85	0.85	0.71	0.71	0.71
		FINISHING SUPERHEATER	1.17	1.17	1.17	1.17	1.17	1.17
		REHEATER	0.97	0.97	0.97	0.97	0.97	0.97
		PENDANT PLATEN SUPERHEATER	0.57	0.57	0.57	0.57	0.57	0.57
		DIVISION PANEL SUPERHEATER	0.59	0.59	0.59	0.59	0.59	0.59
		RADIANT REHEATER	0.58	0.58	0.58	0.58	0.58	0.58
HEAT LOSSES, %		DRY GAS	5.50	5.04	4.40	5.73	5.26	4.56
		H_2 AND H_2O IN FUEL	8.22	7.45	8.03	8.25	7.48	8.05
		MOISTURE IN AIR	0.13	0.12	0.10	0.13	0.12	0.11
		UNBURNED COMBUSTIBLE	0.30	0.30	0.30	0.30	0.30	0.30
		RADIATION	0.17	0.17	0.28	0.17	0.18	0.28
		UNACCOUNTED FOR & MANUFACTURER'S MARGIN	1.50	1.50	1.50	1.50	1.50	1.50
		OTHER LOSSES	0.00	0.00	0.00	0.00	0.00	0.00
EFFICIENCY, %			84.18	85.42	85.39	83.92	85.16	85.20
Customer	Black & Veatch							
Plant	Wisconsin Power & Light, Alliant Energy, Columbia Generating Station							

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Superheater and Reheater The superheater and reheater metallurgy was evaluated for Case 1 (predicted performance shown in Table 5). B&W uses an ASME Code accepted method to determine superheater tube metallurgies and thicknesses. The method involves applying upsets and unbalances to determine spot and mean tube metal temperatures. The upsets and unbalances include empirical uncertainty in the calculation of FEGT, top to bottom gas temperature deviations, side to side gas temperature deviations, steam flow unbalances (a function of tube side pressure drop and arrangement) and gas flow unbalances. FEGT is the average gas temperature entering the inlet (vertical plane) of the superheater pendant platen bank. The method applies these upsets and unbalances simultaneously to a single spot in each row of the superheater. Tube row metallurgy and thickness are then determined from the resultant tube spot and mean temperatures, respectively, according to ASME Code material oxidation limits and allowable stresses. B&W policy does not allow the publishing of design tube metal temperatures or unbalanced steam temperatures. However, these values can be reviewed in B&W's offices, if desired.

B&W determined the design hoop stress level, based on the originally supplied minimum tube wall thickness, at design pressure. The predicted tube operating temperatures, based on B&W's standard design criteria, and the resulting ASME Code allowable stress levels for the existing materials were also determined. Comparison of the design hoop stress with the code allowable stresses results in the percent over the allowable stress. A modest overstress level indicates a modest shortening of remaining life expectancy and, unless otherwise indicated by past maintenance experience, does not warrant immediate tube replacement.

If the tube analysis indicates significant overstress or the tubes are predicted to operate at temperatures above those for which ASME Code stresses are published, then tube replacement should be considered. Significant overstresses are considered as tube rows that are 20% or greater overstressed on a design pressure basis. An overstress of 20% or more does not necessarily mean that immediate replacement of the tube row is required, but it identifies which tube rows should be examined regularly for potential problems. Potential problems could be signs of creep, internal exfoliation, or swelling.

The superheater and reheater tube metals were evaluated based upon the expected fluid and gas design conditions predicted when firing Case 1 of the future operating conditions that were analyzed. The tube metals were all determined to be adequate as is; none of the tube metals were significantly overstressed when firing Case 1.

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CONCLUSION

This B&W engineering study analyzed the effect of a turbine upgrade on boiler performance for Black & Veatch on Alliant Energy Columbia Generating Station Unit 2. B&W evaluated the current operating conditions and future operating conditions and capabilities for a planned turbine HP/IP cylinder retrofit, with respect to economically feasible boiler modifications while firing a representative PRB and targeting 1005 °F superheater and reheater outlet steam temperatures. B&W analyzed the future conditions for 10 cases and the metallurgy with the new turbine and existing boiler arrangement for one case.

Upon installation of the turbine upgrade, B&W determined that 4 cases will reach superheat steam outlet temperatures of 1005°F with spray flow margin and 5 cases will reach reheat steam outlet temperatures of 1005°F with spray flow margin.

In order to achieve full superheat and reheat steam outlet temperatures in more than 4 cases, B&W recommends an increase in the finishing superheater bank heating surface (see Figure 1 for a side view of this surface modification). Furthermore, B&W recommends maintaining a higher cleanliness in the low temperature superheater and the economizer banks. This adjustment will help with the superheater steam outlet temperature while increasing boiler efficiency.

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Appendix 1:

Original Sectional Side View

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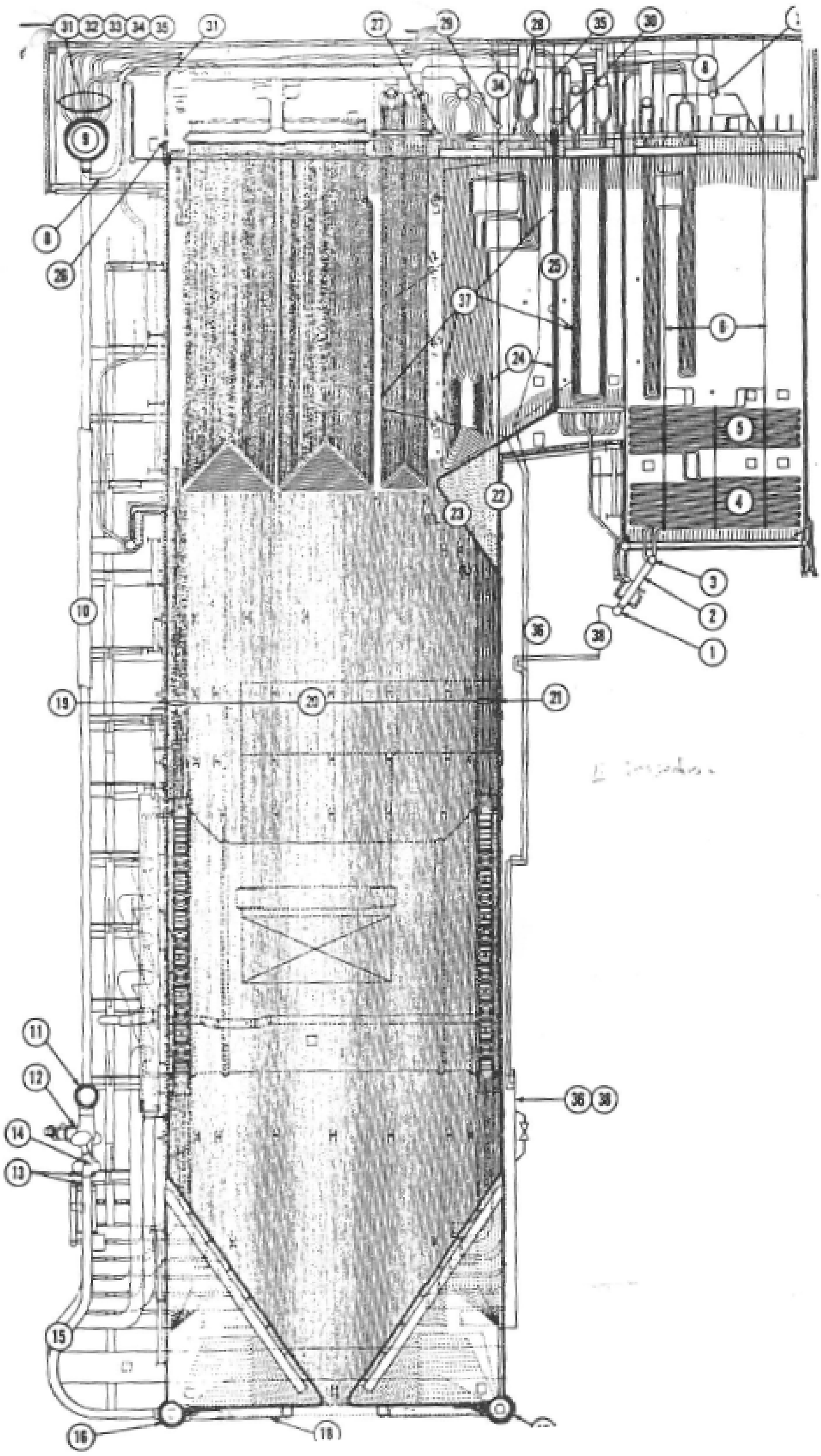

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Appendix 2:

Original Design Steam Turbine Performance

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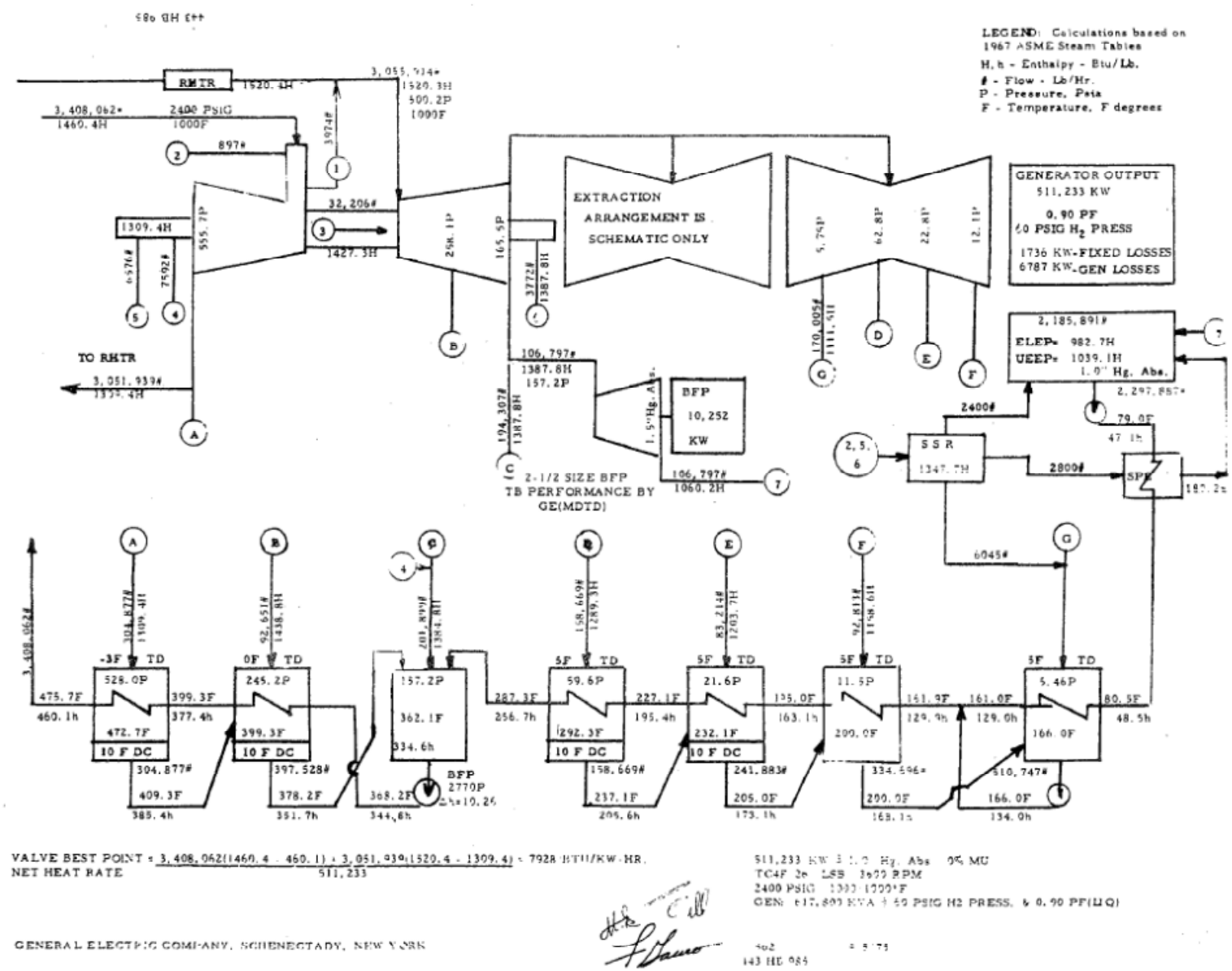

VALVE BEST POINT NET HEAT RATE = $\frac{3,408,062(1460.4 - 460.1) + 3,051,939(1520.4 - 1309.4)}{511,233}$ = 7928 BTU/KW-HR.

511,233 KW @ 1.0" Hg. Abs 0% MU
TC4F 26" LSB 3600 RPM
2400 PSIG 1000/1000°F
GEN: 617,800 KVA @ 60 PSIG H2 PRESS. & 0.90 PF(LIQ)

GENERAL ELECTRIC COMPANY, SCHENECTADY, NEW YORK

143 HB 985

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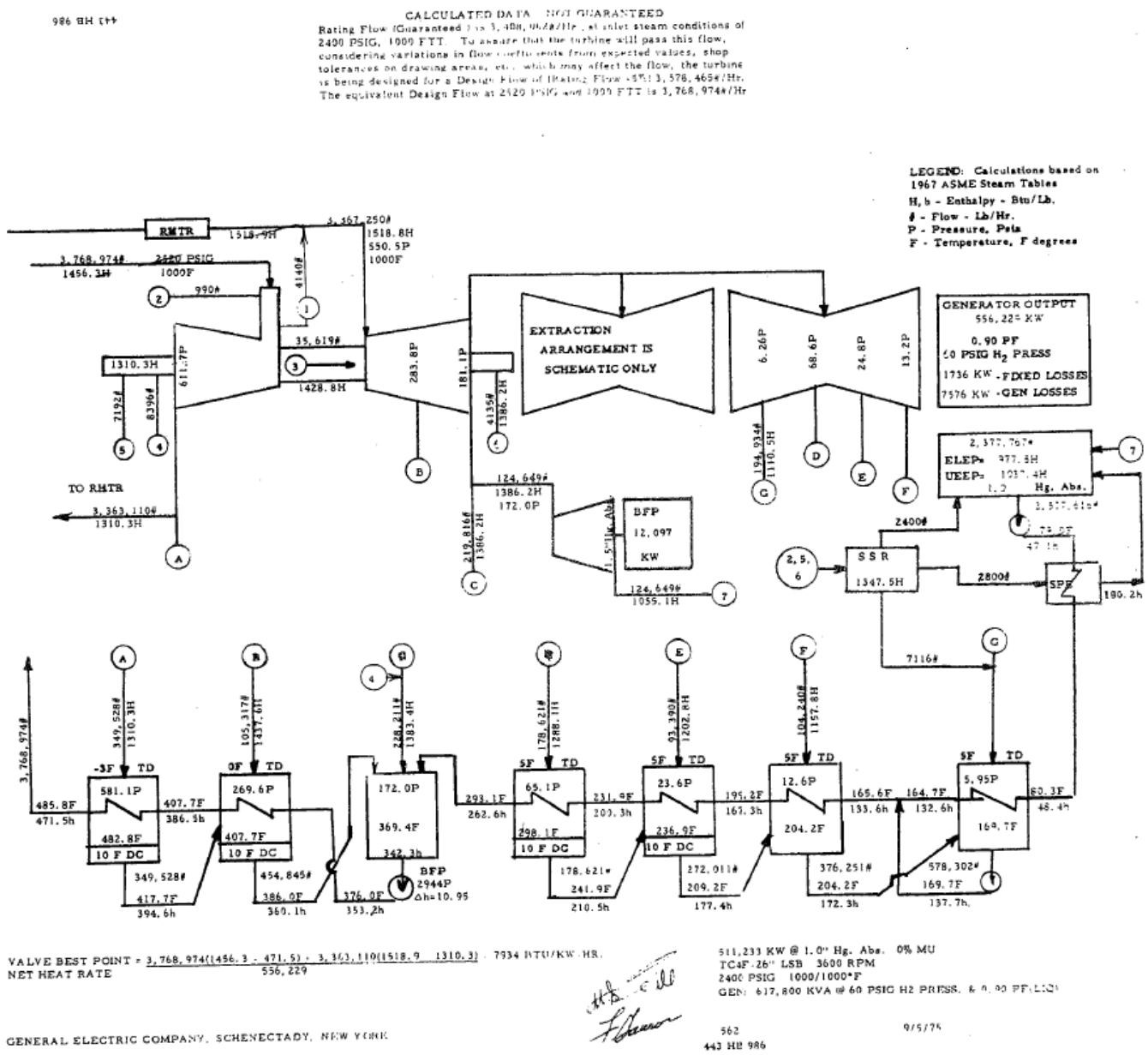

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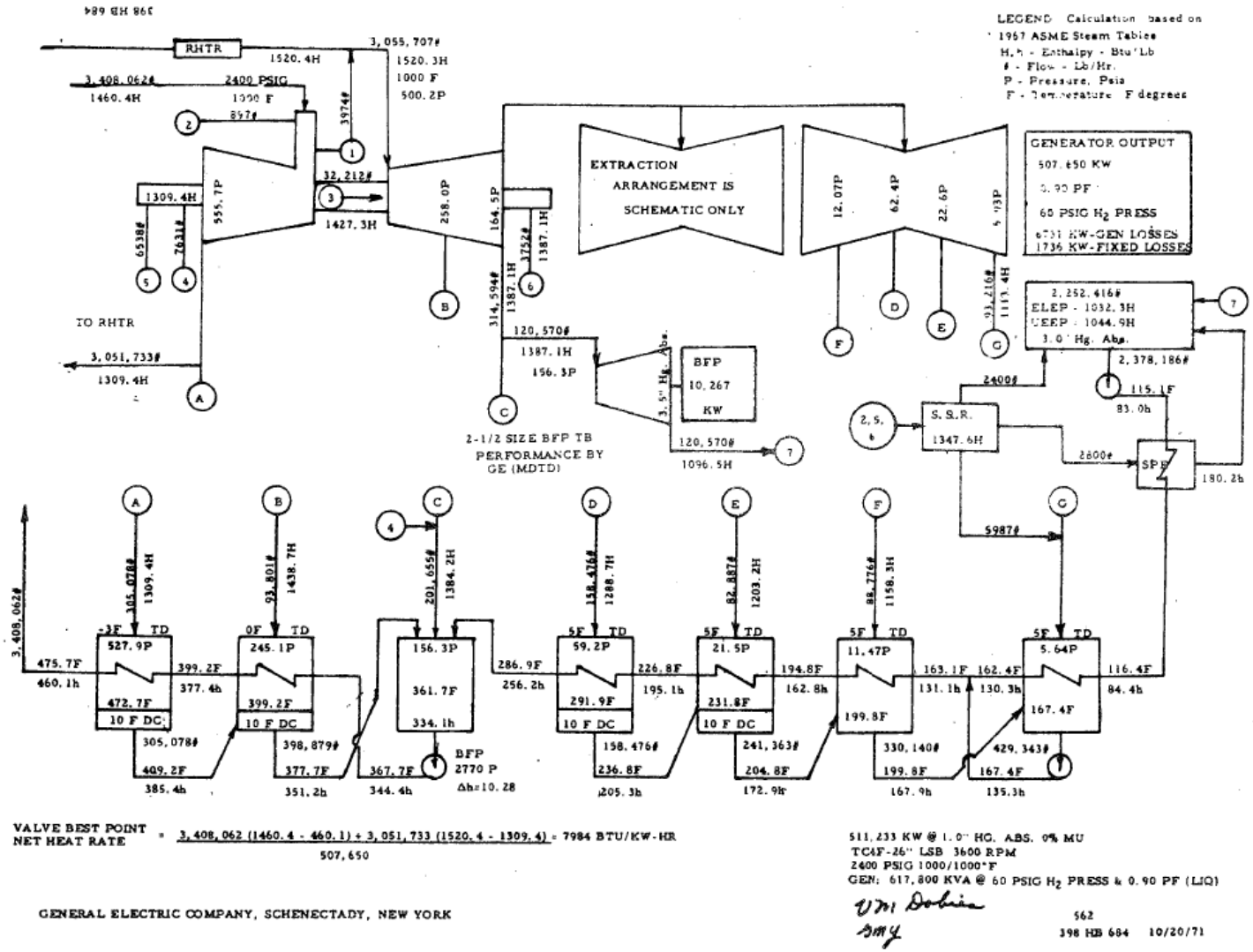

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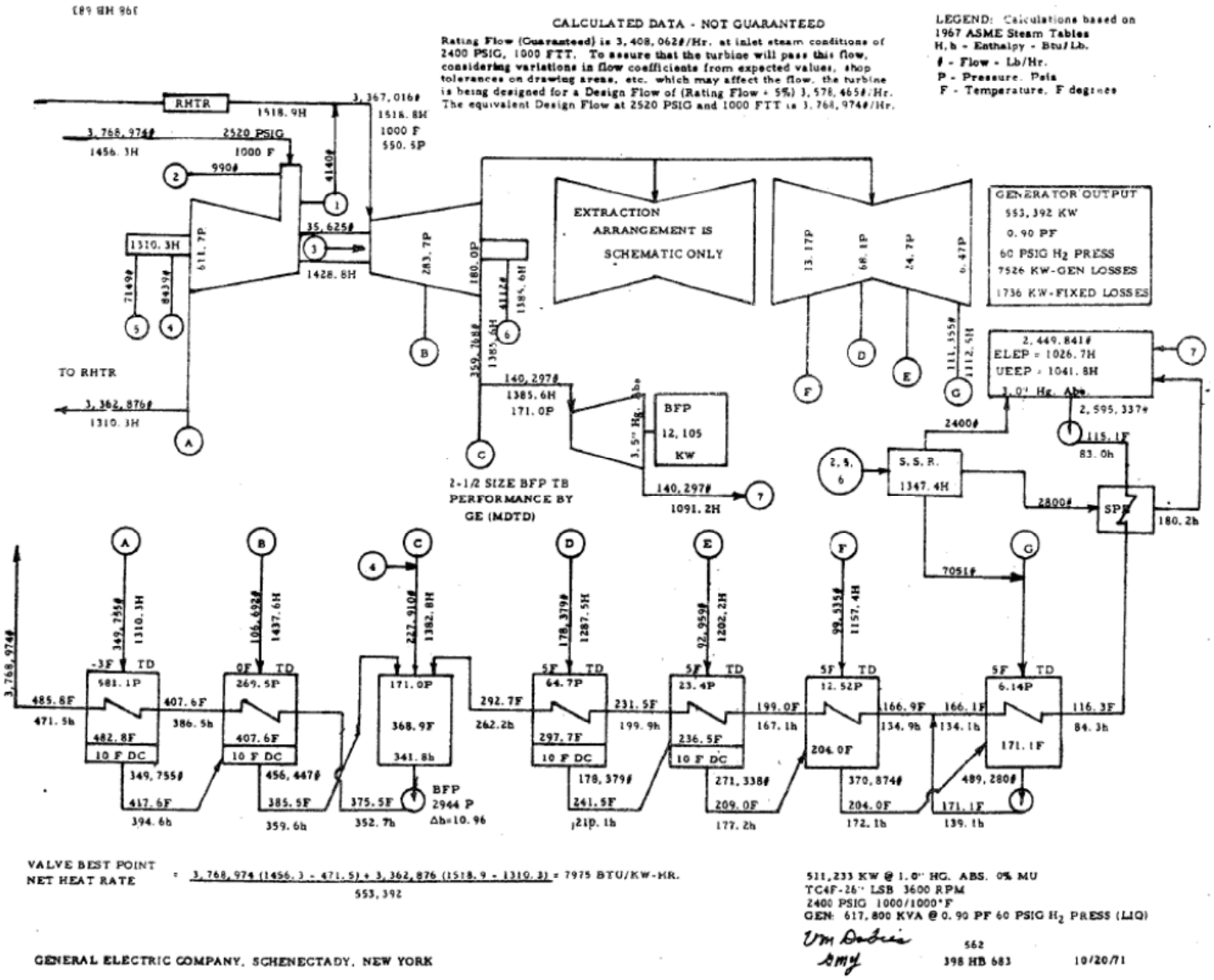

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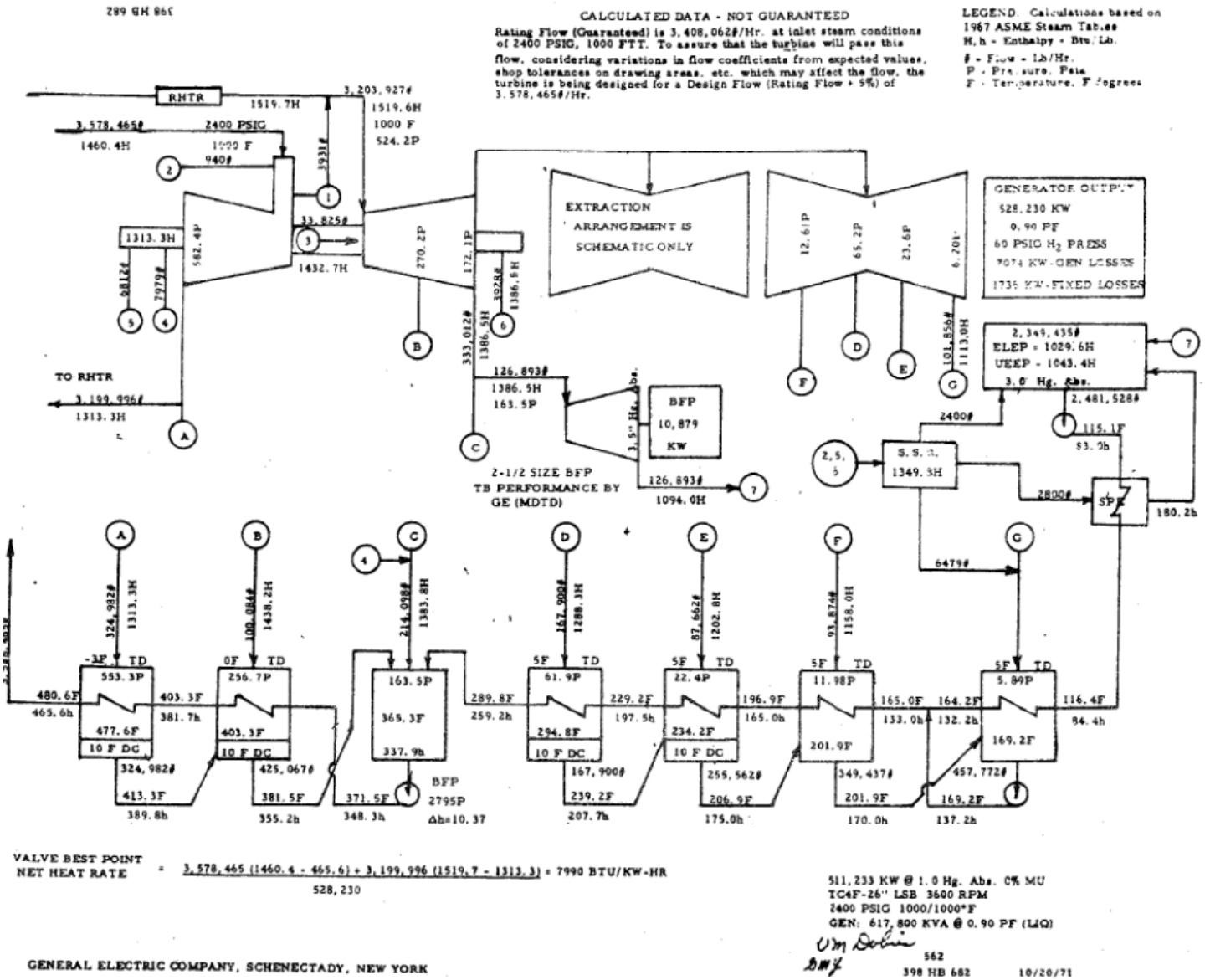

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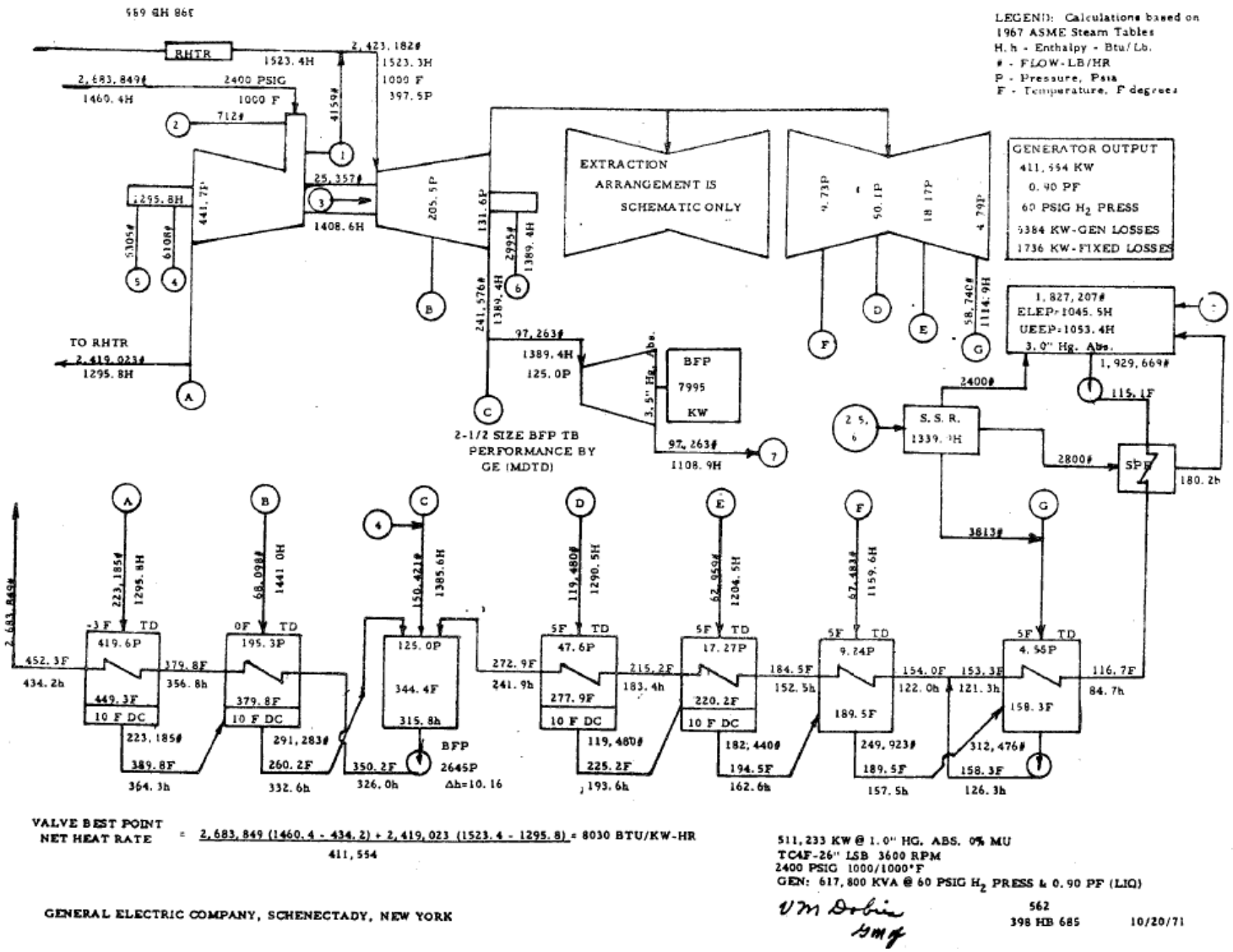

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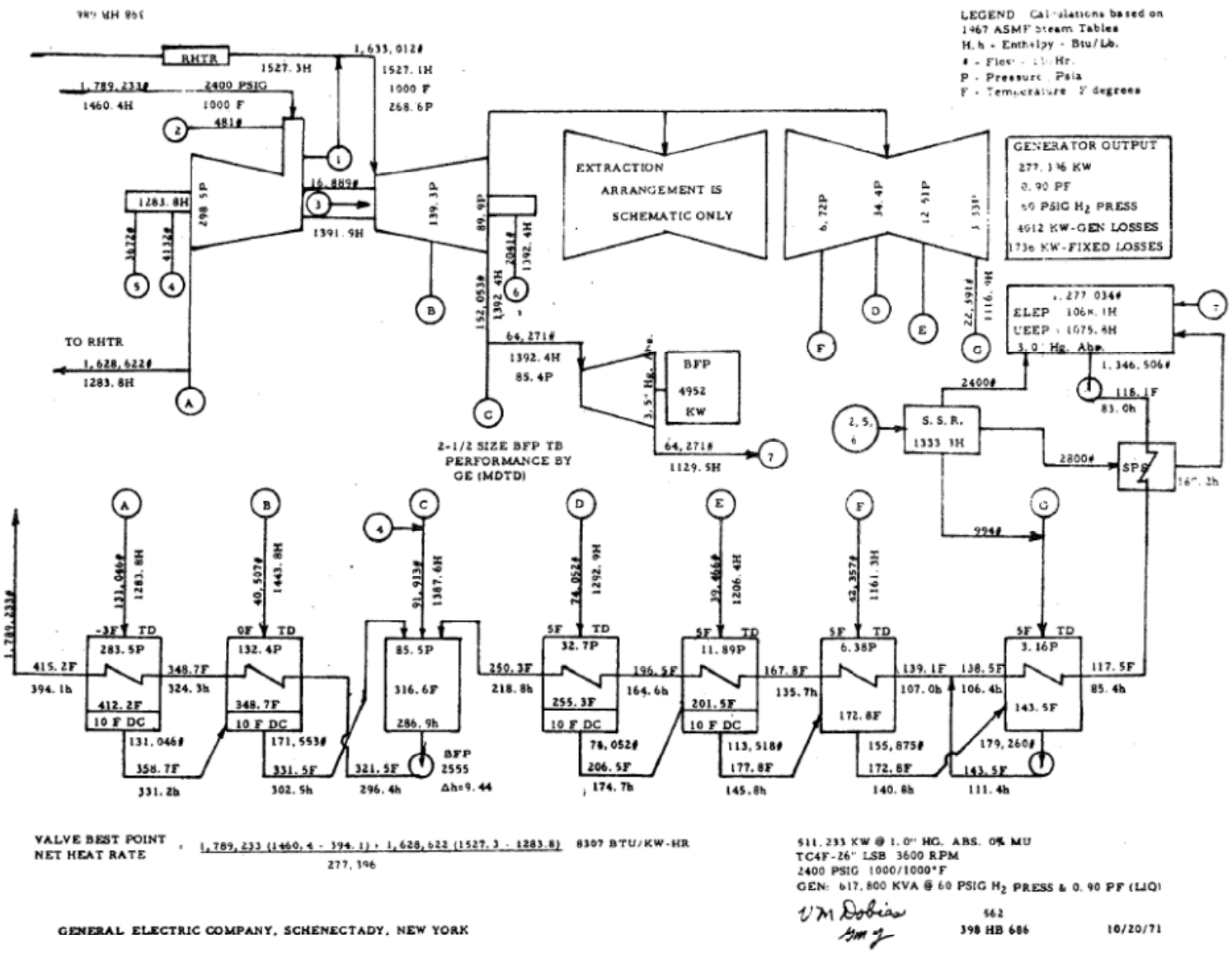

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Appendix 3:

Upgraded Steam Turbine Performance

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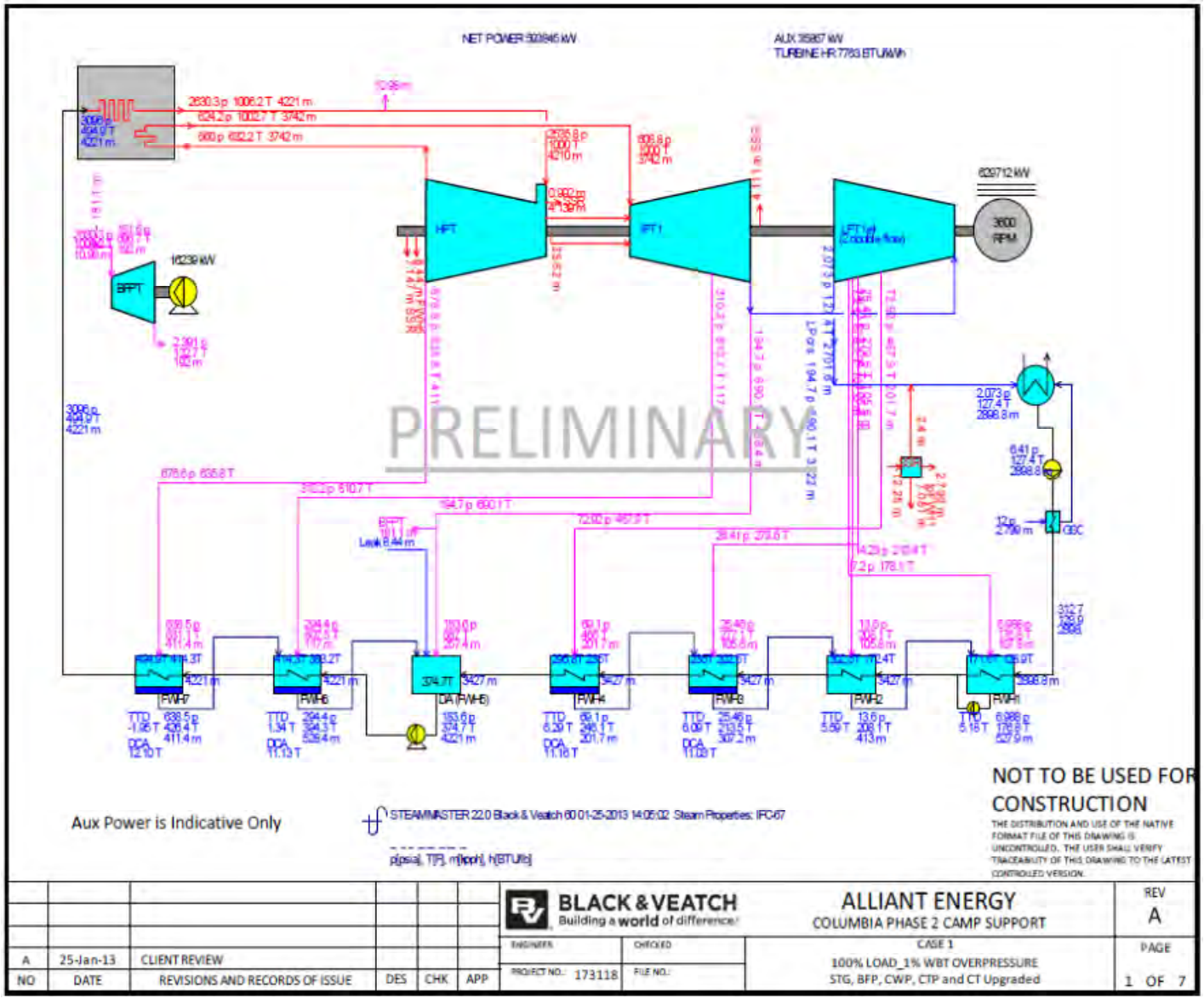

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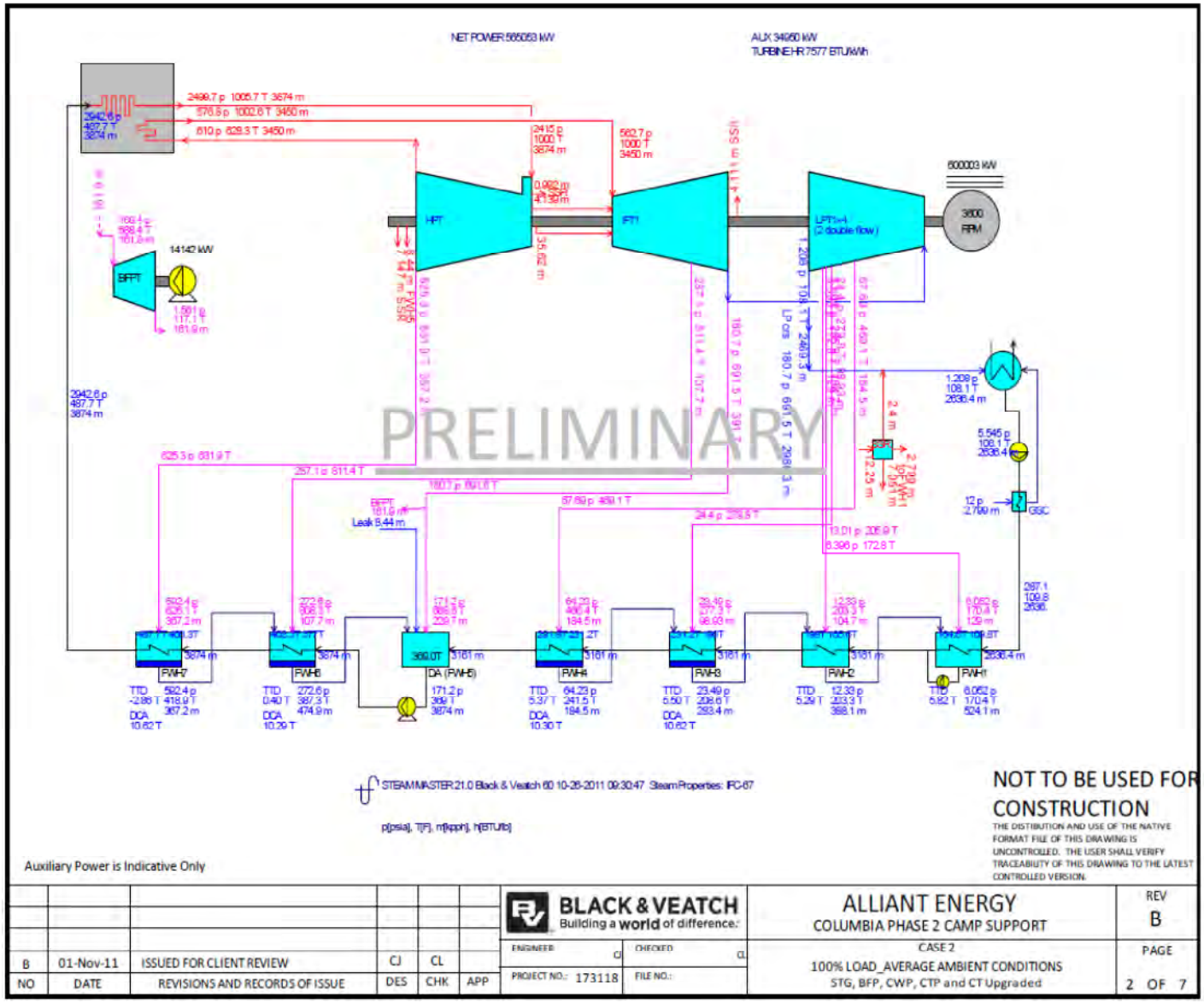

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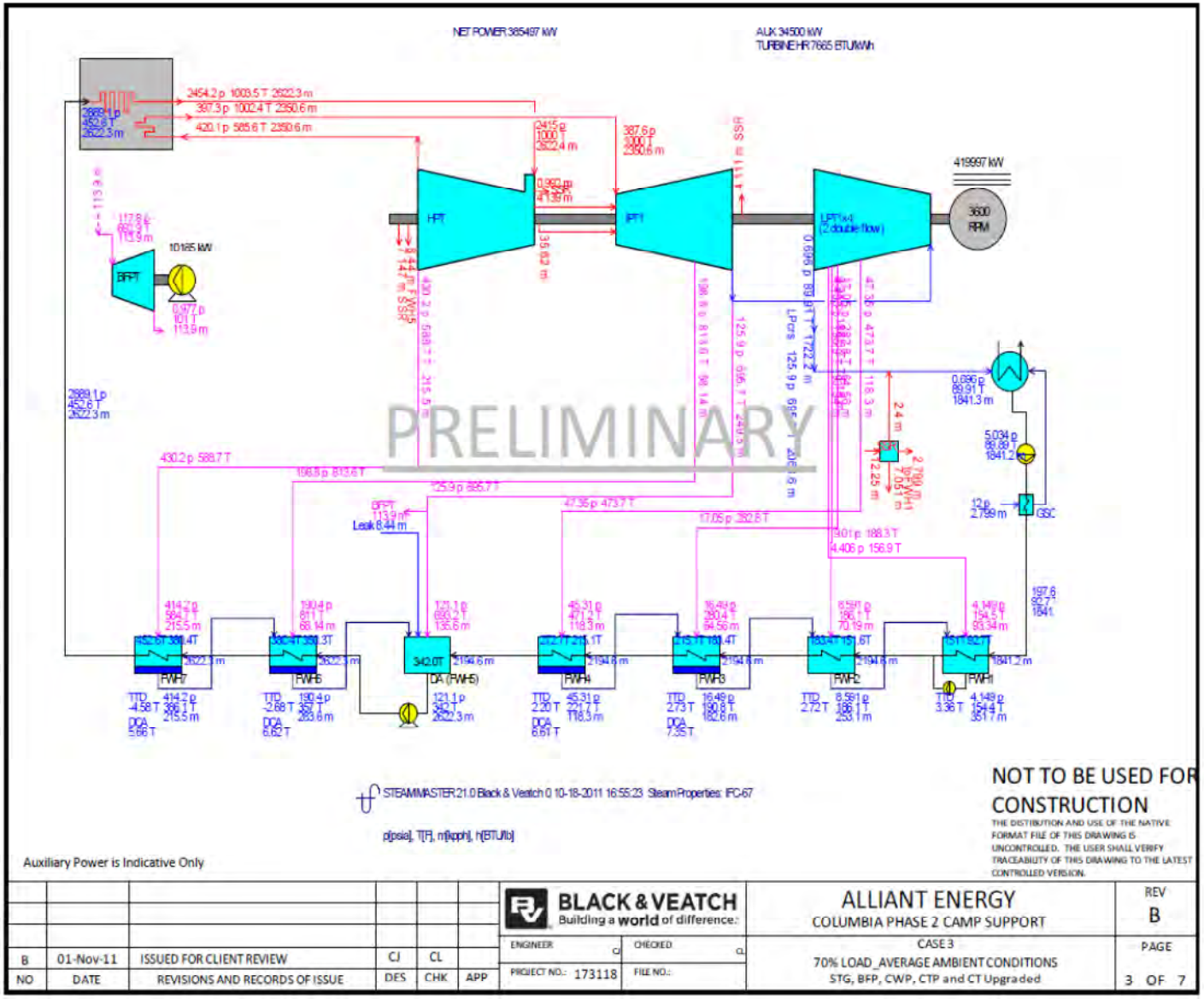

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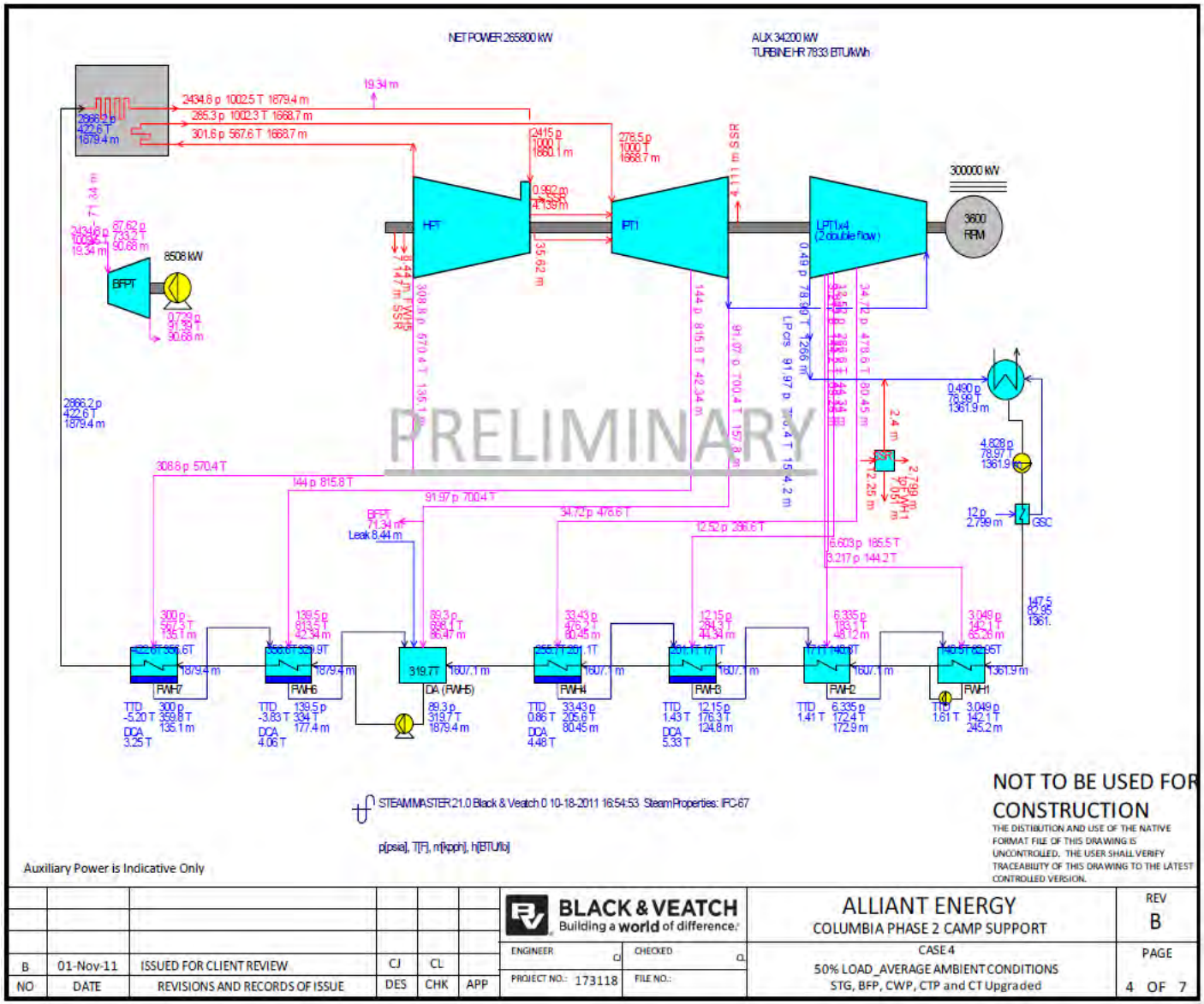

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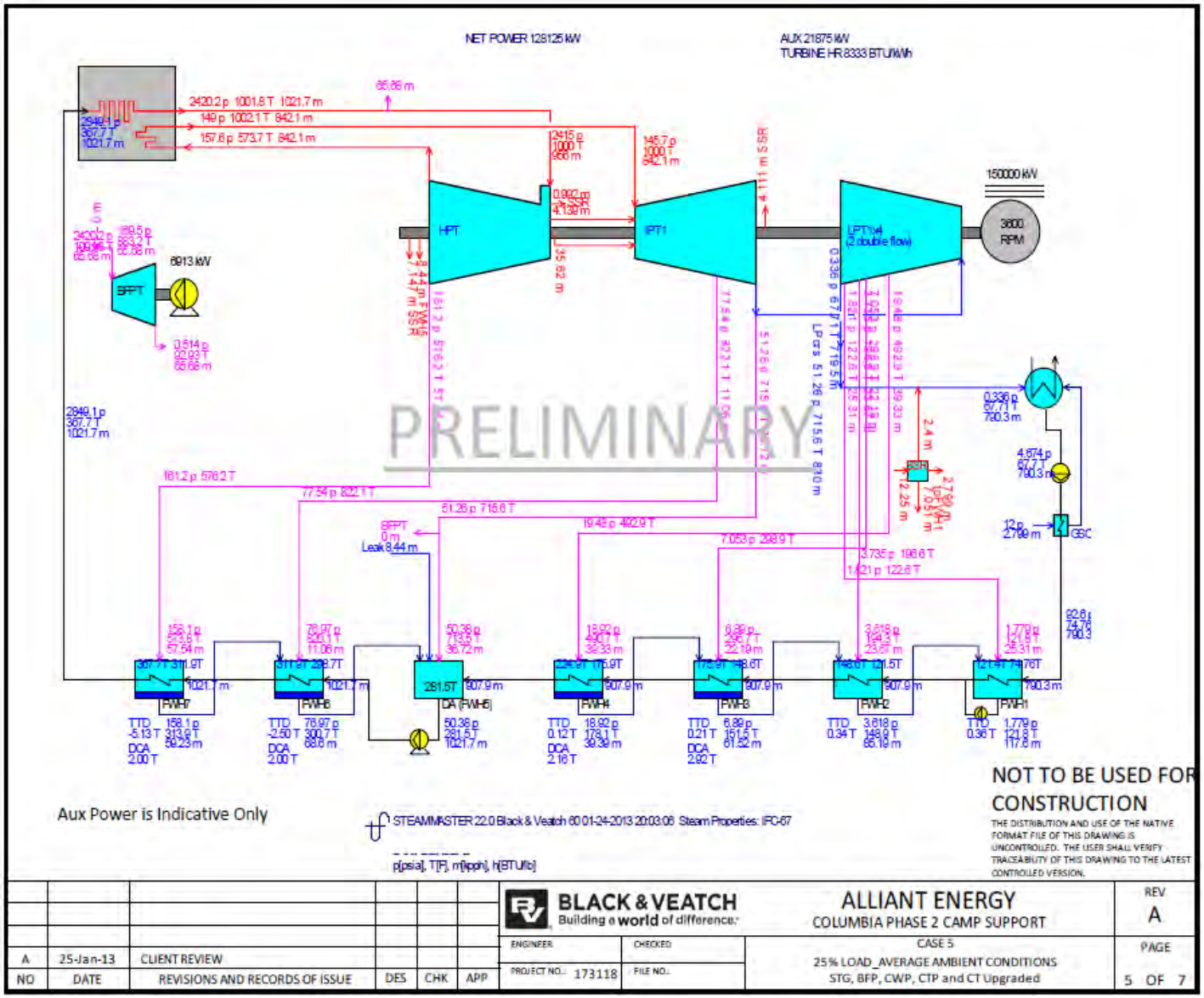

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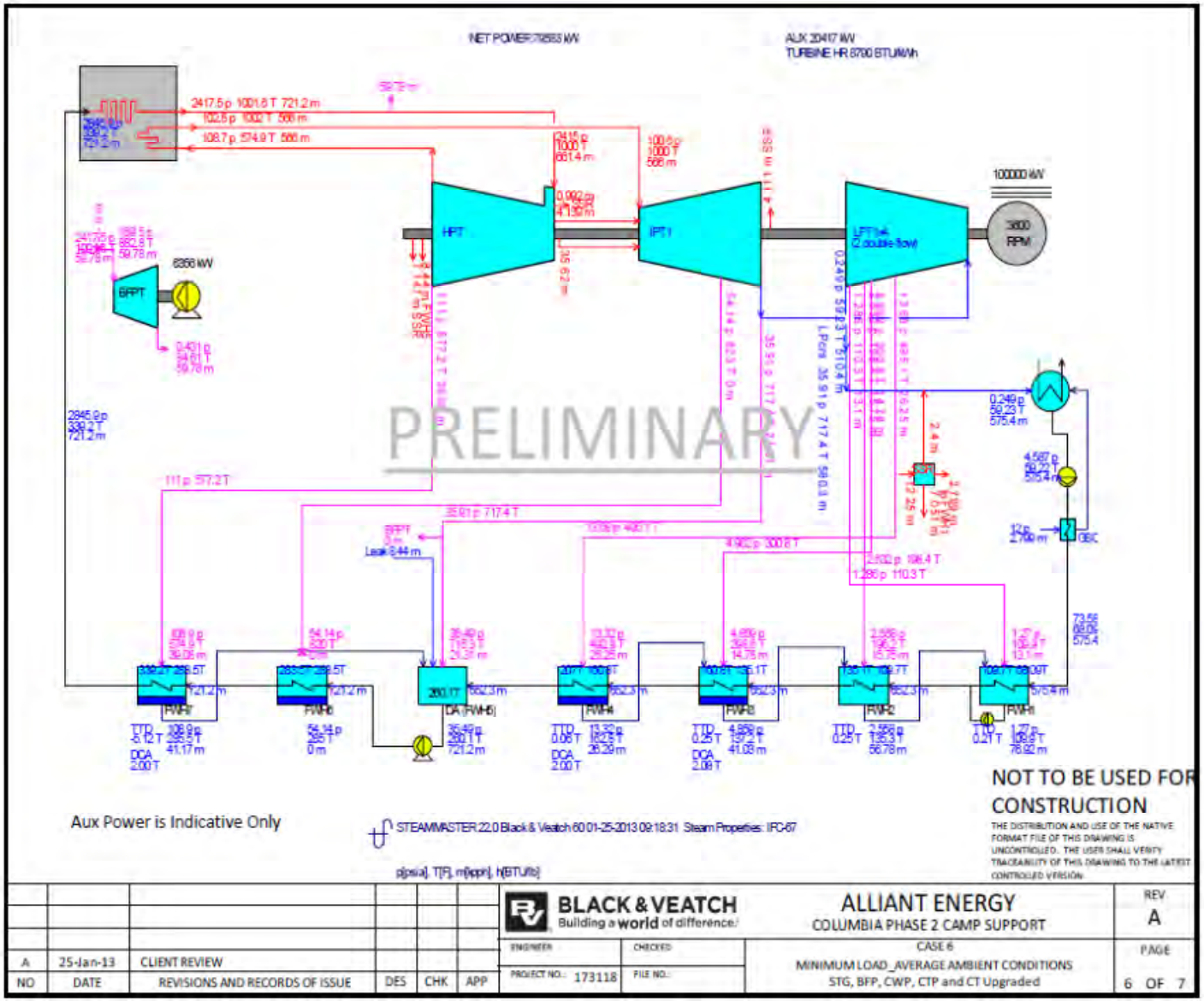

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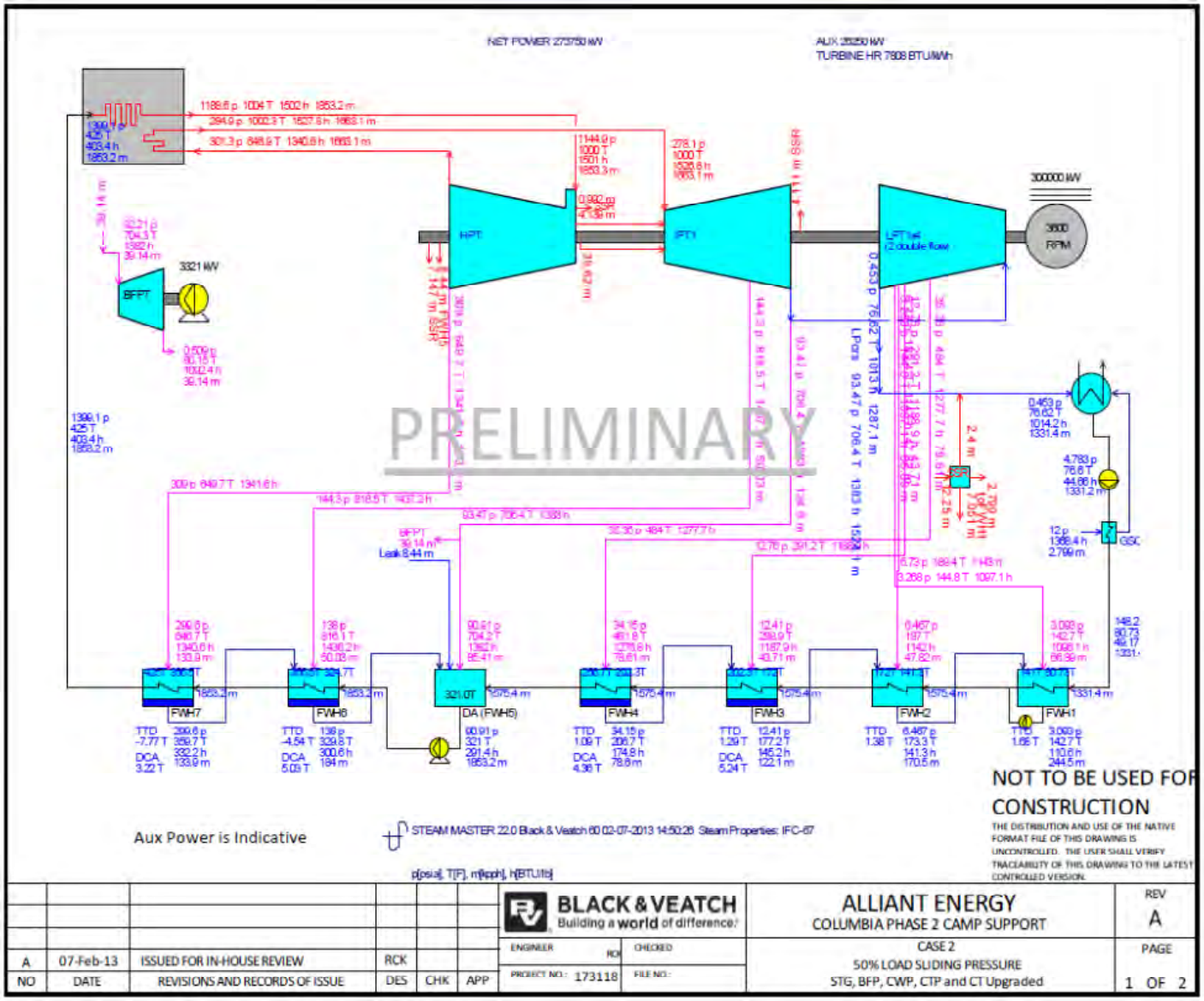

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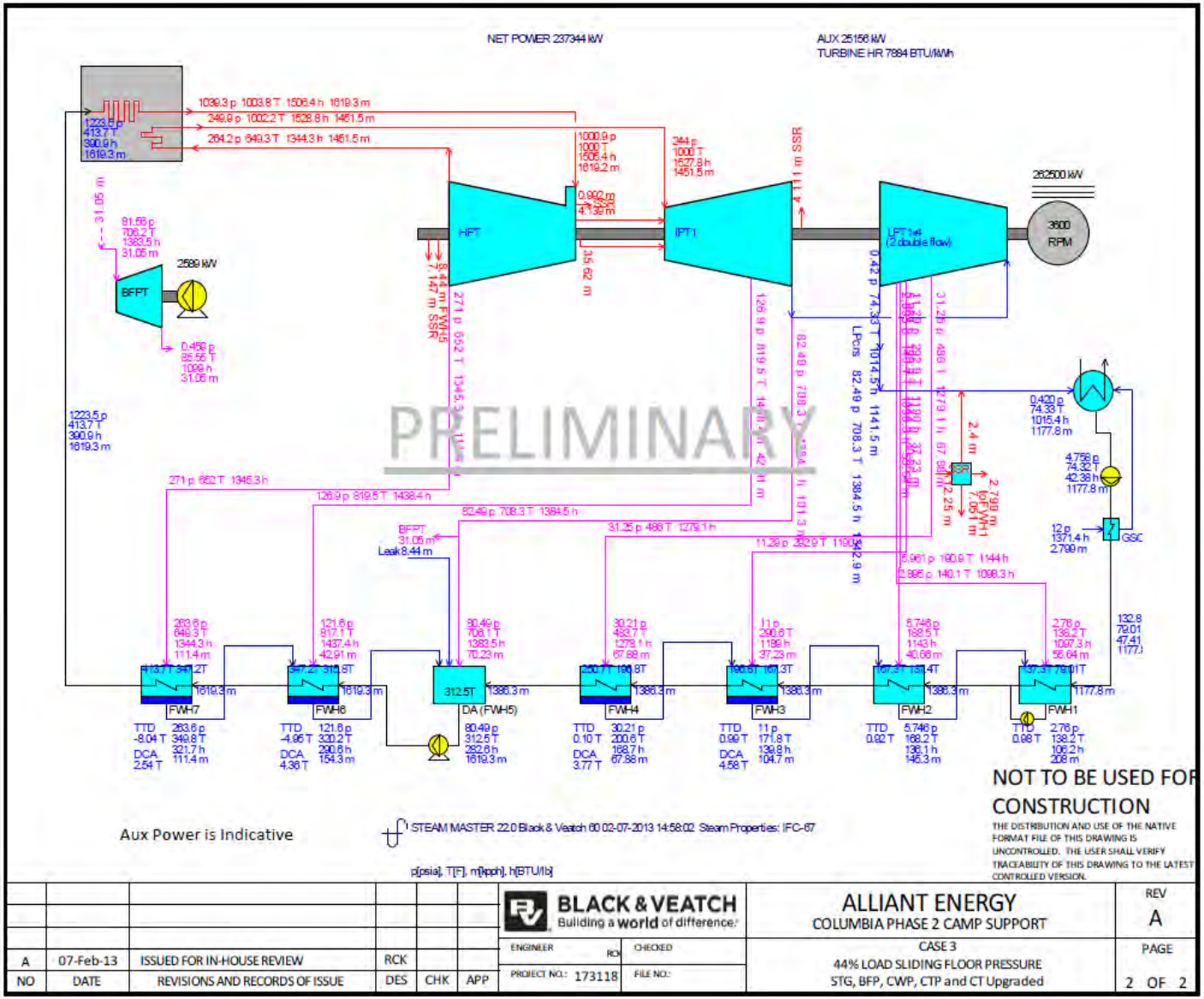

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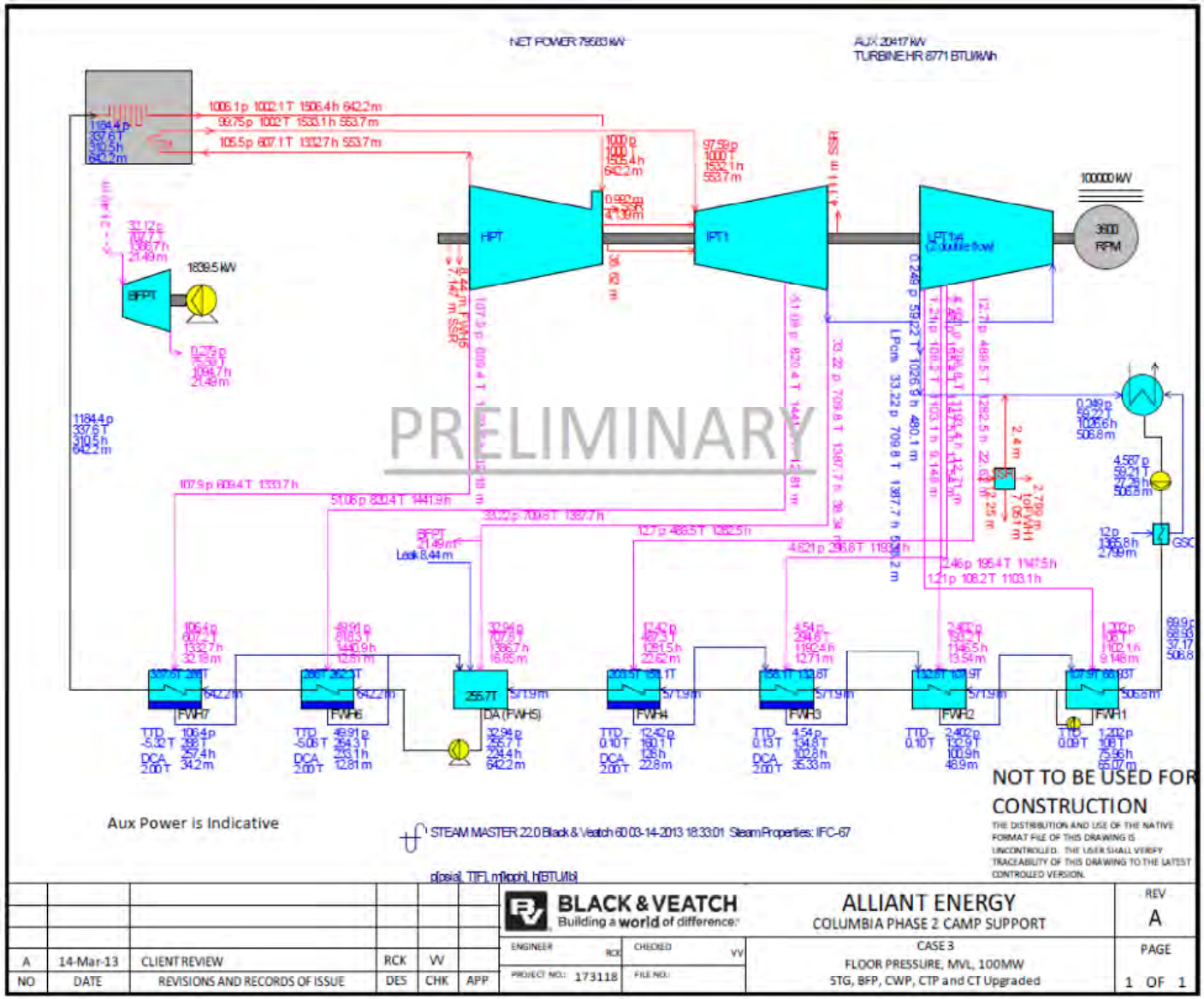

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APPENDIX H – ALSTOM 12% CHROME WELD REPAIR PAPER

12% CHROME WELD REPAIR OF A SERIES OF (12) LARGE LOW PRESSURE STEAM TURBINE ROTORS TO REMEDY STRESS CORROSION CRACKING IN L-1 AND L-2 STAGES

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Abstract:

There are a significant number of steam turbines that have latter stage blading operating in the region where stress corrosion cracking may initiate. When a large utility places heavy reliance on these high capacity turbines the overall integrity of the power generation system may come into risk. In order to minimize the risk exposure while simultaneously maintaining high levels of system integrity and reliability a comprehensive repair program is required. By optimizing unit outages and defining a plan for the repair, these goals can be attained. However, only through developing a relationship requiring very high levels of teamwork between repair facility, operating plant personnel, and engineering support personnel can these goals be met. The importance of these relationships and the coordination of the overall effort are herein outlined.

UTILITY BACKGROUND

Southern Company, a large public utility comprising Alabama Power, Georgia Power, Gulf Power, Mississippi Power, Savannah Electric and other operating facilities, faced a situation in 1998 where a large portion of their coal fired fossil fleet was exposed to undue risk. That risk stemmed from exposure to stress corrosion cracking, SCC, in the L-1 and L-2 stages of their large capacity steam turbines. While some weld repairs had been performed on two units approximately 5 years prior to present conditions being revealed, additional occurrences of SCC were either expected or had been discovered in other units. It was initially believed that the SCC was the result of operational factors and not attributable to deficiencies in materials, design or environment. The initial hypothesis was that the SCC was associated with brackish water in-leakage and associated water/steam chemistry problems. Later evaluations and discoveries revealed the SCC to be attributable to the three constituents of stress corrosion cracking notably; operating stresses, susceptible material and the operating environment existing in the latter stages of the low pressure sections of the turbines. Once it became known that SCC was an active and on-going phenomenon it became apparent to engineering and plant management personnel that a unified, consistent effort should be made to address the problem. This approach to problem solving would be a first for the Southern Company but would allow for optimal outage scheduling while maintaining high system integrity and reliability. In the past numerous owner/operators of large turbines had been told that rotor repair was not feasible, limited to certain, specific circumstances, not cost effective or simply impossible. Repairs were generally limited to enhancing the bucket attachment area or installing long shank buckets. Recently however, the approach to performing weld repairs has undergone a dramatic and radical change. At present a number of repair alternatives have become available.

While some non-invasive methods are available to determine the presence of SCC, still the most definitive method is to open the machine and check for lifting of the bucket from the disc. This is usually accomplished by using feeler gauges to check for lifting or in some instances actually removing the rotor from the machine and removing buckets and inspecting the attachment area. If cracking is discovered an engineering evaluation may oftentimes be needed to provide adequate assurance of continued safe operation. In the alternative, if sufficiently severe cracking is discovered the removal of a blade row may be necessary combined with the installation of pressure plates. As experience proved even these methods were sometimes inadequate to definitively prove the existence of cracking.

UTILITY STRATEGY

Southern Company operates eight units, a total of 16 rotors, of the type believed most susceptible to SCC. See table #1. These units account for 6470 MW of generation in the service territory. Considering the exposure entailed with this quantity of generation,

a system wide approach was believed to be the most beneficial to our customers, stockholders, and the company as a whole.

Table #1:
Most Susceptible Southern Company Units

Operator	Station	Unit #	MW Rating	LSB Length	Vintage
Alabama Power Co.	Barry	5	700	30”	1971
Alabama Power Co.	Gorgas	10	700	30”	1972
Georgia Power Co.	Bowen	2	700	30”	1972
Alabama Power Co.	Gaston	5	884	33.5”	1974
Georgia Power Co.	Bowen	3	884	33.5”	1974
Georgia Power Co.	Bowen	5	884	33.5”	1975
Georgia Power Co.	Wansley	1	856	33.5”	1976
Georgia Power Co.	Wansley	2	856	33.5”	1978

By approaching this effort in a systematic and uniform manner, the anticipated repairs were believed to be attainable in the most advantageous manner. This method would simultaneously allow for a planned, systematic sequencing of outages, effectively utilize restricted resources while maintaining overall electric system reliability and availability, while resulting in the lowest overall possible cost. Where possible, these lengthy outages were coordinated with other turbine repairs, generator repairs, or other long duration activities so as to optimize the overall outage duration. Executive level management was advised of the conditions present and the risks faced by continuing to operate these units in their present condition. Approval was obtained and the overall program was initiated.

The initial facet of this systematic approach was the development of a specification that addressed as many base or recognized factors as possible while also providing for as many contingent possibilities as could be foreseen. Foreseeable or recognized repair methods consisted of re-machining and installing long shank buckets, re-machining to enhance the bucket attachment area, installation of forgings and associated weld attachments along with overall weld build-up using a variety of welding processes. An additional compounding factor to these repairs is the type of blade attachment. That being either the ‘dovetail-hook’ fit or ‘finger-pin’ type of attachment. Lessons learned

from prior Southern Company repairs were incorporated into the specification to directly address or eliminate known or previously experienced difficulties.

Factors as simple as transportation were also addressed in the specification. While transportation may sound like a simple task it must be remembered that each of these components weighs over 100,000 pounds, is approximately 30 feet in length and is approximately 11 feet in diameter. To further compound the transportation facet some states restrict travel to specific hours and in some instances weekend travel is also restricted.

After obtaining appropriate Southern Company internal approvals the initial 'strawman' specification was developed and delivered in early 1999 to operating company turbine engineers and experts at each of the generating plants having the affected units. As noted, this initial specification addressed as many possibilities as could have been reasonably foreseen. See Table #2 [(1)]. Comments, suggestions and individual unit concerns provided by Southern Company experts were incorporated to provide a common repair specification. As outlined the specification contained information ranging from length of available outage through mechanical testing and availability of welding consumables. It must be remembered that the clock was ticking while all of these developments and refinements were taking place. A review was made of proposed outages and associated activities and a planned implementation date of the fall of 1999 was settled upon. This timing allowed for only a period of two months to finalize a specification, evaluate bids and suppliers, award the contract, adjust outages and make initial plans for the overall implementation of repairs. All this occurring while five different operating plants were continuing to implement and execute previously scheduled outages.

Once completed and accepted by each of the operating company representatives the finalized specification was sent to those service suppliers believed capable of performing the repair work. Pre-bid meetings were held with each of the bidding service organizations so as to minimize any confusion as to specification content and intent as well as to clarify any areas of concern contained within the specification. Responses to questions were specifically answered with all answers provided to all bidders. In conjunction with the bid specification site visits were made to each of the proposed repair facilities. This allowed for a first hand evaluation of purported capability as well as verifying performance capability claims.

The base specification allowed for a believed consistent and simplified overall bid evaluation and subsequent contract award. While the bids received contained information as required in the specification and on the required reply form the addition of other options and corresponding contingent pricing proved to be difficult to decipher and reconciled. Nonetheless, operating company representatives were able to evaluate the bids based on cost, time to perform the repair, and capabilities of the repair organizations.

Table #2: Southern Company Specification Options [1]		
Options:	**Description:**	**Details:**
1	Enhanced machining L-1 & L-2 (tangential entry buckets only)	Remove L-1 & L-2 buckets Enhance L-1 rotor attachments Enhance L-2 rotor attachments
2	Weld repair L-1 and enhanced machining L-2	Remove L-1 & L-2 buckets Remove L-1 rotor attachments Inspect L-2 rotor attachments Weld L-1 rotor attachments Enhance L-2 rotor attachments Machine L-1 bucket attachments
3	Weld repair L-1 & L-2	Remove L-1 & L-2 buckets Remove L-1 & L-2 rotor attachments Weld L-1 & L-2 rotor attachments Machine L-1 & L-2 bucket attachments
4	Boresonic support	Contractor support of OEM boresonic examination at their facility
5	L-0 pin work	Removal and replacement of L-0 pins as defined by NDE
6	Transportation	Round trip shipping and associated permitting of the rotor.

REPAIR FACILITY SCHEDULE REDUCTION INITIATIVES

From the beginning, minimum schedule time was a clear priority from the utility's standpoint. Since the same scope of repair was being performed on two rotors, LPA & LPB rotors, duration of the entire project was not only a concern, but also the duration of each rotor in combination with the stager between rotor shipments. During the proposal stage, the repair facility, made an accordant effort to reduce the schedule of each individual rotor, the stager between rotors, and the overall project schedule by:

- Identify developments that could reduce individual task cycle times.
- Identify tasks to promote parallel path work.
- Identify changes in process sequencing.

This brainstorming effort resulted in a 10% to 25% reduction in previously offered/performed overall schedules, depending on the repair option defined and the rotor configurations (i.e. 30” or 33.5” last stage blade design rotors). The following section of this paper defines these initiatives taken by the repair facility, the overall schedule reductions expected from these initiatives, as well as summarizes the actual schedule reductions obtained.

Individual Task Schedule Reduction Initiatives

The individual task cycle time reduction initiatives focused on tasks or process durations that could be reduced by the development of a new design, new tooling, new fixturing, or new processes. These initiatives benefited not only the durations of each rotor during the repair, LPA and LPB rotors, but it also benefited the overall duration of the project. Of the many individual task reductions defined, four were targeted as initiatives that would provide the best ratio of schedule reduction in respect to cost of implementation. These four individual tasks were 1.) the L-1 wheel pinhole finger drilling operation, 2.) the L-0 wheel blade removal and re-installation operation, 3.) the L-1 & L-2 steeple turning operation, and 4.) the L-2 blade assembly operation.

The L-1 wheel pin hole finger drilling initiative involved the reduction in schedule duration for the drilling of the 399 holes per wheel, 798 holes per rotor on the L-1 finger type wheels. The original process for this operation performed on previous repairs [(2)] by the repair facility utilized an HBM (Horizontal Boring Machine) to drill the L-1 finger pinholes. The rotor was fixtured, set up, and aligned to the HBM and (1) hole on (1) end of the rotor was drilled at a time. This original hole drilling process took 7 days per rotor or 14 days per unit being repaired. The new proposed process to reduce this task duration was to design and develop a multi-spindle-drilling head to drill (3) holes on (1) end of the rotor at a time still using the HBM. A task that required definition and procurement of multi-spindle drill head ensuring it met rigidity, accuracy, torque, and access requirements. This new proposed process was estimated to save 3 days per rotor or 6 days per unit. See figure #1.

The L-0 wheel blade removal and re-installation initiative involved the reduction in schedule duration by eliminating the requirement of removing the L-0 blades from the base scope of the project. This operation, although not a contract requirement for the Southern Company rotors, was needed originally for access of the HBM during the finger hole drilling process. The original L-0 blade removal, inspection, and re-installation process took 5 days per rotor or 10 days per unit being repaired. The new proposed process to reduce this task duration was to design and develop a portable

multi-spindle drilling device, taking this operation off of the HBM. By removing this operation from the HBM it would allow the L-0 blades to remain installed on the rotor throughout the repair cycle. A task that required the design and development of a portable multi-spindle-drilling device ensuring it met power, stroke, rigidity, accuracy, torque, access, and locational requirements. This new proposed process was estimated to save 5 days per rotor or 10 days per unit.

The L-1 and L-2 steeple turning initiative involved the reduction in schedule duration for the machining operation of the dovetail wheel steeples. The original process for this operation required the use of multiple rough machining passes as well as multiple final machining passes to complete the final steeple machined geometry. The original process of final machining the steeples took 9 days per rotor or 18 days per unit being repaired. The new proposed process was to maximize the amount of material removal by each roughing pass to best minimize the overall duration of this process. A task that required evaluation of parameters to ensure limits of the machine tool and quality of the end product were not compromised. This new proposed process was estimated to save 2 days per rotor or 4 days per unit.

The L-2 blade assembly initiative involved the reduction in schedule duration for the installation of 194 blades per wheel, 388 blades per rotor. The original process for this operation performed utilized bladers milling the radial and axial tang fits at the foot of the blades in conjunction with installing the blades on the wheel. The original L-2 blade row installation process took a duration of 5 days per rotor or 10 days per unit being repaired. The new proposed process to reduce this task duration was to utilize a small HBM and a machinist to support this tang milling operation. The machinist and the small HBM allowed for set up and milling of multiple blades at once and also removed the blader from this operation, so he could concentrate on installing blades. A task that required design and development of special tooling and fixturing as well as excellent and continuous communication between the assembly and machining departments. This new proposed process was estimated to save 2 days per rotor or 4 days per unit.

Overall these individual task initiatives provided over 20 estimated days of schedule reduction on each unit. Table #3 summarizes these individual task initiatives [(3)] that were recognized as high potentials candidates implemented on the project and the estimated days of duration saved on the overall project schedule.

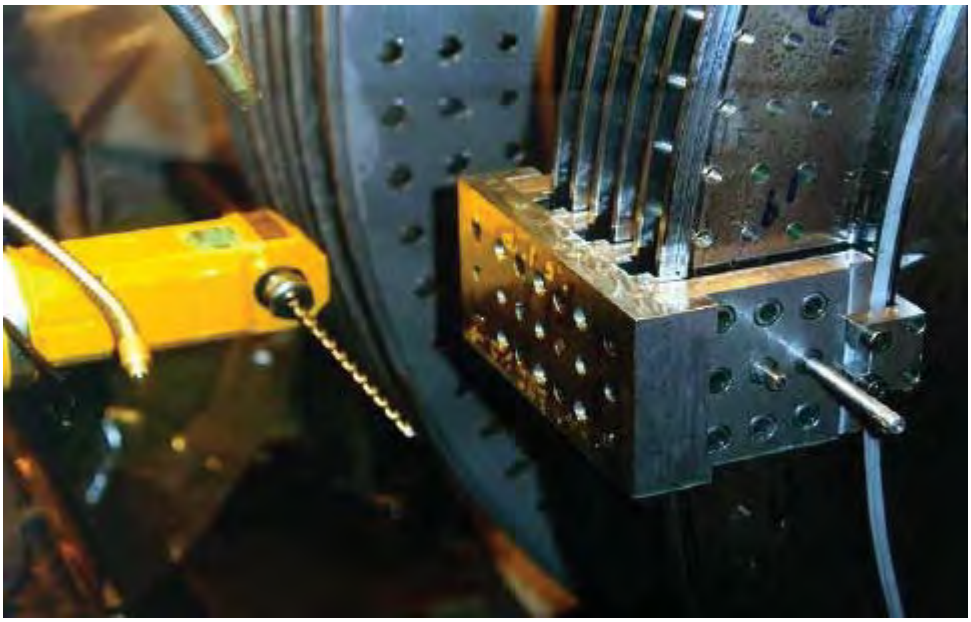

Figure #1:
Original Single Spindle Heads

Table #3:
Individual Task Schedule Reduction Initiative Results [3]

Task	Description	Original Process	Process Duration	New Proposed Process	Est. Days Saved
Finger Drilling	Drill pin holes in L-1 fingers.	HBM drill (1) hole at a time.	7 days per rotor, (14) total.	HBM drill (3) holes at a time.	6 days.
L-0 Blade Work	Removal/re-assy of L-0 blading.	Remove L-0 blades for HBM access during finger drilling.	5 days per rotor, (10) total.	Takes drill process off of HBM, no L-0 removal.	10 days.
Steeple Turning	Rough & final machining of the L-1 & L-2 steeples.	Multiple rough machining passes in series.	9 days per rotor, (18) total.	Maximize roughing cuts & minimize rough mach.	2 days.
L-2 Blade Assembly	Tang mill to assemble blades.	Blader utilizes manual milling machining.	5 days per rotor, (10) total.	Utilize CNC small HBM to reduce cycle.	2 days.

Parallel Path Schedule Reduction Initiatives

The parallel path cycle time reduction initiatives focused on tasks and process duration to determine if they could be performed in parallel by the development, acquisition, or upgrade of equipment to support the work. These initiatives best benefited the overall duration of the entire project by reducing the stager between the first and second rotors. But, it also benefited parallel path work between both ends of each rotor since they were double flow rotors. Of the many parallel path task reductions defined, five were targeted as initiatives that would provide the best ratio of schedule reduction in respect to cost of implementation. These five individual tasks were 1.) the submerged arc weld buildup operation of the L-1 and L-2 wheels, 2.) the L-1 & L-2 steeple turning operation, 3.) the stress relief operation of the welds, 4.) the L-1 wheel pin hole finger drilling operation, and 5.) the L-2 blade long arc shroud assembly operation.

The submerged arc weld buildup initiative involved the reduction in overall schedule duration for the welding of the LPA and LPB rotors in parallel vrs. series. The original process for this operation utilized the large submerged arc welding station for welding the first LPA rotor then the second LPB rotor in series. This original series path operation took 11 days per rotor or 22 days per unit being repaired. The new proposed process to reduce this duration was to upgrade the second submerged arc station to support welding both LPA and LPB rotors in parallel. A task that required design, definition, and procurement of new controllers, steadies, and power supplies ensuring it met power, weight, and configuration requirements. This new proposed process was estimated to reduce the shipment stager between rotors from 11 days due to the weld buildup to 8 days due to the steeple turning operation.

The L-1 & L-2 steeple turning initiative involved the reduction in overall schedule duration by performing steeple roughing operations in parallel to final machining operations. The original process for this operation was to first perform the rough machining operation of the steeples then perform the final machining operation in series. This original series path operation took 8 days per rotor or 16 days per unit being repaired. The new proposed process to reduce this duration was to upgrade the portable lathe to support rough steeple machining of the LPB rotor in parallel with final machining of the LPA rotor. A task that required design, definition, and procurement of a new drive, steadies, and ways ensuring it met torque, weight, rigidity, and maximum envelope requirements. This new proposed process was estimated to reduce the shipment stager between rotors from 8 days due to the steeple turning operation to 4 days due to the stress relief cycle.

The stress relief initiative involved the reduction in overall schedule duration by performing the stress relief operation in parallel between the LPA and LPB rotors. The original process for this operation involved the stress relief of each rotor in series and in the vertical position [(2)]. This original series path operation took 4 days per rotor or 8 days per unit being repaired. The new proposed process to reduce this duration was to stress relief the rotors in parallel in the horizontal position. A task that required

definition and procurement of a new process, steadies, and instrumentation ensuring it met ramp rates, max. temps, weight, data collection, and rotor at temp stiffness requirements. This new proposed process was estimated to reduce the shipment stager between rotors from 4 days due to the stress relief operation to 3 days due to either the high-speed balance or steeple final machining cut operations. See figure # 2.

The L-1 finger drilling initiative involved the reduction of each rotors schedule duration by performing the pinhole drilling operation in parallel between the turbine end and generator end of the rotors. The original process for this operation would have involved (1) portable multi-spindle drilling device to drill one end of the rotor at a time in series. This original series path operation would have took 2 days per end or 4 days per rotor being repaired. The new proposed process to reduce this duration was to procure a second portable multi-spindle-drilling device in order to drill both ends of the rotor in parallel. A task that only required the allocation of capital funds to purchase the second device. This new proposed process was estimated to reduce the schedule of one rotor from 4 days to 2 days per rotor.

The L-2 blade long arc shroud assembly initiative involved the reduction of each rotors schedule duration by performing the long arc shrouding layout in parallel to other work and prior to blading. The original process for this operation involved the installation of the L-2 blades, the layout of the L-2 shrouds, the punching of the L-2 shrouds, and assembly of the L-2 shrouds all in series. This original series path operation took 2.5 days per row or 5 days per rotor being repaired. The new proposed process to reduce this duration was to produce a full size mock up of the wheel to allow off critical path assembly of these blades in order to layout and punch the shrouds. A task that required the procurement and machining of a mock up wheel ensuring it met the same dimensional requirements as the production wheel. This new proposed process was estimated to reduce the schedule of one rotor from 5 days to 4 days per rotor. See figure #3.

Overall the LPA to LPB rotor parallel path initiatives provided an estimated reduction of 8 days on the stager between rotors and the overall project schedule. The parallel path initiatives for each rotor provided another estimated reduction of 6 days per unit. Table #4 defines the parallel path initiatives [(3)] that were recognized as high potential candidates implemented on the project and the estimated days of duration saved on the overall project schedule.

Figure #2:
Vertical vrs. Horizontal Stress Relief

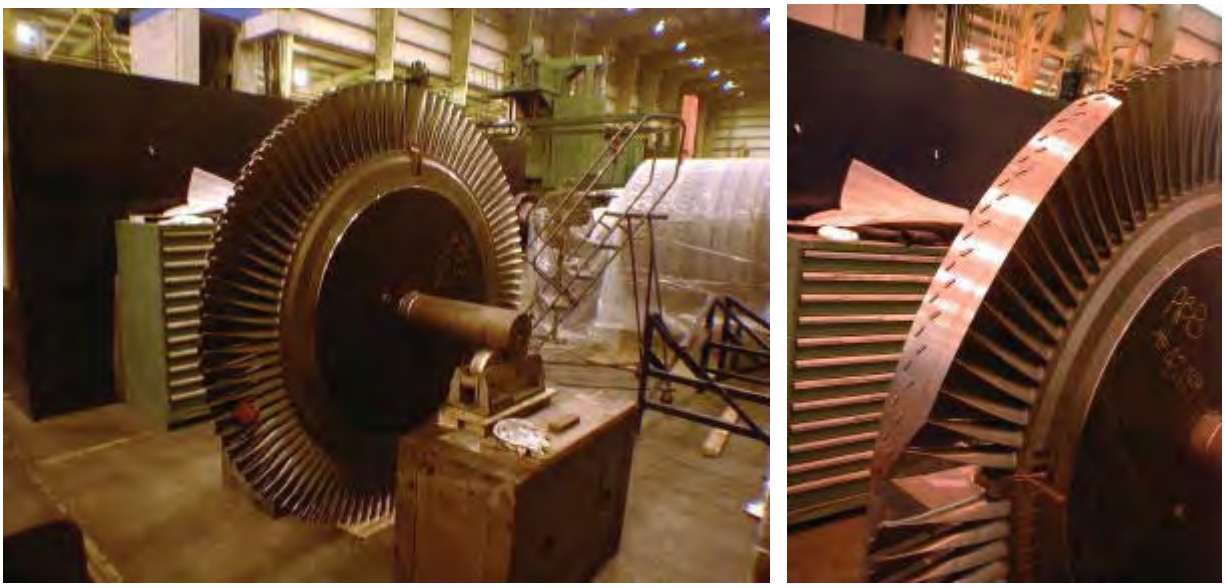

Figure #3:
L-2 Mock-up Wheel & Long Arc Shroud Installed

Table #4:
Parallel Path Schedule Reduction Initiative Results [3]

Task	Description	Original Process	Process Duration	New Proposed Process	Est. Days Saved
Weld Buildup	Weld buildup of L-1 and L-2 wheels.	Weld buildup LPA then LPB in series.	11 days per rotor, (22) total.	Weld buildup both rotors in parallel.	11 days.
Steeple Turning	Rough & final machining of the L-1 & L-2 steeples.	MFD CNC lathe utilized for rough & final machining in series.	8 days per rotor, (16) total.	Utilize portable lathe for rough operations in parallel.	4 days.
Stress Relief	Stress relief of welds.	Vertical stress relief LPA then LPB in series.	4 days per rotor, (8) total.	Horizontal stress relief both rotors in parallel.	4 days.
Finger Drilling	Drill pin holes in L-1 fingers.	Drill TE wheel then GE wheel in series, (3) holes at a time.	4 days per rotor, (8) total.	Drill TE and GE wheels in parallel, (6) holes at a time.	4 days.
L-2 blade assy	Assembly of L-2 blades using long arc shrouds.	Assemble blades, layout shrouds, punch, fit, & peen.	5 days per rotor, (10) total.	Create mockup to assemble, layout, punch, and fit shrouds in parallel.	2 days.

Process Sequencing Schedule Reduction Initiatives

The process sequencing initiatives focused on areas of individual processes to determine the best sequence of events to maximize productivity and work flow through the facility. These initiatives benefited both the overall duration of the project and the duration's of each rotor by minimizing wait and/or down time. Of the many processes throughout the project, the incoming processes proved to provide the best benefit of return. Table #5 details these incoming process sequence changes [3] defined and implemented.

Table #5:
Original vrs. New Incoming Inspection Process Sequencing Results [3]

Original Process Steps		**New Process Steps**	
LPA Rotor	**LPB Rotor**	**LPA Rotor**	**LPB Rotor**
1. Receive rotor 2. Move to blasting 3. Blast clean rotor 4. Move to insp. 5. Visual insp. 6. MT insp. 7. Move to lathe 8. Rev. eng. 9. Move to assy 10. Remove blades 11. Move to lathe 12. Weld prep 13. Move to welding	1) **** Wait **** 2) Receive 3) Move to blasting 4) Blast clean 5) **** Wait **** 6) **** Wait **** 7) Move to insp. 8) Visual insp. 9) MT insp. 10) **** Wait **** 11) **** Wait **** 12) Move to lathe 13) Rev. eng. 14) Move to assy 15) Remove blades 16) Move to lathe 17) Weld prep 18) Move to welding	1. Remove blades on-site 2. Receive 3. Move to blasting 4. Blast clean 5. Move to insp. 6. Visual insp. 7. MT insp. 8. Move to lathe 9. Rev. eng. 10. Weld prep 11. Move to welding	1) Remove blades on-site 2) **** Wait **** 3) Receive 4) Move to lathe 5) Rev. eng. 6) Weld prep 7) Move to blasting 8) Blast clean 9) Move to insp. 10) Visual insp. 11) MT insp. 12) Move to welding
18 Steps Total LPB rotor waits a total of 5 times		12 Steps Total (reduced by 6) LPB rotor waits only once	

As can be seen in the above sequencing, the initiative to remove blades on-site was a great benefit to the overall re-sequencing of the incoming process. Not only did it reduce the overall schedule duration of the operation; it also allowed the utility to perform some initial inspections of the exposed dovetails and fingers on-site. This on-site blade removal was accomplished through teamwork between the boresonics vendor and repair facility. Blade removal was performed in parallel to the bore plug removal and bore honing operation. Since blade removal was not allowed to be

performed during the actual bore ultrasonic inspection, this time was used to blast a small area of the steeple and MT inspect for stress corrosion cracking.

Schedule Reduction Analysis Summary

The following is a summary of the schedule reduction innovations [(3)] utilized on the project and the estimated vrs. actual cycle time saved on the overall duration of the project. See table #6.

Table #6:
Schedule Reduction Initiatives Summary

Task	Initiative Implemented	Est. Cycle Reduction	Actual Cycle Reduction
Finger Drilling & No L-0 Blade Work	Design Multi-spindle portable drilling devices to remove the operation from the HBM (no L-0 work required) and to drill (3) holes on each end of the rotor at once, (6) holes total.	12 days	15 days
Welding & Stress Relief	Upgrade of second submerged arc welding station to allow weld buildup and horizontal stress relief of LPA and LPB rotors in parallel.	15 days	16 days
Steeple Turning	Maximize roughing operation and also reserve and upgrade the portable lathe to allow the steeple rough machining operation for the LPB rotor to be performed in parallel with the final machining of the LPA rotor.	6 days	7 days
L-2 Blade Assy	Design full size mock up for parallel path layout, punching, and fitting long arc shrouds as well as utilizing small HBM for blade foot tang milling.	4 days	4 days
New Incoming Process Steps	Detail a new incoming process sequencing to minimize wait and down time.	1 day	1 day

It should be noted that not all of the above stated schedule reduction incentives could be implemented on every set of rotors. The L-1 finger drilling incentive, no L-0 work incentive, and the L-2 long arc shroud mock-up incentive were only able to be utilized on rotors with 33.5" last stage blades. Also, the steeple turning incentive and the welding / stress relief incentive were only utilized on dovetails that were weld repaired and had a greater affect on the rotors with 30" last stage blades. Overall, the incentives utilized on each particular rotor provided beneficial schedule reductions in support of a successful repair program.

REPAIR RATIONALE

It has become apparent that an across the board Stress Corrosion Cracking (SCC) problem exists within LP rotor dovetails of fossil steam turbine units with once through boilers [(4)]. In fact, 100% of the rotors designated for repairs at the ABB Alstom Power have exhibited advanced SCC type cracking in the L-1 rows. For L-1 & L-2 straddle or dovetail root design, the problem is manifested in the form of hook to sidewall radius cracks in the bucket attachments. See Figure #4. In the L-1 finger root design, cracks are found in the finger flanks, and to a lesser extent, as cracks emanating from the pinholes. See Figure #5.

Despite the fact that all the L-1 stages have exhibited cracking, none of the L-2 bucket attachments repaired by ALSTOM Power have been found to have SCC type cracking. Never the less, general corrosion and severe widespread pitting has been seen. This pervasive corrosive attack encompasses the entire L-2 attachment including the highly stressed hook to sidewall radius areas. See Figure #6.

To date, we know of no catastrophic failures that have been reported. However, during a scheduled inspection outage at least one unit was found to be dangerously close to a failure. The estimate by the OEM was that a failure was eminent and perhaps only weeks away. See Figure #7.

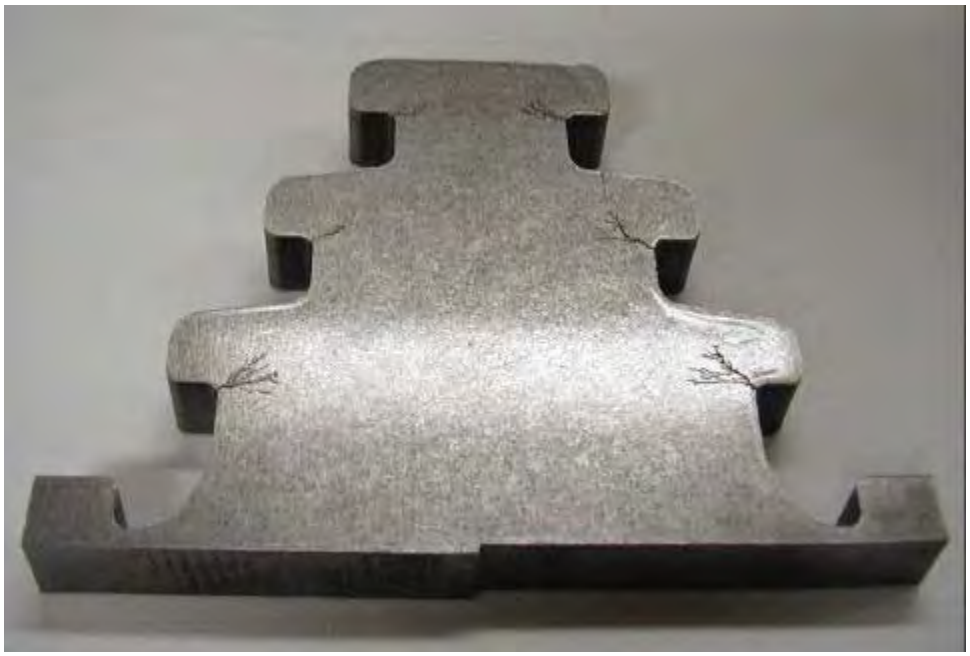

Figure #4:
Cracking in Straddle or Dovetail Root Designs

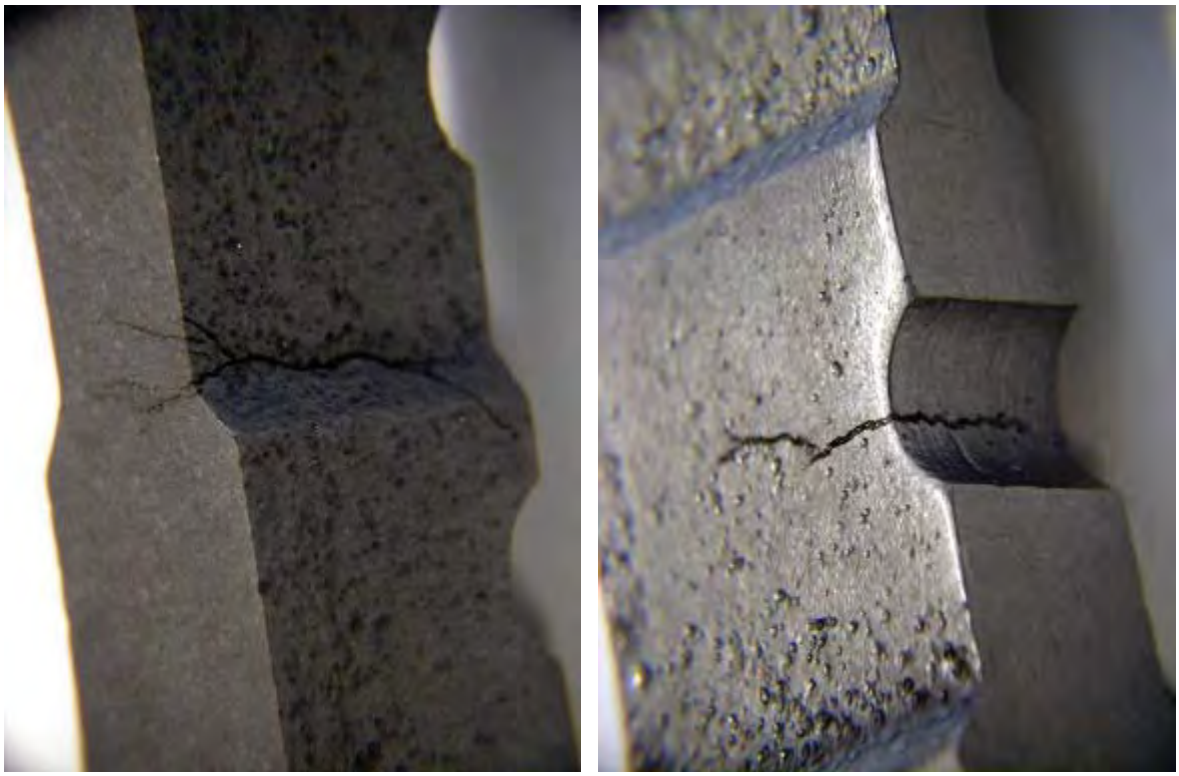

Figure #5:
Cracking in Finger Type Root Designs

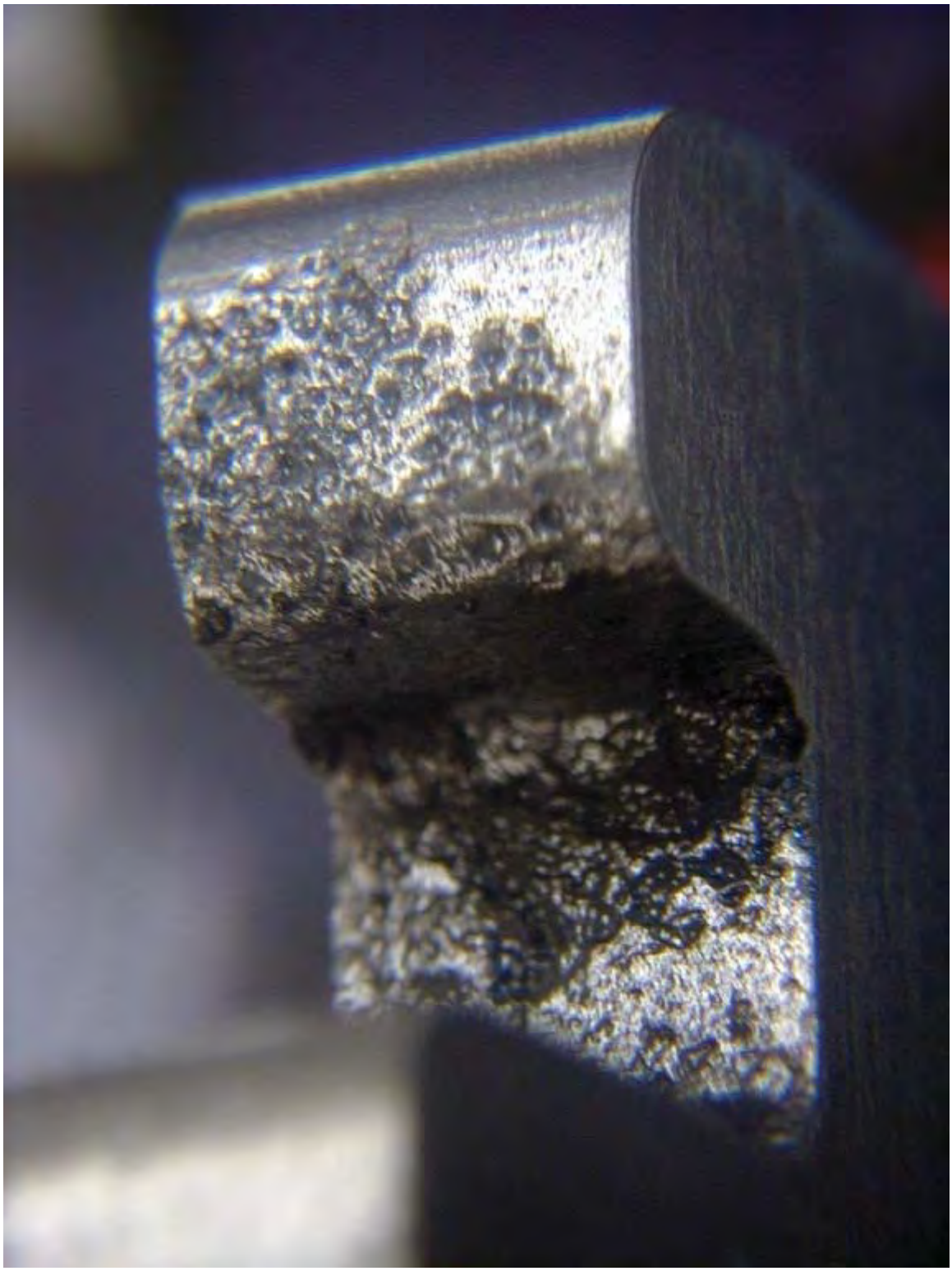

Figure #6:
Corrosion pitting in L-2 dovetail hook to sidewall radius area

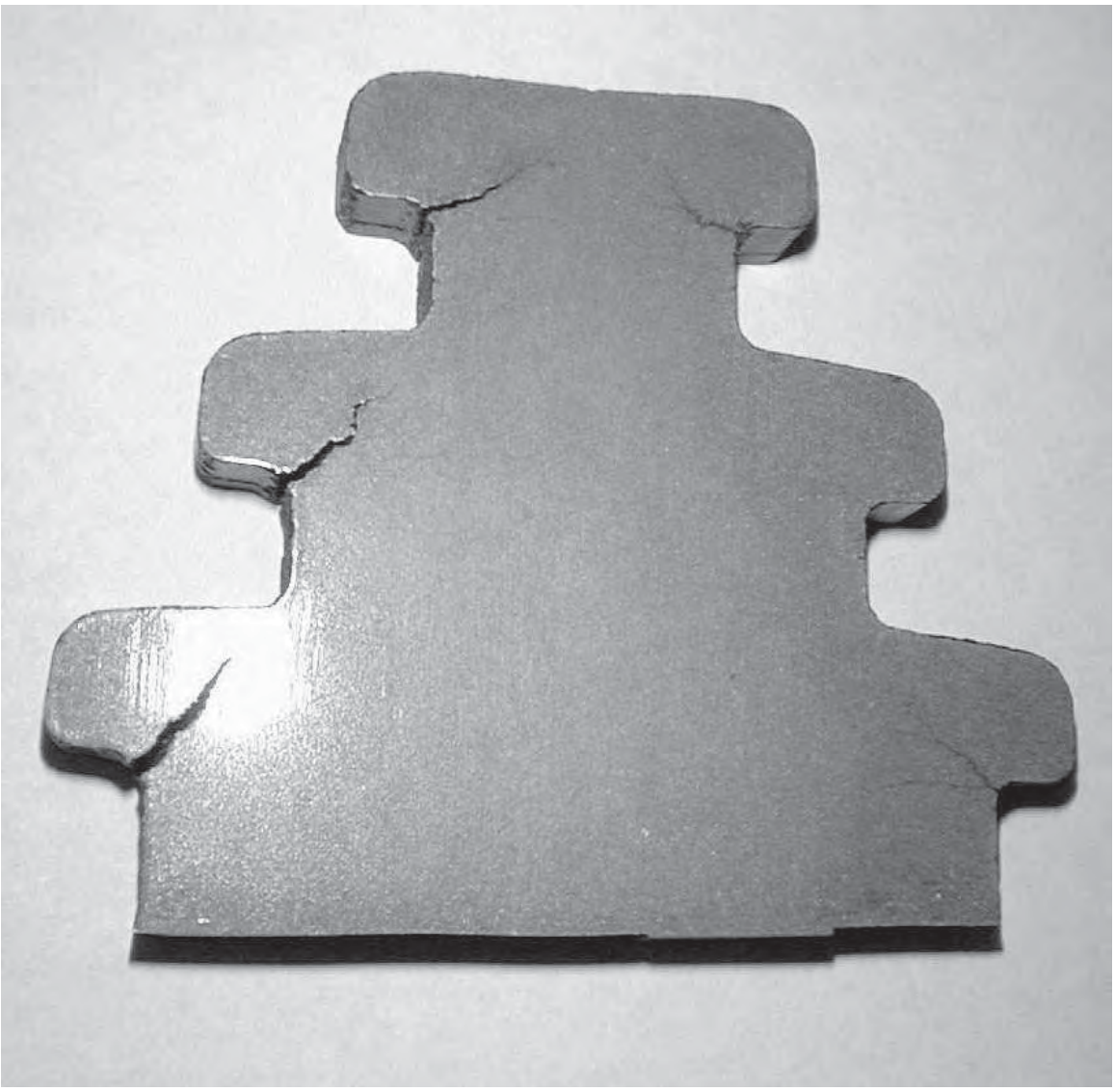

Figure #7:
Cracking Close to Failure in a Straddle or Dovetail Root Design

REPAIR OPTIONS

Enhanced radius machining has been implemented for some of the L-2 straddle root dovetail designs where cracking and pitting are minimal. This option is performed by machining a CNC undercut compound radius in place of the original radius between the hook load face and the neck sidewall. See Figure #8.

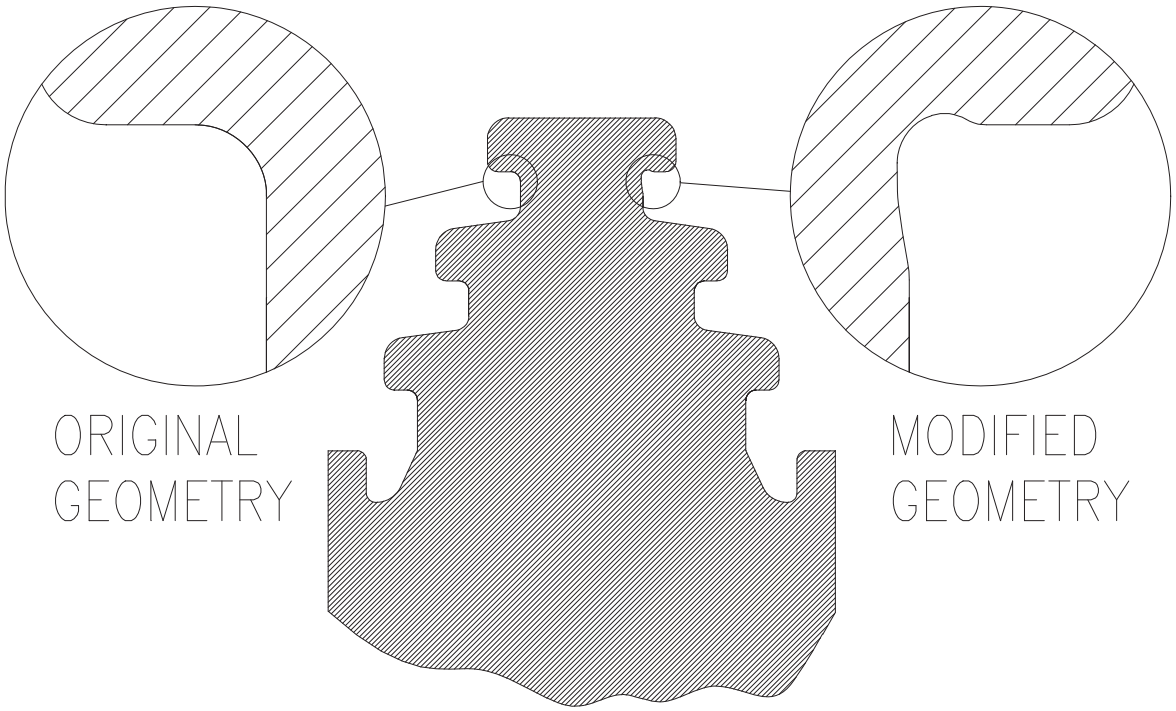

Figure #8:
L-2 Enhanced Radius Machining Profile

This operation has been used previously in the industry and will remove pitting and small cracks, restoring the highly stressed hook radius to a smooth and continual surface. The intent of this option is to decrease the stress concentration notch effect of the cracking and pitting to counter an increase neck tensile stress in order to optimize and have minimal or no change in the area peak stresses. The advantages of this option are a) schedule of the operation is short and b) the cost of the operation is low. The disadvantages of this repair method are a) the application is not always possible due to compromising structural integrity, b) the corrosion susceptible base material remains, and c) shot peening of the newly machined area becomes impractical due to masking duration.

Submerged arc weld repair, which includes removal and replacement of the entire bucket attachment, offers a more costly but comprehensive permanent solution. This option has been implemented extensively in the industry and for all of the L-1 finger type and dovetail type wheel attachments, and some of the L-2 dovetail type wheel attachments. Since the corrosion and corrosion pitting of the rotor base material is the leading factor in SCC crack initiation, an alternate material is selected for the weld filler metal. Considering that chromium alloyed steels begin to show corrosion resistance above 10% chrome content, a 12% chrome filler metal is utilized.

The tensile strength of this type filler metal is more than adequate for this application (about 140 ksi). Although the room temperature impact strength values (18-25 CVN) fall below modern day vacuum melted rotor steels produced according to ASTM A470,

they do exceed those of the air melted rotor steel produce according to ASTM A 293. This is due to a combination of factors; the limitations of the heat treatment, which must be adjusted to limit base metal softening; and the submerged arc welding process.

Submerged arc welding is utilized because of its rapid and reliable execution. No other process is capable of producing high quality sound welds in a time frame that supports the outage window needed by the utilities. See Figure # 9.

Figure #9:
Submerged Arc Welding of an L-1 Wheel

Join welding forged rings utilizing either a conventional join weld prep or a fine line welding prep was also considered. This option, although providing the best possible material properties, could not provide a repair within the outage window. This option has had minimal experience in the industry for this application and has yet been performed successfully within a critical path outage duration.

Other options, such as **long shank buckets**, were considered, but soon dropped. This option is only applicable for the dovetail type root design and does not apply to the L-1 finger root design, which represented 66% of the bucket attachments to be repaired. In the cases where there were straddle root dovetails, there are three fundamental disadvantages noted; 1) CF stresses are typically increased due to the extra shank

material, which will contribute to an accelerated return of SCC, 2) the original corrosion susceptible material still remains, and 3) the original rotor configuration is now deviated from original design.

REPAIR EXECUTION AND SCHEDULE

In order to accommodate weld repairs to multiple units during the same outage season, an agreement was made to have at least 3 weeks between arrivals of sets of rotors at the repair facility (i.e. LPA & LPB from the first unit then LPA & LPB from the second unit). With this stager, four rotors could be processed simultaneously for certain durations. Actual repair durations are given below for each unit repaired. Prior to the outages, a communication plan was established. The key parties and functions were identified and a mini directory was published. It was also agreed that the repair shop would issue a daily update to 60 recipients within Southern Company and ALSTOM Power.

A total of twelve rotors are to be repaired in this program and to date eight have been completed. The following details the repairs on the first eight rotors.

Alabama Power Gorgas #10

The first rotors, in the series of twelve, came from the Alabama Power Company's Gorgas Steam Plant Unit #10 in the fall of 1999. Both the L-1 and L-2 rows were the straddle root dovetail type in this case. During unit disassembly, ALSTOM Power crews, working on site, were able to remove all the buckets from the eight, L-1 and L-2 rows, and performed a large part of the initial inspections. The initial plan for these rotors was to perform the enhanced machining on both the L-1 and L-2 rows. However, when the buckets were removed on site, cracks were found in the L-1 stages and sever pitting was seen in the L-2 stages. Before they even left the station, the decision was made weld repair all eight wheels. When the rotors arrived at the repair facility, the normal sequencing such as; inspection, grit blasting, MT and lathe machining were varied as defined in the sequencing schedule reduction initiatives such that both the rotors could be worked simultaneously. The total time for the shop side repairs including miscellaneous repairs and machining was 40 days for LPA and 43 days for LPB.

Gorgas #10 Scope of Work:

- Remove (8) wheels L-1 and L-2 (LPA and LPB)
- Weld build up (8) wheels with 12% Cr
- Machine and shot peen the original L-1 and L-2 geometry's
- Install (8) rows of new buckets
- High speed balance

Georgia Power Bowen #3

The second set of rotors arrived at the shop three weeks after the first set had arrived still in the fall of 1999. These were from Georgia Power's Plant Bowen Unit #3. In this case, the L-1 stages had finger root construction while the L-2 again had the straddle root dovetail. The decision to weld repair all eight wheels had been made in advance of the outage. Again, bucket removal began on site during unit disassembly and bore honing. When the rotors arrived at the repair facility one rotor went to the lathe and one went to be grit blasted. This repair including round trip transportation from Georgia to Richmond Virginia and return was completed in 48 days for LPA and 51 days for LPB.

Bowen #3 Scope of Work:

- Transportation from and to the plant
- Remove eight wheels L-1 and L-2 (LPA and LPB)
- Weld build up eight wheels with 12% Cr
- Machine and drill the original L-1 and L-2 geometry's
- Shot peen
- Install eight rows of new buckets
- Remove and install new L-0 covers
- Find and replace cracked L-0 pins
- High speed balance

Georgia Power Wansley #2

The third set of rotors arrived at the shop in the spring of 2000. These were from Georgia Power's Plant Wansley Unit #2. Again, in this case, the L-1 stages had finger root construction while the L-2 had the straddle root dovetail. The decision was to weld repair the L-1 finger wheels and perform enhanced machining of the L-2 straddle root dovetails. Again, bucket removal began on site during unit disassembly. When the rotors arrived at the repair facility, L-2 bucket removal was completed, and one rotor went to the lathe and one went to be grit blasted. This repair including round trip transportation from Georgia to Virginia and return was completed in 45 days for LPA and 46 days for LPB.

Wansley #2 Scope of Work:

- Transportation from and to the plant
- Enhance radii machine four wheels L-2 (LPA and LPB)
- Remove four wheels L-1 (LPA and LPB)
- Weld build up four wheels L-1 with 12% Cr
- Machine and drill the original L-1 geometry
- Shot peen
- Install eight rows of new buckets
- Remove and install new L-0 covers

- Find and replace cracked L-0 pins
- Low speed balance

Alabama Power Gaston #5

The fourth set of rotors arrived at the shop four weeks after the third set had arrived in the spring of 2000. These were from Alabama Power's Plant Gaston Unit #5. In this case, the L-1 stages had finger root construction while the L-2 again had the straddle root dovetail. The decision was to weld repair the L-1 finger wheels and perform enhanced machining of the L-2 straddle root dovetails. Again, bucket removal began on site during unit disassembly and bore honing. This repair was completed in 36 days for LPA and 42 days for LPB.

Gaston #5 Scope of Work:

- Transportation from and to the plant
- Enhance radii machine four wheels L-2 (LPA and LPB)
- Remove four wheels L-1 (LPA and LPB)
- Weld build up four wheels with 12% Cr
- Machine and drill the original L-1 geometry
- Shot peen
- Install eight rows of new buckets
- Find and replace cracked L-0 pins
- High speed balance

The remainder of the Southern Company rotor repair series is planned for the fall of 2000 for the Wansley #1 rotors and the spring of 2001 for the Barry #5 rotors. Below is a repair summary detailing the unit, rotor, rating, last stage blade length, vintage, and the repair option chosen on the L-1 and the L-2 stages. See table 7.

Table #7:
Repair Summary of Southern Company Units

Operator	Station	MW	LSB	Vintage	Outage Date	Repair Scope	Rotor	Duration	L-1	L-2
Alabama Power	Barry #5	700	30”	1971	Spring 2001	Weld repair L-1 & L-2 dovetails, HSB.	LPA	N/A	**N/A**	**N/A**
							LPB	N/A	**N/A**	**N/A**
Alabama Power	Gorgas #10	700	30”	1972	Fall 1999	Weld repair L-1 & L-2 dovetails, HSB.	LPA	40	**W**	**W**
							LPB	43	**W**	**W**
Alabama Power	Gaston #5	884	33.5”	1974	Spring 2000	Weld repair L-1 fingers, ERM L-2 dovetails, HSB.	LPA	36	**W**	**ERM**
							LPB	42	**W**	**ERM**
Georgia Power	Bowen #3	884	33.5”	1974	Fall 1999	Weld repair L-1 fingers & L-2 dovetails, HSB, transportation.	LPA	48	**W**	**W**
							LPB	51	**W**	**W**
Georgia Power	Wansley #1	856	33.5”	1976	Fall 2000	Weld repair L-1 fingers, ERM L-2 dovetails, HSB, transportation.	LPA	N/A	**N/A**	**N/A**
							LPB	N/A	**N/A**	**N/A**
Georgia Power	Wansley #2	856	33.5”	1978	Spring 2000	Weld repair L-1 fingers, ERM L-2 dovetails, LSB, transportation.	LPA	45	**W**	**ERM**
							LPB	46	**W**	**ERM**

W = Welded | ERM = Enhanced Radius Machined | HSB = High Speed Balance | LSB = Low Speed Balance

CONCLUSION:

Without exception, every suspected LP rotor that has been sent to ALSTOM Power for repair has exhibited advanced SCC type cracks in the L-1 stage and corrosion pitting in the L-2 stages. To date this amounts to twelve rotors repaired, forty 48 wheels, with four more rotors scheduled.

Southern Company recognized the magnitude of this issue and took a proactive approach to consolidate the repair of all the suspected units in their system. This was accomplished under a single contract that provided a number of benefits for Southern Company as well as ALSTOM Power. The benefits of a multiple unit repair scope were:

A utilities unified and consistent effort to address the problem that also allowed for optimal outage scheduling while maintaining high system integrity and reliability.

A utility creation of a specification/contract addressing as many repair and refurbishment possibilities as could have been reasonably foreseen as well as individual unit concerns.

A repair vendor's ability to allocate personnel and funds in support of winning a contract with substantial order backlog.

A repair vendors ability to define schedule reduction initiatives based on a return of investment of a large repair order.

A communication structure and monitoring through a single repair vendor vrs. multiple vendors.

As a result of these focused efforts, eight Southern Company rotors have been repaired, returned to site ahead of schedule, and are operating satisfactory with minimal disruption to system integrity and reliability.

ACKNOWLEDGEMENTS

ALSTOM Power Inc. would like to take this opportunity to thank Southern Company, Alabama Power Company, and Georgia Power Company, and the associates of ALSTOM Power Inc. for their outstanding support throughout the entire project. In particular ALSTOM Power would like to thank the following individuals that supported this repair effort.

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Gorgas Station:
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Bowen Station:
Gene Ussery, Jimmy Baker, Don Rhodes, & Bruce McClure.

Wansley Station:
Bill Sewell, Danny Carnes, Scott Mayo, Buddy Luther, & Tony Brown.

Barry Station:
Butch Adkinson, Danny Martin, & James Martin.

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APPENDIX I – STEAM TURBINE AND HEAT REJECTION OPTIMIZATION STUDY

FINAL - REV 2

COLUMBIA PHASE 2 CAMP SUPPORT

Steam Turbine Generator Upgrade Analysis

B&V PROJECT NO. 173118

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9 MARCH 2012

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Report Revisions and Record of Issue

Rev.	Date	Issue Status	Revisions and Record of Issue	EDT	CHK	APP
0	12/9/11	Final		CEL	DJB	DJB
1	2/23/12	Final	Incorporate WPL and HDR Comment	CEL	DJB	DJB
2	3/9/12	Final	Update Figures 5-1 and 5-2 and Appendix C	CEL	DJB	DJB

1.0 Executive Summary

Wisconsin Power and Light (hereinafter referred to as "WP&L") has been evaluating the technical and economic viability of a Comprehensive Asset Management Program (CAMP) for the Columbia Energy Center, Units 1 and 2, located in Pardeeville, Wisconsin. WP&L, with Black & Veatch support, has been conducting a series of studies to evaluate potential capital improvement projects to be executed as a means to achieve the CAMP goals shown in Section 2-1. Two of the primary CAMP goals provide for achieving significant improvements in unit net generating capacity and operating efficiency. The Phase 1 CAMP Study identified a major steam turbine upgrade as the most likely technically and economically viable CAMP project to achieve these two primary goals. WP&L requested Black & Veatch to perform a steam turbine generator (STG) upgrade analysis to determine an economically optimized design basis for a major steam turbine (STG) upgrade that would achieve the CAMP unit capacity and efficiency goals. Recognizing that the turbine cycle performance must be integrated with the unit cycle heat rejection system performance, the analysis was also tasked with identifying and optimizing the scope of heat rejection system major equipment modifications and/or upgrades required to properly match-up with the steam turbine upgrade.

The steam turbine upgrade portion of the analysis was performed to screen potential steam turbine upgrade options from leading turbine OEM's that would achieve the primary Columbia CAMP goals for improvements in unit heat rate and capacity. Major activities and conclusions included the following.

- Based on the results of the CAMP Phase 1 Study, a short-form procurement specification for the steam turbine upgrade was developed with the goal of increasing the steam turbine gross output up to the practical limits of the existing generator; about 600 MW. The increase in STG output was envisaged to be a result of both the steam turbine efficiency improvement as well a small increase in main steam flow.
- Based on the budgetary proposals received from STG original equipment manufacturers (OEMs), it was determined that the low pressure turbine section upgrade could include an increase in last stage blade length from 26 to 30 inches.
- A heat balance simulation model was used to evaluate turbine cycle and overall unit heat rate benefits of the steam turbine upgrade. The modeling confirmed the ability to achieve the 600 MW gross turbine output goal with ambient conditions coincident with the local summer one percent web bulb temperature.
- At average annual ambient conditions, the modeling estimated the ability to achieve a net unit heat rate of approximately 9,600 Btu/kWh which compares well to the CAMP goal of 9,800 Btu/kWh.

The heat rejection system optimization analysis was performed to identify and economically optimize the scope of heat rejection system equipment modifications and/or upgrades required to support the upgraded turbine cycle performance. This included providing for

increased overall system cooling capacity so that the 600 MW gross steam turbine output could be achieved at a 1 percent summer wet bulb temperature. Major activities and conclusions included the following:

- The design and current performance of all major heat rejection system equipment was evaluated to determine the extent of existing performance degradation to establish refurbishment needs. The range of potential equipment modifications and upgrades was also established. Finally, key equipment performance parameters were reviewed to identify those that could be economically optimized as well as those that required limits and/or constraints.
- An economic optimization was conducted using an in-house financial proforma to determine the optimum modified and/or upgraded heat rejection system configuration.
- Based on the results of the heat rejection optimization, the upgraded design basis for system equipment was incorporated into short-form procurement specifications to obtain budgetary pricing from potential equipment OEM's.
- Since each potential CAMP project for the Phase 2 CAMP Study was evaluated individually, Black & Veatch was required to break down and distribute the overall unit heat rate and capacity improvements among the individual turbine cycle and heat rejection equipment CAMP projects.

The conclusions and recommendations are as follows:

- It appears to be technically and economically feasible to upgrade the steam turbine generator and heat rejection system major equipment to achieve the Columbia Station CAMP goals for unit efficiency (heat rate) and net capacity.
- The increase in plant generating capacity will require a small increase in STG main steam flow. In addition, the higher efficiency HP turbine will result in lower temperature steam exhausting from the HP turbine and returning to the boiler reheater, so additional steam generator reheater surface may be required.
- The heat rejection system optimization included upgrades to overall system capacity to support achieving the CAMP goal for 600 MW gross steam turbine output with summer one percent ambient conditions
- The unit turbine cycle and heat rejection system operate as an integrated system. It is recommended that the steam turbine upgrade as well as the boiler feed pump, circulating water pump and helper cooling tower & pumps CAMP projects be bundled and evaluated as a single project.

2.0 Introduction

2.1 PROJECT BACKGROUND

Wisconsin Power & Light (hereinafter referred to as "WP&L) will be installing new air quality control (AQC) equipment at its Columbia Energy Center, Units 1 and 2, to meet more stringent environmental regulations. Considering the substantial capital investment associated with the new AQC equipment installation, WP&L was interested in evaluating other capital improvements which could concurrently be implemented that could help improve plant operating performance and reliability under the coordinated objectives of a Comprehensive Asset Management Program (CAMP.)

WPL set forth the CAMP goals shown in Table 2-1 for the Columbia Energy Center and subsequently indentified, through a Phase 1 CAMP screening process, several opportunistic projects that could assist in achieving these goals, including a major steam turbine generator (STG) upgrade. This analysis evaluates the range of STG and turbine cycle upgrades applicable for these units.

Table 2-1 Columbia Units 1 and 2 CAMP Goals

PARAMETER	CURRENT	GOAL
Equivalent Availability Factor, percent	~ 85	> 90
Equivalent Forced Outage Rate (EFOR), percent	~ 4.0	< 2.5
Capacity Factor, percent	~ 78	> 85
Maximum Net Capacity, MW_{NET}	~535 (URGE)	565 (Throttle pressure of 2400 psig and all heaters in Service)
Net Plant Heat Rate, Btu/kWh	~ 10,500	9,800
Scheduled Outage, Weeks/yr	5	2
Minimum Load w/o support fuel, MW	150	80 – 100
Delivered Fuel Cost	--	Lower
Ramp Rate, MW/min	5	10
Safety, LTA	0	0
Environmental, Violations	0	0

The Columbia Energy Center's existing steam turbines are General Electric (GE) tandem compound, single reheat, three casing, four flow, condensing, G2-Series turbines. The steam turbines' original nameplate ratings are 512,008 kW (at 0.9 power factor [PF]) with main steam conditions of 2,400 pounds per square inch gauge (psig)/1,000° F/1,000° F and a turbine exhaust backpressure of 1.0 inches HgA. Each steam turbine is coupled to a GE 617,800 kilovolt-ampere (kVA) hydrogen and water cooled generator. Unit 1 was commissioned in 1975, and Unit 2 in 1978. The steam turbines have not had a recent major internal component upgrade, except for modification of the L-0 buckets to a continuously coupled type in 1994; both units contain 26 inch L-0 buckets. Other STG system changes include the following.

- The existing electrohydraulic control (EHC) Mark I/II systems were replaced with Ovation control systems in 2005 and 2006.
- In 2006, Unit 1 was upgraded to a Bentley Nevada Turbine Supervisory Instrument (TSI) with proximity and seismic probes. Unit 2 still utilizes the original single plane shaft riders, but the bearings are equipped with ports for "Y" access probes.
- The turbines are controlled by separately mounted, individually controlled, balanced design control valves. The stop valves have been converted to a Toshiba multiple-hole trim design.
- The EHC pumps were recently upgraded, and the accumulators replaced.

3.0 Steam Turbine Upgrade Analysis

3.1 OBJECTIVE

The objective of this analysis was to sufficiently conceptualize and optimize STG and turbine upgrade design options that would achieve the primary Columbia CAMP goals for improvements in unit heat rate and capacity. The design basis would also support estimating of feasibility-level capital cost estimates that potential stakeholders may consider in their evaluation for further project development.

3.2 REQUIREMENTS

The following CAMP objectives governed this analysis, with the specific goals shown in Table 2-1:

1. Achieve an increase in the unit generating capacity, to be achieved primarily by improved STG isentropic efficiency, but could also include an increase in the designed steam swallowing capability of the HPT first stage.
2. Achieve an improvement in unit sustained heat rate.
3. Supporting the goal of extending the scheduled duration between major planned maintenance intervals, with a target of 10 years between STG openings.
4. Support goals associated with reductions in unit outage durations.
5. Support goals for improvement in unit ability for sustained low load operation without supplemental fuel.

3.3 DESIGN CONSTRAINTS

The scope of realistic potential steam turbine upgrade modifications would be constrained by planned reuse of the existing steam turbine outer cylinders along with existing foundations and connecting piping. Thus, the modified steam path upgrade would be installed within the existing outer cylinders. Other high level constraints included the following.

- The STG upgrade would be constrained by the maximum capacities of the electrical generator, steam generator (boiler,) and heat rejection system.
- The targeted 600 MW gross STG output was based on the maximum upgraded output that could be supported by reuse of the existing electrical generator.
- During the Phase 1 CAMP study, it was concluded that evaluation of an incremental increase in main steam pressure/temperature conditions was not considered a desired or economically viable alternative.

3.4 APPROACH

The analytical approach taken was as follows.

- Existing STG, turbine cycle, and steam generator arrangements and operating parameters were identified and documented based on information provided by WP&L.
- A "base case" heat balance diagram was modeled using heat balance diagrams and other thermal kit data from Columbia Units 1 and 2 design documents. The base case heat balance (GE heat balance diagram #510HB443 with 558,953 kilowatt [kW] gross output) and the GE heat balance diagram at valve-wide- open (VWO) Nominal Pressure (NP), heat balance diagram # 510HB415 provided the initial basis for the model. Initial model results were compared to actual plant performance data to determine the approximate turbine efficiency degradation and to establish historically achievable operating parameters and modifications to the existing steam turbine cycle. Based on the operating data over the last five years, the average STG output of the two units, with main steam conditions of 2,400 psig and 1,000 F and steam flow rate corresponding to the heat balance #510HB415, has been approximately 522.4 MW. When compared to the heat balance predicted output of 533.9 MW, but neglecting back pressure corrections, the difference would indicate approximately 11.5 MW of output degradation.
- The existing generator is sized at 617 megavolt-ampere (MVA) with a rated PF of 0.9. Based on observations during a plant visit and discussion with plant personnel, it was determined that the plant typically operates near a unity power factor. To maximize STG upgrade potential, but maintain some power factor design margin, the upgraded turbine size of 600 MW maximum also included a revised power factor margin of 3 percent.
- The steam turbine short-form procurement specification was written to request 600 MW gross STG output at 2,415 pounds per square inch absolute (psia) main steam throttle pressure to maximize reuse of existing balance-of-plant (BOP) system equipment.
- Requests for budgetary quotations were sent to viable STG OEM's to solicit indicative pricing, scope of work for turbine modifications, and indicative performance improvement estimates.
- The STG OEM performance estimates were used to modify the base case heat balance to determine overall upgraded overall unit performance. All of the OEM's indicated the ability to utilize a low pressure turbine (LPT) last stage blade length of 30 inches so that arrangement was utilized for the estimate. To determine estimated net unit output, an estimated auxiliary power allowance of 35 MW (25MW for the existing unit and 10 MW for the new AQC equipment) was used to calculate the post STG upgrade net unit output of 565 MW.

- At the conclusion of the STG upgrade analysis, an economic optimization was performed on the existing heat rejection system (see Section 4.0) to determine modifications and/or upgrades required to support the upgraded STG design basis performance as well as to provide the best match-up to the LPT exhaust conditions, based on the 30 inch last stage blade exhaust loss curve, for plant operating conditions throughout the year. The heat rejection system was sized so that the desired 600 MW STG gross output could be achieved on a one percent hot summer day. For the annual average day, the boiler steam flow will need to be reduced to stay within the generator limits.
- The preliminary upgraded unit heat balance shown in Appendix B. Case 1 shows the maximum unit capacity scenario when operating at the summer one percent ambient wet bulb temperature. Case 2 shows the unit performance when operating at the annual average ambient condition. The STG arrangement was optimized considering impacts on upgraded STG design conditions and sizing for other associated CAMP projects, such as boiler feed pump (BFP), circulating water pump upgrade, and helper cooling tower upgrade. Table 3-1 shows the steam turbine sectional efficiencies used for the heat balance based on responses from various STG OEMs.
- Turbine cycle BOP equipment design capabilities were reviewed to verify the ability to support the upgraded STG and turbine cycle operating conditions.

Table 3-1. Steam Turbine Efficiency Used in Heat Balance Model

	HPT EFFICIENCY (%)	IPT EFFICIENCY (%)	LPT EFFICIENCY (%)
1% Hot Day	91.9	93.6	94.4
Average Ambient Day	91.2	93.5	94.0
LPT efficiency is based on Exhaust Line End Point (ELEP)			
Refer Appendix B for heat balance diagram			

3.5 STEAM TURBINE GENERATOR ORIGINAL EQUIPMENT MANUFACTURER (OEM) COMPARISON

Budgetary price quotations were requested from Alstom, GE, Hitachi, Siemens, Mitsubishi, and Toshiba for steam turbine upgrades to meet the targeted gross output of 600 MW. All OEMs except Mitsubishi were interested in this potential opportunity and provided a response. The responses received from the OEMs varied in scope and detail; summary descriptions of the turbine OEMs' responses are shown in Table 3-2.

The steam turbine upgrade would include steam path modifications for the HP, IP, and LP shells. Typically, the existing outer turbine casings would be reused, provided that there are no

existing deformations or cracks observed. The design of the turbine rotors would be modified to incorporate an optimized number of higher efficiency stages. The inner casings, diaphragms, and other internals of the turbine assembly would also be replaced.

3.5.1 General Electric

GE typically offers their advanced "Dense Pack" steam turbine upgrade. The Dense Pack design achieves optimum efficiency by identifying the minimum packing diameter based on rotor stability and torque criteria along with the maximum number of stages that can be fitted into the available span based on bucket loading and diaphragm stress criteria. GE suggested upgrading the LPT last stage blade length from 26 to 30 inches.

3.5.2 Hitachi

As a former GE licensee, Hitachi has significant experience with the existing steam turbine arrangement. Hitachi has already been on-site to take overall physical measurements of the STG's. Hitachi was able to evaluate HP/IP and LP steam path modifications for improved isentropic efficiencies as well as to allow for greater steam swallowing capability. Hitachi also suggested upgrading the LPT last stage blades from 26 to 30 inches.

3.5.3 Alstom

Alstom responded to the RFQ via a telephone conference. Alstom did not discuss physical-related features of its proposed steam path upgrade; however, based on Black & Veatch experience, a summary of typical design features offered by Alstom is provided. Alstom typically uses disc and diaphragm construction using low reaction at the base diameter of the rotating blades. The majority of the stage pressure drop occurs across the fixed blade diaphragm. Rotors are manufactured from creep resisting alloy steel monoblock forging. All the HP/IP rotating blades have integral tip shrouding. The fixed blade diaphragms are of welded construction. Alstom's design includes an HP first stage with relatively low numbers of large scale fixed blades, which reduces the chances of significant solid particle erosion (SPE) damage beyond normal surface roughening. The typical inspection interval for the upgraded turbines is 10 years.

Table 3-2. Comparative STG OEM Performance

PARAMETER (SINGLE TURBINE)	BASE CASE	STG OEM				
		ALSTOM	GE	HITACHI	SIEMENS	TOSHIBA
HP/IP AND LP UPGRADE						
Control Valve Position	VWO	VWO	VWO	VWO	VWO	VWO
Control Mode	Partial Arc	Partial Arc	Partial Arc	Partial Arc	Partial Arc	Partial Arc
Last Stage Blade Length	26	30	30	30	30	33.5
Main Steam Flow, lb/h	3,578,465	4,000,000	4,020,000	3,743,074 to 3,871,899	--	3,939,503
Throttle Pressure, psia	2,414.70	2,414.70	2,414.70	2,414.70	--	2414.7
Throttle Temperature, °F	1,000	1,000	1,000	1,000	--	1000
Hot Reheat Temperature, °F	1,000	1,000	1,000	1,000	--	1000
Condenser Pressure, in HgA	3	--	2 to 3	2 to 3	--	2 to 3
Generator Power Factor	0.9	--	0.97 to 0.98	--	--	0.9 to 0.97
Final Feedwater Temperature, °F	480.6	--	492.2	--	--	480.6
Increase in Main Steam Flow, lb/h	Base	421,535	441,535	164,609 to 293,434	--	361,038

HP - High-pressure; IP - Intermediate-pressure; LP - Low-pressure; VWO - Valves wide open; lb/h - Pounds per hour.

3.5.4 Toshiba

Toshiba's proposal was the most detailed proposal received from all the OEMs. Toshiba is not as active in the STG retrofit market, however, as GE, Siemens, or Alstom. Toshiba does have the largest share of the steam turbine market in North America in recent years for new steam turbine orders. Toshiba has measured and designed a number of "G2" machines and, as a GE licensee from the late 50s to the early 70s, has obtained significant design details and insight. However, Toshiba does not have any experience with retrofitting a GE G2 model steam turbine.

3.5.5 Siemens

Siemens proposed BB44 a partial arc (PA) HP/IP STG retrofit. The scope of this upgrade would include: partial arc STG control valve configuration based on unit operating mode and boiler capabilities; fully integral, monoblock rotor design; elimination of rotor bore inspections T-root; integral shroud stationary and rotating with 3-D blading; optimized thermal performance; and new integral inner cylinder with horizontal joint bolting slide-in contour-end-wall nozzle block (PA design.) Based on experience with similar sized LPT's, Siemens proposed a 5.6 square meter (m^2) back-end design. Siemens does not have any experience with retrofitting the GE G2 model steam turbine.

3.6 BALANCE-OF-PLANT CONSIDERATIONS FOR STG UPGRADE

3.6.1 Mechanical Systems

Turbine cycle mechanical BOP systems were reviewed to confirm that the design basis of existing major components would support the upgraded unit performance.

3.6.1.1 Condensate Pumps

The original condensate pumps were designed for 2,700 gallons per minute (gpm), per the unit equipment datasheet. See Table 3-3 for condensate pump flow comparison between pump design flow, base heat balance flow and proposed upgraded plant performance flow.

Table 3-3 Condensation Pump Flow Comparisons

CONDENSATE PUMP FLOW COMPARISONS			
Unit Operating Condition	Flow Per Pump, gpm	Total Flow (2 pump Operation), gpm	% of Original Pump Design Flow
Base Plant Heat Balance	2,623	5,246	97.14%
Upgraded STG – Average Ambient – Case 2 Heat Balance	2,656	5,312	98.36%
Upgraded STG – 1% Summer WBT – Case 1 Heat Balance	2,782	5,564	103.04%
Existing Pump Design	2,700	5,400	100%

For the Upgraded STG –1% Summer WBT Heat Balance operating condition, each pump would operate about 82 gpm above the original pump design flowrate which corresponds with a slightly lower TDH operating point. The nominal higher flow and lower TDH condition should be achievable within the flexibility of the condensate control valves operating range.

Based on a review of plant operating data, it appears there is impeller degradation resulting in TDH losses greater than 100 feet on Unit 1 and 50 feet on Unit 2; subsequent plant feedback indicated there could also be significant cycle isolation issues. While details of condensate control valve operation weren't available, it is assumed the valve is making up the decrease in the pump TDH by opening more. The estimated margin between the system resistance curve and the calculated pump operating curve is approximately 15 feet for Unit 1 and 65 feet for Unit 2; refer to B&V preliminary design calculation "Condensate Pump Review," B&V File 43.0000.1201, dated 1/6/12 for more detail. The small margin between Unit 1 calculated operating pump curve and the system resistance curve warrants further review during detail design and, as necessary, schedule pump refurbishment maintenance to reestablish pump TDH performance capabilities.

The condensate pumps are supplying feed water to the deaerator, and the deaerator operating pressure would experience a small increase in operating pressure from 179.8 psia to 185.2 psi, a delta of 5.4 psi, for the upgraded turbine cycle performance condition. As long as the existing condensate control valves are able to accommodate the operating range of the reduced pressure, no additional modifications would be necessary.

3.6.1.2 Boiler Feed Pumps and Drive Turbines

The original boiler feed pumps (BFP) and drive turbines were designed at 2 x 60 percent which provides for a generous operating margin. Upgraded heat balance performance data were reviewed with the existing pump characteristic curves. The existing pump performance characteristics are acceptable for the upgraded heat balance conditions; see Table 3-4 for BFT operating comparison between pump design flow, base flow and upgraded plant performance flow.

Table 3-4 Boiler Feed Pump Operating and Design Conditions

OPERATING CONDITION	FLOW PER PUMP, GPM (NOTE 1)	% OF DESIGN FLOW, % IR %BJ	TDH IR, FT BJ, FT	PUMP DISCHARGE PRESSURE IR, PSI BJ, PSI (NOTE 2)	% OF DESIGN PUMP DISCHARGE PRESSURE % IR %BJ
Unit 1 Ingersoll Rand (IR) Design	5,320	Base	7806	3,217	Base
Unit 2 Byron Jackson (BJ) Design	5,350	Base	7,650	3,157	Base
Base Plant Heat Balance	4,280	80.50%	8,710	3,561	110.70%
		80.03%	8,900	3,634	115.09%
Upgraded STG – Average Ambient – Case 2 Heat Balance	4,400	82.75%	8,611	3,524	109.54%
		82.27%	8,800	3,596	113.88%
Upgraded STG –1% WBT – Case 1 Heat Balance	4,538	85.34%	8,500	3,477	108.09%
		84.85%	8,600	3,519	111.46%

Notes
1. Based on pump design curves' noted design points and two (2) pump operation.
2. Calculation based on normal deaerator storage tank level and no pressure losses in pump suction line.

The Base Plant Heat Balance pump discharge pressures are 111% (IR) and 115% (BJ) greater than the IR and BJ Pump Design Conditions. The upgraded heat balances and corresponding pump operating pressures operate in the 108% to 114% greater than the design condition which is in the pressure range margin of the Base Plant Heat Balance operating condition at rated pump constant speed. The Unit 1 boiler feed pump rated curve speed is 5,990 rpm. The Unit 2 boiler feed pump rated curve speed is 5,850 rpm. At the 1% WBT operating condition, which is maximum flow, the Unit 1 boiler feed pumps will operate approximately in the speed range 5,615 rpm to 5,655 rpm and Unit 2 will operate approximately in the speed range 5,450 rpm to 5,490 rpm meet the calculated required discharge pressure and flow.

Refer to Section 5.2.3 for further details on the BFP refurbishment CAMP Project.

3.6.1.3 Feedwater Heaters and Deaerator

Feedwater Heaters

Tube velocities were reviewed for both the original and replacement feedwater heaters. HP feedwater heaters 1F1/1F2/2F1/2F2 and 1G1/1G2/2G1/2G2 were designed for single circuit and double circuit operation. The latest edition of Heat Exchange Institute for Closed Feedwater

Heaters (HEI) tube velocities were used to confirm that feedwater tube velocities were not exceeded. With the upgraded performance, all LP heaters (original design and replaced heaters) were within the latest HEI tube velocity requirements. The HP heaters meet the HEI velocity requirements with double circuit operation and the upgraded performance conditions. HP heaters 1F1/1F2/2F1/2F2 exceed the velocity requirements by less than 1 foot per second (ft/s) during single circuit operation on the 1% Hot Day Full Load Operating Condition. HP heaters 1G1/1G2/2G1/2G2 meet the HEI velocity requirements during single circuit operation with the upgraded performance conditions. Single HP heater operation is typically only exercised when there is a tube leak in one of the high pressure heater streams and the velocity exceedance would only occur if the single heater operation coincided with ambient conditions near the 1% Summer Day Full Load Operating Condition, therefore, temporarily operating in this range for short durations would be acceptable.

Test reports were available for review for the Unit 2 high pressure feedwater heaters. Only one (1) high pressure feedwater heater (2F2) has reported leakage with subsequent plugging of 34 of the 1800 tubes during the year of 2011. Unit 1 high pressure feedwater heaters and Units 1 & 2 low pressure feedwater heaters test reports were not available for review. It is recommended that Unit 1 high pressure and low pressure heaters and Unit 2 low pressure heaters be inspected at next available outage if recent test reports are not located.

Deaerators

The existing deaerator design capability was compared with the upgraded operating condition and summarized in Table 3-5, which indicates that guarantee flows are nominally exceeded, and the deaerator would be operating around its design maximum output.

Table 3-5 Deaerator Operating and Design Conditions

DEAERATOR OPERATING CONDITIONS	OUTLET FLOWRATE LB/H	OUTLET TEMPERATURE °F
Deaerator – Guaranteed Water Capacity	3,774,000	370
Upgraded STG Performance – Average Ambient Day – Full Load	3,874,000	369
Deaerator –Maximum Outlet Capacity	3,963,000	
Upgraded STG Performance – 1 % WBT – Full Load	3,990,000	370.9

The Unit 1 deaerator supplier (Graver) was contacted to confirm that the existing deaerators would be able to operate with the upgraded performance conditions without spray nozzle modifications or other retrofits. They confirmed that both the oxygen level and thermal performance would be achievable at the upgraded operating conditions. The Unit 2 deaerator OEM (Chicago Heater) is no longer in business. Another deaerator supplier (KC Deaerator), that typically services Chicago Heater's deaerators was contacted, they expressed concerns about the spray-type

deaerator design verses the more conventional tray-type deaerator design. They also noted some of the potential physical degradation problems encountered with the spray-type design. From the performance stand point, they declined to endorse adding additional flow and/or duty to the existing deaerators.

Subsequent to the previous version of this report, the plant provided historical physical condition inspection reports for B&V review. The reports documented a number of areas, primarily in the deaerator heater vessels, which have required significant repairs; especially for Unit 2. B&V submitted a written review of the inspection reports in early February. While none of the deaerator heater damage issues noted appear to point toward imminent failure, the combination of the type and extent of the required ongoing repairs, in conjunction with the age of the equipment and current and anticipated cyclical operation of the units point toward a reduction in reliability which may negatively impact the availability and operability of the upgraded plant.

The stated deaerator storage volume at normal operating level is 69,000 gallons. At average day full load upgraded operating conditions, there is approximately 7.8 minutes of storage time at the normal operating level storage volume. It is recommended to have 5 minutes of storage at the deaerator low water level where the low-level alarm is triggered; see B&V preliminary design calculation "Deaerator Review," B&V File 43.0000.1202, dated 1/6/12 for more detail. A boiler feed pump net positive suction head (NPSH) transient analysis should be completed to check deaerator storage volume , deaerator levels and BFP operation protection during the detailed design phase.

Overall, while the spray-type deaerator may have numerous performance and reliability deficiencies compared to the tray-type design, the estimated increase in duty from the STG upgrade appears pretty nominal and insignificant unless plant operating experience to-date indicates operating problems. Unless further plant investigation uncovers such performance issues, the existing deaerators appear to have sufficient capacity to handle the nominal increase in flow/duty associated with this CAMP performance review; pending the recommended additional detail design reviews. The deaerator inspection reports, however, indicate that both deaerator heating vessels have been experiencing ongoing and repetitive damage sufficient to require repair and/or replacement of some components. It is likely that replacement of these deaerator heaters should be considered for replacement and recent discussion with WPL has noted that the existing plant capital budget includes funds for replacement of at least one of the deaerator heaters.

Turbine Water Induction Prevention

With the steam turbine upgrades and enhancements to the Turbine Water Induction Prevention (TWIP) measures specified in ASME TDP-1, it is recommended that a TWIP study be conducted during the detailed design phase to assess the current condition of piping and instrumentation installation. The steam turbine supplier may require that the plant be audited for compliance with the most recent TWIP recommendations in order to provide a steam turbine guarantee.

TWIP deviations encountered more frequently and prioritized for implementation to include the following:

- Feedwater heater alternate drain improvements
  - Addition of alternate drain or rerouting to more appropriate destination
- Motive steam line drip pot/drain automation and resizing (larger)
  - Automation of manual valves with position feedback and enlargement to meet minimum ID recommendations
  - Other drain line automation
  - Replacement or bypass of traps and manual valves with automated valves with position feedback
  - Segregation of pressure levels for drains headers
  - Separate lower pressure drains from higher pressure drains and reroute them in parallel
- Instrumentation/control redundancy or alarm initiation improvements
  - Separate instrument trees to protect against accidental isolation
  - Provide recommended number of instruments
  - Add recommended alarms to control room
- Improve automatic control
  - Add logic to take recommended action based on existing or improved instrumentation

TWIP study prioritized recommendations take into consideration the following:

- Operating history
- Severity of deviation
- Planned outages and plant improvements
- Budget challenges
- Manpower limitations

3.6.1.4 Steam Systems

Code

An HP superheater outlet isolation valve is not installed in the existing main steam system. As a result, the main steam piping should be classified as boiler external piping and should be designed in accordance with the Boiler Pressure Vessel Code (BPVC) Section I. The applicable BPVC code year, piping markings, and installation requirements have not been verified as part of this analysis because of a lack of readily available documentation and should be performed during the detailed design stage. Black & Veatch, however, reviewed the main steam system design with both BPVC 1968 and 1971. The notable difference between the 1968 and 1971 editions is that the wall thickness calculation for piping greater than 24.5 inches outer diameter (OD) maintains its own separate formula in the 1968 version; whereas, the 1971 version uses the same formula as smaller sized pipes. It is also noted that the existing plant 01-21-1972, Piping Design Table, does not list the material with boiler code “S” symbology for main steam. The material is listed as A335 instead

of SA335. In addition, there were some line sizes that did not have the minimum wall values specified in the Piping Design Table.

The reheat piping (hot and cold) is non-boiler external piping based on American Society of Mechanical Engineers (ASME) B31.1, Code for Power Piping. However, the B31.1 code year and installation requirements have not been verified as part of the analysis because of a lack of documentation. Although the cursory review of the B31.1 code years in place near the time period of the plant design have similar strength values and other similarities, the BPVC and B31.1 code years should be verified.

Main Steam

Main steam operating pressures for the upgraded performance are approximately the same as the original base plant operating case; therefore, safety valve set points are acceptable. Upgraded performance main steam flow rates are greater than the original plant design. Main steam system pipe velocities were checked for the upgraded operating conditions and found acceptable. The main steam system safety valve capacities with existing safety valve capacities are listed on the piping and instrument diagrams (P&IDs). Main steam safety valve existing capacities (piping and drum safety valves) are acceptable. See Table 3-6for a summary of Main Steam Operating Conditions and Table 3-7 for Main Steam Safety Valve Capacities.

Table 3-6 Main Steam Operating Conditions at Boiler Superheater Outlet

OPERATING CONDITION	PRESSURE PSIA	TEMPERATURE F	FLOWRATE LB/HR	FLOWRATE % INCREASE
Base Plant Heat Balance	2611	1005.3	3,769,000	Base
Upgraded STG – Average Ambient – Case 2 Heat Balance	2499.7	1005.7	3,874,000	3%
Upgraded STG – 1% WBT – Case 1 Heat Balance	2504.8	1006	3,990,000	6%

Table 3-7 Main Steam Relief Valve Capacities

SAFETY VALVE IDENTIFICATION	RELIEVING CAPACITY, LB/HR
RV-7	410,400
RV-8	413,360
PRV-9	263,244
HP Drum Safety Valves Sub-Total	3,208,100
TOTAL SAFETY VALVE CAPACITY	4,295,104

Cold/Hot Reheat Steam

The upgraded performance impact results in the reheat system having higher flows and operating pressures than the base plant heat balance. Table 3-8 summarizes the cold reheat operating conditions.

Table 3-8 Cold Reheat Operating Conditions

OPERATING CONDITION	PRESSURE PSIA	PRESSURE % INCREASE	TEMPERATURE F	FLOWRATE LB/HR (NOTE 1)	FLOWRATE % INCREASE
Base Plant Heat Balance	611.7	Base	632.5	3,712,800	Base
Upgraded STG – Average Ambient – Case 2 HB	625.3	2%	631.9	3,817,200	3%
Upgraded STG – 1% WBT – Case 1 HB	643	5%	636.3	3,933,400	6%

Notes
1. Total Cold Reheat Flowrate is HP Turbine Exhaust Flow which includes extraction steam flow to High Pressure (HP) Heater 7 (1G1/1G2/2G1/2G2)

Cold reheat steam system operating pressures for the upgraded performance are approximately 14 pounds per square inch (psi) higher for the average ambient heat balance and 30 psi higher for the one percent hot day heat balance than original plant operating pressures. The upgraded performance reheat system operating pressures are below the lowest safety valve set pressure; however, the pressure margins between the upgraded operating pressures and the relief valve set pressures and closing pressures is decreased. The reduction in these margins can result in the valve steaming and the valve may not fully close after being actuated. Reheat systems generally have the lowest safety valve set point at 15 percent margin above the maximum operating condition to prevent safety steaming. It is noted that the base plant operating condition cold reheat had 13 percent margin, and hot reheat had 23 percent margin above the operating pressure. Cold reheat lowest safety valve set pressure is 675 psig, which is equivalent to the steam generator reheater section design pressure; therefore, raising set pressures is not viable unless the reheater section is redesigned for a higher pressure. Both the cold reheat and hot reheat piping are designed for 700 psig.

Average ambient heat balance operating conditions have 11 percent pressure margin above the relief valve set pressure and 7 percent pressure margin above the relief valve closing pressure. For the 1 percent hot day heat balance, operating conditions have 7 percent pressure margin above the relief valve set pressure and 4 percent pressure margin above the relief valve closing pressure. During the 1 percent hot day, the lowest level set safety valve may experience some partial opening and improper closing because of the low margins between operation/set point/closing pressure.

Refer to Table 3-9 for a summary of the cold reheat operating pressures in comparison to the cold reheat relief valve set pressures.

IPT inlet area modification can be made to reduce the IPT inlet pressure thereby reducing the cold reheat system pressure and eliminate the problem of reduced pressure margin.

Table 3-9 Cold Reheat Operating and Safety Valve Pressures

OPERATING CONDITION (NOTE THAT VALUES HAVE BEEN ROUNDED)	COLD REHEAT OPERATING PRESSURE (PSIG)	COLD REHEAT LOWEST SAFETY VALVE SET POINT (675 PSIG)		COLD REHEAT LOWEST SAFETY VALVE CLOSING POINT (655 PSIG)	
		MARGIN (PSI)	MARGIN (PERCENT)	MARGIN (PSI)	MARGIN (PERCENT)
Base Plant Heat Balance	597	78	1.13	58	1.10
Upgraded STG – Average Ambient	611	64	1.11	44	1.07
Upgraded STG – 1% WBT	628	47	1.07	27	1.04

Hot reheat steam system operating pressures for the upgraded performance are approximately 14 psi higher for the average ambient heat balance and 30 psi higher for the one percent hot day heat balance than original plant operating pressures. The upgraded performance reheat system operating pressures are below the lowest safety valve set pressure; however, the pressure margins between the upgraded operating pressures and the relief valve set pressures and closing pressures is decreased. The reduction in the margin between the operating pressure and safety valve set pressure and closing pressure solicits the same review as the cold reheat safety valve set points. Refer to Table 3-10 for a summary of the hot reheat operating pressures in comparison to the hot reheat relief valve set pressures.

Table 3-10 Hot Reheat Operating and Safety Valve Pressures

OPERATING CONDITION	HOT REHEAT OPERATING PRESSURE (PSIG)	HOT REHEAT LOWEST SAFETY VALVE SET-POINT (630 PSIG)		HOT REHEAT LOWEST SAFETY VALVE CLOSING-POINT (611 PSIG)	
		MARGIN (PSI)	MARGIN (PERCENT)	MARGIN (PSI)	MARGIN (PERCENT)
Base Plant HB	550	80	1.15	61	1.11
Upgraded STG – Average Ambient	562	68	1.12	49	1.09
Upgraded STG – 1% WBT	578	52	1.09	33	1.06

The upgraded performance impact also would result in the reheat system having higher flows and operating pressures than the base plant heat balance. Table 3-11 summarizes the cold reheat operating conditions.

Table 3-11 Hot Reheat Operating Conditions

OPERATING CONDITION	PRESSURE PSIA	PRESSURE % INCREASE	TEMPERATURE F	FLOWRATE LB/HR	FLOWRATE % INCREASE
Base Plant Heat Balance	564.3	Base	1002.6	3,362,000	Base
Upgraded STG – Average Ambient	576.8	2%	1002.6	3,450,000	3%
Upgraded STG – 1% WBT	593.1	5%	1002.6	3,551,000	6%

Reheat steam system velocities were checked for the upgraded operating conditions and found acceptable. The reheat steam system safety valve capacities were checked with existing safety valve capacities listed on the P&IDs. Both the ASME BPVC 1968 and ASME BPVC 1971 state that the total reheat relieving capacity shall be "at least equal to the maximum steam flow for which the reheater is designed." Reheater maximum flow design was not located in existing documentation; therefore, heat balance operating conditions were used to review the reheat relieving capacity.

Because of the increased reheat steam flow in the upgraded performance, the existing total capacity of the reheat safety valves falls short of relieving capacity requirements. An additional relieving capacity of approximately 125,000 lb/hr (Upgraded performance) would be needed for the reheat system. The existing valves should be reviewed to determine whether modifications to the valves can achieve this gap, or an additional reheat safety valve can be added. It is noted that the ASME BPVC Section 1 requirement for hot reheat safety valves on the reheater outlet to pass 15 percent of the total flow is still met with the existing hot reheat safety valves. Refer to Table 3-12 for Existing Reheat Safety Valve Flow Capacities.

Table 3-12 Existing Reheat Safety Valve Flow Capacities

SAFETY VALVE IDENTIFICATION	RELIEVING CAPACITY, LB/HR
Cold Reheat RV-10	466,694
Cold Reheat RV-11	470,106
Cold Reheat RV-12	473,473
Cold Reheat RV-13	476,840
Cold Reheat RV-14	480,207
Cold Reheat RV-15	480,207
Total Cold Reheat Safety Valves	2,847,527
Hot Reheat RV-16	251,636
Hot Reheat RV-17	328,016
Total Hot Reheat Safety Valves (meets 15% of Reheat Flow)	579,652
15% of Reheat Flow	532,650
TOTAL COLD AND HOT REHEAT SAFETY VALVES CAPACITY	3,427,179
UPGRADED REHEAT FLOW (RH only. Does not include Htr 7 Ext Steam)	3,551,000
UPGRADED REHEAT SYSTEM SAFETY VALVE CAPACITY SHORTAGE	123,821

The reheat relief valve should be inspected by the relief valve supplier to confirm valve operation still meets the original design conditions, the valve is in an acceptable condition, and the reduced margins are acceptable. Based on the safety valve supplier's report, proposed operating conditions may require additional review.

3.6.1.5 High Energy Piping and Support Evaluation

High energy piping systems (steam and feedwater) for plants of this operating age should be evaluated in further detail during the execution phase because of the potentially dangerous consequences if system integrity is compromised. High energy piping and support evaluation should be conducted to establish the current condition of the piping material, develop remedial plans (if required), and establish the remaining life of the piping systems. Feedwater systems are particularly susceptible flow accelerated corrosion (FAC), whereby the protective oxide layer on carbon steel interior pipe surfaces dissolves, and a new layer of protective oxide is formed that also ultimately dissolves, resulting in pipe wall thickness thinning.

3.6.2 Boiler Impacts

The higher efficiency steam path results in modified steam exhaust properties from the individual turbine sections. For example, the higher efficiency HP turbine will result in lower temperature steam exhausting the HP turbine and returning to the boiler reheater. The boiler must provide additional heat input to the steam entering the reheater to maintain the hot reheat steam temperatures at design conditions. Additional steam generator reheater surface may be required to ensure that that these conditions can be maintained following the turbine upgrade project.

Doosan Babcock and Babcock & Wilcox were both contacted to solicit their opinion to determine if any boiler modifications would be required. Both companies were of the opinion that each unit would probably be able to maintain the hot reheat temperature without the addition of any reheat surface but a more formal review should be performed to confirm this. It would be advantageous if this work/review was performed by one of these companies since both already have a relatively up-to-date model of the Unit 1 and Unit 2 boilers.

As illustrated by Figure 3-1, the boiler full load fuel heat input (burn rate) would typically increase in proportion to load if increasing from the current maximum continuous rating (MCR) of 550 MW gross output to 600 MW gross output with the existing STG. The increased isentropic efficiency of the upgraded STG, however, would reduce the boiler burn rate per MW of gross generation. The projected fuel burn rate for the upgraded STG unit performance would result in a decrease in boiler fuel heat input, as shown in Table 3-13.

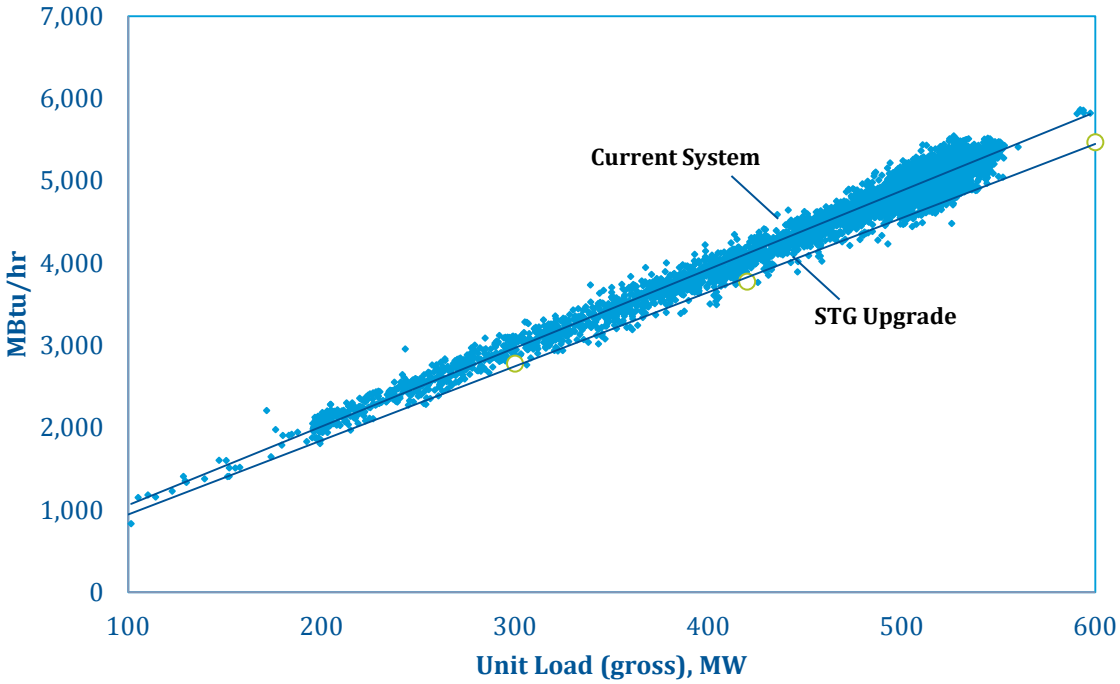


Figure 3-1 Boiler Fuel Heat Input versus Gross Unit Load

Table 3-13 Differential Fuel Burn Rate

	600 MW	420 MW	300 MW
Current System	5,834	4,115	2,969
STG Upgrade	5,468	3,775	2,779
Differential	**366**	**340**	**190**

3.6.3 Electrical/Control Systems

The existing generator would be reused with the STG upgrade; thus, no major electrical impacts will be caused by the steam turbine upgrade project. The existing generator step-up transformers, however, will be loaded to near their full 65 C rise capabilities with the generators operating at 600 MW and expected auxiliary electrical system loading. Although the expected generator step-up transformer loading should not exceed the transformer capability, the remaining life of the transformers is not easily predicted since it is unknown how the transformers have been loaded over their 35+ years in operation.

The existing generator step-up transformers are rated 530 MVA (at 55 C rise) and 593.6 MVA (at 65 C rise). This rating is based on a normal 24-hour average ambient temperature of 30 C and maximum temperature of 40 C. The average 24-hour maximum temperature during the hottest month of the year is approximately 28 C for Madison, WI. IEEE Std C57.91 (IEEE Guide for Loading Mineral-Oil-Immersed Transformers) indicates that the load may be increased 0.75 percent of the kVA rating for each °C lower than 30 C average ambient temperature for FOA transformers. Thus, the generator step-up transformers should be capable of a minimum of 602.5 MVA for the maximum ambient conditions at the site without loss of normal life expectancy.

In addition, the generator step-up transformer loading should not exceed 602.5 MVA with the generators operating at 600 MW and within the generator reactive power capability and steady state stability limits as long as the total auxiliary system load is above approximately 9 MW. Based on the generator MVAR capability at 600 MW, as indicated by the generator capability curve with superimposed steady state stability limit for Unit 1, the generator step-up transformer loading is not expected to exceed approximately 596 MVA for Unit 1 and 592 MVA for Unit 2 (see summary Table 3-14 below.) These values were calculated using the generator step-up transformer test data and expected auxiliary system load data based on typical measured values on May 20, 2011 with Generator 1 running at approximately 543 MW and Generator 2 at 528 MW. Measured auxiliary system loading for Unit 2 was increased approximately 5% to account for increased loading with generator output of 600 MW. Measured auxiliary system loading for Unit 1 was increased approximately 5% after reduction of ID Fan load (which will eventually be removed from the auxiliary system buses – approximately 4 MW each). Auxiliary load power factor was estimated at approximately 0.85, as this information is not available in the historical data.

Table 3-14 Summary of Expected GSUT Loading at 600 MW Generator Output Based on Generator Capability and Expected Auxiliary System Loading

SUMMARY OF EXPECTED GSUT LOADING AT 600 MW GENERATOR OUTPUT BASED ON GENERATOR CAPABILITY AND EXPECTED AUXILIARY SYSTEM LOADING								
Operation	345 kV System Voltage (pu)	Gen MVAR Capability (MVAR)	Gen PF	Approx. Gen Voltage (pu)	5/21/11 Aux Load (MW)	Estimated Aux Load at 600 MW	Approx GSUT Output (MVA)	Approx PF at 345 kV System
Unit 1 Lagging	0.95	147.2	0.971	0.967	23.3	16.0	589.2	0.989
	1.0	147.2	0.971	1.016		16.1	589.8	0.988
	1.02	147.2	0.971	1.036		16.2	590.1	0.987
	1.05	16.3	1.0	1.05		16.2	583.4	- 0.998
Unit 1 Unity PF at Gen	0.95	20.6	0.999	0.95		15.9	583.8	- 0.998
	1.001	10.34	1.0	1.0		16.0	584.1	- 0.997
	1.02	57.6	1.0	1.02		16.1	583.5	- 0.998
	1.05	16.3	1.0	1.05		16.2	583.4	- 0.998
Unit 1 Leading	1.0	- 70.6	- 0.993	0.99		16.0	595.9	- 0.977
	1.02	- 70.6	- 0.993	1.01		16.1	595.5	- 0.978
	1.05	- 70.6	- 0.993	1.04		16.2	595.0	- 0.979
Unit 2 Lagging	0.95	147.2	0.971	0.966	19.5	20.4	584.5	0.989
	1.0	147.2	0.971	1.016		20.6	585.1	0.988
	1.02	147.2	0.971	1.036		20.7	585.3	0.987
	1.05	19.2	0.999	1.05		20.7	578.8	- 0.998
Unit 2 Unity PF at Gen	0.95	23.5	0.999	0.95		20.3	579.3	- 0.998
	1.001	13.2	1.0	1.0		20.5	579.6	- 0.997
	1.02	12.3	1.0	1.02		20.6	579.5	- 0.997
	1.05	19.2	0.999	1.05		2.7	578.8	- 0.998
Unit 2 Leading	1.0	- 70.6	- 0.993	0.988		20.3	592.1	- 0.998
	1.02	- 70.6	- 0.993	1.01		20.5	591.6	- 0.977
	1.05	- 70.6	- 0.993	1.039		20.7	591.0	- 0.978

Although the STG upgrade project should not result in increased short-circuit duties on the existing isolated phase bus (IPB), the existing ratings should be confirmed to be adequate during detailed design and if the existing generator step-up transformers are to be replaced at a future date. Based on H.K. Porter drawings U-122018, Rev. 3 and U-122018X1, Rev. 3, the IPB is rated 22 kV, 110 kV BIL, 65 C Max. Rise, 16,213 A Main Bus (327 kA Momentary Asymmetrical Short-Circuit Withstand), 1,500 A Tap Bus (440 kA Momentary Asymmetrical Short-Circuit Withstand). Based on tested values of impedance and X/R ratio for the existing generator step-up transformers,

generator impedance and time constant data for Generator 2 (GE Serial No. 180X657), Unit Auxiliary Transformer test data, and estimated auxiliary system motor data, calculations indicate the main bus withstand capability of 327 kA should be adequate but the tap bus withstand capability should be approximately 450 kA minimum, rms, asymmetrical. In addition, the 16,213 A continuous rating of the IPB is equal to the generator rating at 100% generator voltage. Although the continuous rating of the IPB is assumed to be based on 65 C rise above 40 C ambient, the ambient conditions at the site may allow for a higher continuous current capability. The IPB should be capable of continuous operation with the generator operating at minimum (95%) voltage, with at least a 5% margin. This would require an IPB continuous capability of approximately 17,920 A at the site ambient conditions. Thus, the short-circuit duties and IPB ratings require further investigation during detailed design.

3.6.4 Civil/Structural Considerations

Civil/structural impacts for the steam turbine system modifications would be minimal. Design information for the existing STG pedestal and foundation was provided to all of the steam turbine OEM's during the preliminary RFP process. None of the OEM's expressed any concerns regarding civil/structural limitations of the existing design and this matches B&V experience. If subsequent OEM inspection and evaluation of the condition of the existing outer cylinders uncovers cracks or other compromising conditions, they will have to be replaced and would be designed to match the footprint of the existing outer cylinders.

4.0 Heat Rejection Upgrade Analysis

4.1 OBJECTIVE

The objective of this analysis is to sufficiently conceptualize and optimize heat rejection system equipment modifications and/or upgrades to allow estimating of feasibility-level capital cost estimates that potential stakeholders may consider in their evaluation for further project development. The STG Upgrade Analysis, Section 3.0, established the estimated upgraded turbine cycle performance required to achieve the CAMP unit generating capacity and heat rate (efficiency) goals. This heat rejection optimization was performed to determine the scope of major equipment modifications and/or upgrades required to support the upgraded turbine cycle performance. This included modifying the heat rejection system design performance so that the desired 600 MW STG gross output would be achieved at a one percent summer wet bulb temperature. The optimization also determined the best match-up of heat rejection equipment sizing to the STG LPT exhaust conditions, based on the 30inch last stage blade exhaust loss curve, for plant operating conditions throughout the year.

4.2 REQUIREMENTS

One of the primary goals for the Columbia CAMP project would be to produce 600 MW gross STG output at ambient conditions of 75° F wet-bulb temperature (WBT) and 83.5° F dry-bulb temperature (DBT) while the STG is operating at rated pressure of 2,415 psia and the turbine valves-wide-open (VWO) operating condition. The above ambient condition is based on the American Society of Heating, Refrigerating and Air-Conditioning Engineers' (ASHRAE's) one percent WBT occurrence for Madison, Wisconsin.

The larger annulus area of the proposed upgraded STG LPT with 30-inch last stage blades would also provide for higher STG efficiency at a lower back pressure resulting in a better plant heat rate. Since most of the STG OEMs confirmed that the 30 inch LSB was feasible for these units, it was determined to perform the heat rejection optimization with the 30-inch LSB in order to achieve the other primary CAMP goal of a target plant heat rate of 9,800 Btu/kWh. The upgraded STG heat balance establishes the heat load requirements for the modified/upgraded heat rejection system to achieve this goal.

Finally, in addition to supporting the two preceding primary goals, the heat rejection system would also be optimized for unit STG output and heat rate against capital investment over forecasted unit operating conditions for the entire year.

4.3 DESIGN CONSTRAINTS

Heat rejection system design constraints were governed by the existing equipment limitations discussed in the following subsections.

4.3.1 Condenser

Based on input received from WPL, no upgrades were considered for the condenser for either of the two units. This was primarily because of an already approved investment in the retubing of the condenser for Unit 1 and a decision by not to retube the condenser for Unit 2. The optimization study was conducted for the post retubing scenario for Unit 1 condenser. The geometry information for the condenser is as follows:

- Each condenser has 13,348 tubes per shell. Each unit has two identical shells.
- The effective length of the tubes is 35.8 feet.
- The OD of the tubes is 1 inch.
- Tube material is Sea Cure UNS44660 for Unit 1 and SS304 for Unit 2. Both materials have similar thermal conductivity; therefore, for the purpose of heat rejection optimization, both the units were modeled as UNS44660.
- Approximately 8.2 percent of the tubes have a 0.035 inch wall thickness; the remaining are 0.028 inch (22 Birmingham Wire Gauge [BWG]) tubes. For the purpose of heat rejection system optimization, it was assumed that all tubes are 22 BWG.
- The original design condenser tube cleanliness factor was 90 percent for both units. Unit 1 has an on-line condenser tube cleaning system, but it is not functional and the plant reported reliability issues and marginal benefit when in-service. Unit 2 doesn't have a tube cleaning system. A condenser cleanliness factor of 75 percent was used for the heat rejection optimization as more representative of realistic plant operating condition.

4.3.2 Cooling Tower

The existing helper cooling towers were constructed when Unit 2 was built and the wood framing and decking have reached the point where major restoration and/or reconstruction work would be required. The poor physical condition of the towers coupled with poor thermal performance would make them a better candidate for reconstruction rather than rehabilitation. Therefore, the CAMP evaluation was based on demolition and replacement of the existing cooling towers and new counterflow cooling towers would be furnished and erected in the place of the existing towers. A counterflow cooling tower design would provide better thermal performance and also have a lower head requirement allowing for the potential for higher flow through the cooling tower and cooling tower pumps. There are several design constraints as listed below:

- The cooling tower cannot be extended lengthwise because of space limitations; therefore, the maximum longitudinal dimension was fixed at 36 feet x 7 = 252 feet. The width of the existing cooling tower basins would be extended as necessary to accommodate the additional width of the counterflow towers.
- Both an in-line and back-to-back arrangement were considered. However, as mentioned above, length limitations prohibit the installation of an in-line arrangement.

- The existing cooling tower electrical supply provides for the operation of seven, 200 horsepower (hp) motors. Minor modifications would allow an eighth 200 hp motor. Any quantity greater than eight will require significant additional capital investment and, hence, was not considered for this study.
- An increase in fan motor size greater than 200 hp would also require significant capital investment and, therefore, was not considered.
- 2° F cooling tower recirculation allowance was used.

4.3.3 Circulating Water Pumps

Even though the circulating water pumps have been overhauled in the past (Pump 1A in 1997; Pump 1B in 1992 and 2006; Pump 2A in 1998 and 2005; Pump 2B in 1988 and 2000), plant data indicates significant degradation in performance. This project would provide for removal of the pumps to be refurbished to recover the lost flow capacity since the last overhaul with corresponding improvement in condenser backpressure and plant heat rate. The overhaul would also provide for the potential to increase the pump design flow beyond the existing design if determined to be economically optimal in this analysis. It was assumed that the circulating water pump motors would not be replaced because of the high capital cost of replacement motors plus the associated electrical supply upgrades; therefore, the following constraints were used in the optimization:

- Circulating water pump motors are rated at 1,250 hp.
- For optimization purposes, pump motor operating load will not exceed a 0.97 service factor.

4.3.4 Cooling Tower Pumps

The plant reported that the existing cooling tower pumps have not been overhauled since the early '90s (Pump 2A in 1990 and Pump 2B in 1993) and were believed to have experienced significant degradation in performance. Since it is difficult to measure the actual cooling tower pump flow, it was not possible to assess the extent of degradation for this analysis. This project would provide for removal of the pumps to be refurbished to recover the lost flow capacity since the last overhaul. In addition, overhaul would also provide for the potential to increase the pump design flow beyond the existing design. The cooling tower and cooling tower pumps work together as a subsystem so for this analysis they were treated as a single upgrade project. Like the circulating water pumps, it was assumed that the cooling tower pump motors will not be upgraded or replaced; therefore, the following constraints were added in the optimization:

- Cooling tower pump motors are rated at 2,250 hp.
- For optimization purposes, pump motor operating load will not exceed a 0.97 service factor.

4.4 OPTIMIZATION APPROACH AND CONSTRAINTS

The function of the heat rejection system is to reject waste heat energy from the turbine cycle to the atmosphere. The heat rejection system consists of the condenser, circulating water

pumps, cooling tower pumps, cooling towers, cooling pond, and intake and discharge structures. The cooling tower works as a helper tower, thus operating in parallel with the plant cooling pond. Figure 4-1 provides the schematic of the heat rejection system.

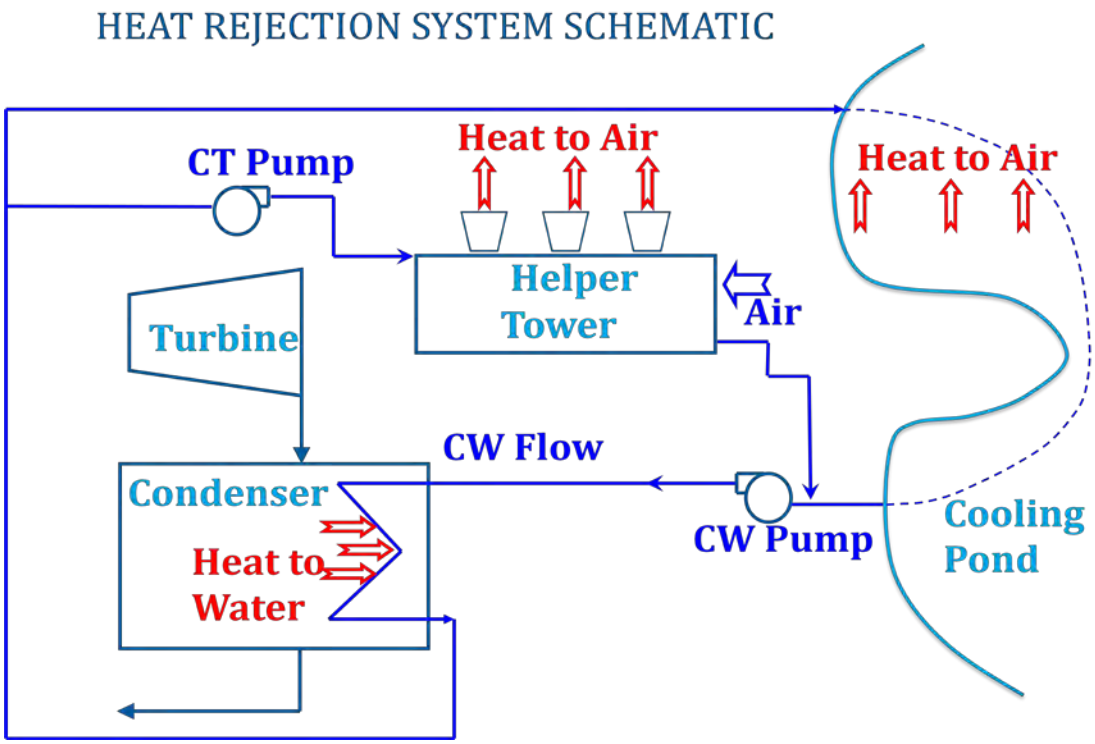


Figure 4-1 Heat Rejection System Schematic

The plant auxiliary cooling water system operates independently of the circulating water pumps but the heat load is also rejected by the cooling pond and the cooling tower. It was assumed that the auxiliary cooling system will not be significantly changed by the CAMP projects; therefore, auxiliary cooling load was not considered as material in the heat rejection optimization.

Monthly average WBTs were used for the optimization analysis. It was assumed that the cooling tower will operate from May through October (i.e., 6-months). Table 4-1 presents the annual monthly average dry-bulb and average wet-bulb temperatures. The DBT is based on ASHRAE, 2009 data for Madison, Wisconsin, while the WBT has been calculated using relative humidity from the ISMCS 1995.

Table 4-1 Monthly Average Dry-Bulb and Average Wet-Bulb Temperatures

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
DBT	19.6	24.3	34.1	46.8	57.6	67.3	71.8	69.4	61.3	49.3	36.4	24.1
WBT	16.6	22.2	31.2	40.3	51.7	60.5	65.3	63.9	56.7	45.3	33.1	22.0

The heat rejection optimization analysis was performed by generating alternative heat rejection system design combinations by varying the cooling tower approach, cooling tower flow, circulating water flow (condenser tube velocity), basin water loading, and cooling tower cell dimensions. Each of these alternative design combinations was checked against the design constraints discussed in Subsection 4.3 to provide a set of feasible solutions. A capital recovery analysis was then conducted using economic criteria provided by WP&L (refer to Subsection 4.5.1) for all the feasible solutions to yield the optimum solution.

Black & Veatch in-house capital cost data was used for estimating the differential cooling tower, piping, pump, etc. costs for the various heat rejection system design alternatives. [For the CAMP cost estimate, the optimized heat rejection system design performance basis was used for seeking major equipment vendor quotes.]

4.5 HEAT REJECTION OPTIMIZATION

This subsection discusses the details of the optimization process and the results.

4.5.1 Economic Criteria

The comparative capital and annual operating costs for the feasible options were evaluated based on the economic factors presented in Table 4-2. Detailed economic criteria are attached in Appendix A.

Table 4-2 Economic Evaluation Factors

PARAMETER	VALUE
Economic Evaluation Period, years	30
Acceptable Payback Period, years	15
Interest Rate During Construction, percent	5.5
Escalation Rate	
Material, percent	3.0
Fuel, percent	2.0
Fuel Charge in 2013, $/MBtu (Million British thermal units)	2.69
Fixed Charge Rate, percent	8
Discount Rate, percent	7

4.5.2 Optimization Analysis

Heat rejection system optimization was conducted using an in-house developed financial proforma spreadsheet that varies design parameters to generate thousands of possible heat rejection system configurations. The parameters being varied are listed in Table 4-3.

Table 4-3 Optimization Design Parameters

The range of back pressures (BP) (at 1 percent WBT day) from the minimum to the maximum were analyzed in increments as specified below.	
Minimum BP of interest, in HgA	3.0
Maximum BP of interest, in HgA	4.2
Incremental change in BP, in HgA	0.05
The range of approach temperatures from the minimum to the maximum will be analyzed in increments as specified below.	
Minimum approach temperature of interest, °F	7.00
Maximum approach temperature of interest, °F	15.00
Incremental change in approach, °F	1.00
The range of circulating water velocities within the condenser tubes from the minimum to the maximum will be analyzed as specified below.	
Minimum in tube velocity of interest, ft/s	6.50
Maximum in tube velocity of interest, ft/s	8.00
Incremental change in velocity, ft/s	0.02
Percentage of flow to cooling tower	
Minimum	45
Maximum	55
Incremental change	1

Variation of the design parameters in Table 4-3 resulted in 144,000 possible combinations, however, not all the combinations represent a technically valid or feasible solution, so all combinations were checked against the various optimization design constraints. Since condenser heat rejection duty and steam turbine gross output is affected by the condenser pressure, back pressure curves that relate the condenser duty and steam turbine gross output to the condenser pressure were developed using commercially available SteamMaster software. The basis of these curves is an approximate model of the steam turbine after the CAMP-related upgrade. These curves were then added to the heat rejection optimization spreadsheet for quick evaluation of heat rejection and steam turbine performance for each combination. The optimization program also performed off-design condenser and cooling tower performance calculations to estimated heat rejection system and overall steam turbine cycle performance for average monthly ambient temperatures from May through October.

The technically valid and feasible combinations were sorted based on net present cost. The net present cost includes the capital cost, cost of fuel and variable O&M costs. The lowest net present cost option is the optimum solution. Figure 4-2 presents a plot of the differential net present cost and the differential capital costs. The differential capital cost is the cost difference between the cost of a feasible option and the lowest cost among all feasible options that were analyzed in this study. Since the feasible designs range from back pressure of 3.95 to 4.25 inch HgA, the differential cost variation between the best and the worst option was relatively small. In general, the options with lower back pressure have higher initial capital costs, however because of the heat rate improvement these options provide for lower fuel and variable O&M costs.

Figure 4-3 presents the variation of differential capital cost (average of all the examined feasible options at each back pressure) and differential net present cost (average of all the examined feasible options at each back pressure) with the condenser pressure. The figure shows that for the feasible range of condenser pressure examined, the lowest net present cost corresponds to the lowest condenser pressure.

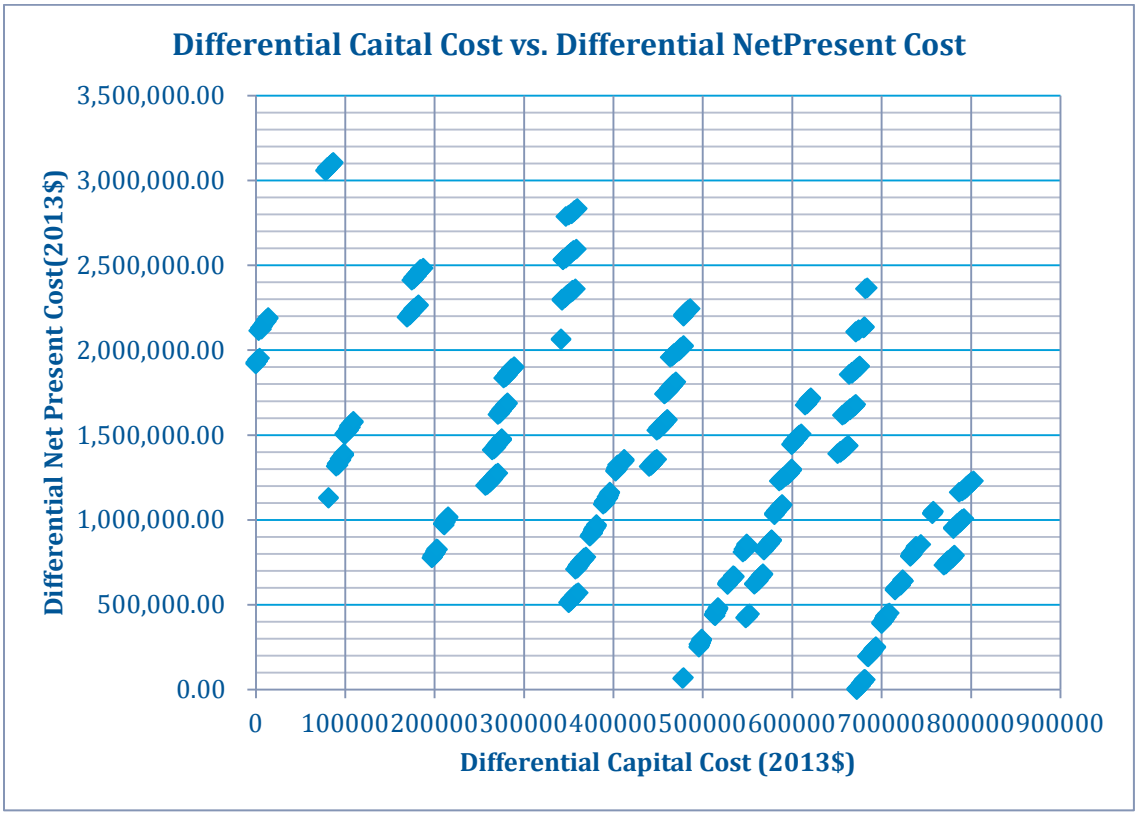


Figure 4-2 Differential Capital Costs versus Differential Net Present Cost

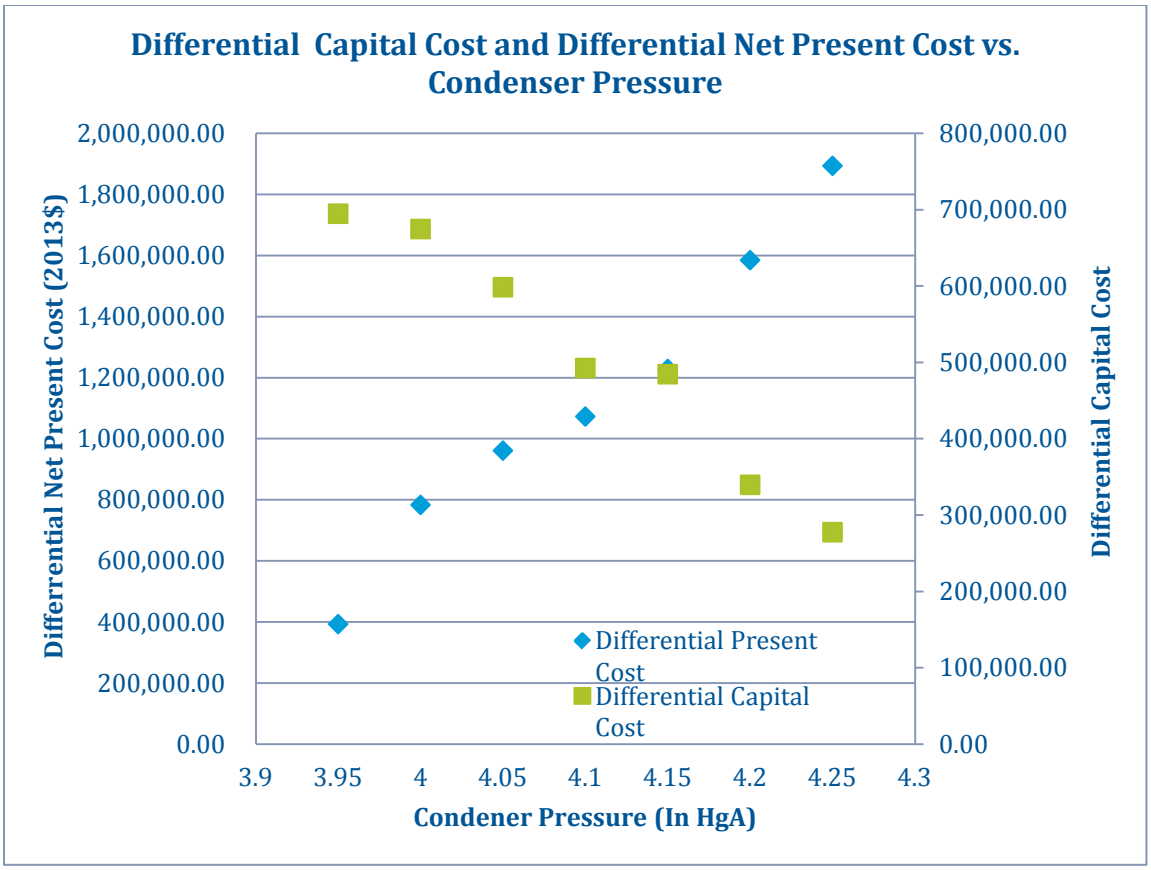


Figure 4-3 Differential Capital Cost and Differential Net Present Cost vs. Condenser Pressure

4.5.3 Optimization Results

The optimized cooling tower performance parameters are listed below. Based on the input received from pump vendors regarding cooling tower pump flow capability, the final design was slightly modified from the one generated from the optimization spreadsheet.

Table 4-4 Cooling Tower Design Conditions, Each Tower

COOLING TOWER DESIGN CONDITIONS, EACH TOWER	
Cooling tower flow, gpm	107,000
Cooling tower inlet water temperature, °F	111.8
Cooling tower outlet water temperature, °F	87

The corresponding HEI calculation basis for the condenser is provided in Table 4-5. The table presents the important condenser parameters for the optimized design. It should be noted that since the heat rejection capacity of the cooling pond has been kept constant and because the increase in steam turbine capacity will increase the heat rejection load, in the optimized design approximately 53 percent of the circulating water flow would be directed to the cooling tower and the remaining 47 percent directed to the cooling pond.

Table 4-5 HEI Condenser Performance for Optimized Design at 1% WBT

Steam Table Version	1967
Design Heat Load, MBtu/h (per shell)	1,294.00
Condenser Back Pressure, in. HgA	3.95
Corresponding Saturation Temperature, °F	125.0
Cold Water Inlet Temperature, °F	88.60
Number of Condenser Passes	2
Condenser Tubes	
Material (9th Ed.)	UNS S44660
Gauge, BWG	22
Effective Length, ft	35.80
Diameter, in. OD	1.000
Cleanliness, %	75.00
Velocity, ft/s (Analysis 1 only)	7.00
Condenser Performance and Size	
Cooling Range, °F	25.73
Circulating Water Flow, lb/h (per shell)	50,455,463
Circulating Water Flow, gpm (per shell)	101,226
Number of Tubes per pass	6,629
Surface Area Required, ft^2 (per pass)	124,257
Actual Surface Area, ft^2 (per pass)	124,260
(Based on number of tubes)	
TTD, °F	10.62
Total Circulating Water Friction Loss, ft H_2O	16.92

4.6 BALANCE-OF-PLANT CONSIDERATIONS FOR HEAT REJECTION OPTIMIZATION

4.6.1 Mechanical Systems

The change from cross-flow to counter-flow cooling towers would require piping modifications to the hot water supply distribution headers. On cross-flow towers, the hot

circulating water is distributed through the towers by two headers that run lengthwise along the top deck. On counter-flow towers, the distribution headers would typically be installed at or below grade along the length of the cooling towers. With the back-to-back counterflow cooling tower arrangement, the supply headers would be modified to install headers along both longitudinal sides of the cooling towers. Individual riser piping would convey water from the underground supply headers to each cooling tower cell. The existing cooling tower basin would be expanded and circulating water distribution headers modified to accommodate the new counter -flow cooling towers.

The refurbished cooling tower pumps would not require any changes to existing system interfaces and/or tie-ins.

It is expected that underground circulating water piping from the cooling tower pumps to the cooling towers would not required significant modification. The circulating water flow velocities in all the piping sections were found to be reasonable for the upgraded conditions. To the extent possible, the cooling tower basin would be expanded in the direction away from the cooling pond.

4.6.2 Electrical/Control Systems

The existing cooling tower electrical supply consists of two motor control centers (MCCs) each fed by an outdoor, oil filled auxiliary transformer per cooling tower. Four, 200 hp fan motors and some miscellaneous auxiliary loads are supplied from one MCC, and three 200 hp fan motors and some miscellaneous auxiliary loads are supplied from the other MCC. Relatively minor modifications would allow an eighth 200 hp motor to be added for the proposed new cooling tower. Any number of fans/motors greater than eight or fan motor power consumption above 200 hp wwould require major electrical power supply upgrades which to significantly increase the required capital investment.

The existing cooling tower auxiliary transformers are sized for four, 200 hp motors but have experienced high temperatures when operated near the maximum rating. This transformer overloading is primarily due to the fan motors being operated in an overloaded condition resulting from changes to the fan blade pitch that were made to cooling tower cooling capability by raising the tower air flow. In designing the new cooling tower to fully consume the available electrical supply capacity, it would not be recommended to operate the new cooling tower fan motors in an overloaded condition. If the auxiliary transformers continue to experience high temperatures after the upgrade, the transformers could be retrofitted with cooling fans to provide a small increase in the operating capacity.

One additional vertical section, along with a Size 5 motor starter, would be added to the existing MCC that has only three existing fans to supply power to. The new section for provide the power supply to the eight fan motor of each cooling tower. In addition, a new 480 volt panelboard that feeds from one of the existing cooling tower MCCs would be added in each electrical building to supply power to the motor-operated valves (MOVs) to be installed as part of the isolation valves to

be installed in the riser piping to each cooling tower cell; the MOVs would be supplied with integral motor starters. The panelboard would also supply power to the cooling tower basin sump pump.

Other electrical supply system modifications would include the following.

- Tear out and replacement of the ductbank between the existing cooling tower electrical buildings and the new cooling towers.
- Modification of the ground grid around the cooling tower basins to match the size of the new cooling towers and to interface with the new tower grounding and lightning protection.
- Modifications to the distributed control system (DCS) for the modified cooling tower and pumping arrangement.

4.6.3 Civil Structural Considerations

The existing cooling tower basins are 252 feet long and 51.5 feet wide. The replacement cooling towers would require expansion to provide approximately 241 foot long and 85 foot wide basins. The expanded basin would likely require removal of the existing north basin wall, extension of the existing basin floor, a new north basin wall, and a new wall at the end opposite of the discharge flume. The existing opposite end wall would likely be abandoned in place, and the space between the new and existing opposite end walls filled-in. The cooling tower discharge flumes would also require modification so that they match the basins at the interface. Each new discharge flume would require removal of the existing north flume wall, extension of the existing flume floor, and a new north flume wall. Other miscellaneous work such as walkway extensions, pipe supports, etc., would also be required.

As noted in Section 4.6.2, the new cooling towers would also require new duct banks to supply electrical power and control from the existing electrical buildings. The cooling towers are located within the regulated bank setback of the cooling pond, so expected ground disturbances associated with the project would likely need to be permitted.

The cooling tower and circulating water pump intake structures have not been studied in detail. The current analysis was based on the assumption that small changes in circulating water and cooling tower pump flow will not have any major impact on the intake structures. It is recommended that during detail design, the intake and outfall structures be further examined for impact due to the increased water flow.

5.0 Performance Benefit Analysis

5.1 EXISTING PLANT PERFORMANCE ESTIMATE

In order to evaluate the benefits that can be achieved due to the cooling tower replacement and the cooling tower pump refurbishment project, it was important to establish how the current cooling tower, cooling pond, and circulating water pumps have been performing in recent years. For the purpose of this study, plant operating data over the last 5-years (01-Sep-06 through 01-Sep-11) were used to evaluate this performance.

5.1.1 Measurement Data Evaluated

Table 5-1 presents the measurement parameters that were evaluated. It also presents the tag number of the associated sensors. Table 5-2 presents the derived performance parameters.

Table 5-1 Measured Parameters and Tag Numbers

MEASUREMENT PARAMETER	TAG NUMBER(S)		
Cooling Pond Temperature (assumed as the pond temperature just before mixing with the cooling tower cold circulating water)	1A1842.S		
Circulating Water Temperature at Condenser Discharge (Unit 1)	1A1012.Q 1A1013.Q 1A1014.Q 1A1015.Q 1A1017.Q 1A1018.Q 1A1019.Q 1A1020.Q	1A1012.S 1A1013.S 1A1014.S 1A1015.S 1A1017.S 1A1018.S 1A1019.S 1A1020.S	1A1012.V 1A1013.V 1A1014.V 1A1015.V 1A1017.V 1A1018.V 1A1019.V 1A1020.V
Circulating Water Temperature at Condenser Discharge (Unit 2)	2A1012.Q 2A1013.Q 2A1014.Q 2A1015.Q 2A1017.Q 2A1018.Q 2A1019.Q 2A1020.Q	2A1012.S 2A1013.S 2A1014.S 2A1015.S 2A1017.S 2A1018.S 2A1019.S 2A1020.S	2A1012.V 2A1013.V 2A1014.V 2A1015.V 2A1017.V 2A1018.V 2A1019.V 2A1020.V
Circulating Water Temperature at the Cooling Tower Inlet	1A1936.Q	1A1936.S	1A1936.V
Circulating Water Temperature at the Cooling Tower Outlet	1A1934.Q 1A1935.Q	1A1934.S 1A1935.S	1A1934.V 1A1935.V
DBT	1A1846.Q 2A1846.Q	1A1846.S 2A1846.S	1A1846.V 2A1846.V
Relative Humidity	2A1844.Q	2A1844.S	2A1844.V

Generator Gross Load (Units 1 and 2)	1A1696.Q 2A1696.Q
Calculated Circulating Water Flow	1CC.VW.F00.C.V 2CC.VW.F00.C.V

Table 5-2 Derived Performance Parameters

AVERAGE WBT, ° F	COOLING DONE BY LAKE, ° F	DELTA T ACROSS COOLING TOWER, **° F**	AVERAGE **DBT, ° F**	COOLING TOWER INLET, ° F	CONDENSER INLET TEMP, ° F	CONDENSER OUTLET TEMP, ° F
75.0	25.5	27.8	90.7	119.7	91.6	122.2
71.0	24.7	28.9	87.4	118.2	90.2	120.6
67.0	24.4	28.7	83.7	115.8	88.3	118.1
63.0	24.2	30.0	80.5	114.5	87.1	117.0
59.2	24.6	31.2	75.0	113.7	86.2	116.1
55.1	24.7	29.3	68.6	109.2	83.1	112.9
51.1	24.2	30.2	63.1	105.6	78.6	108.2
47.1	23.8	32.2	60.2	104.8	78.5	108.2
43.1	24.0	33.1	54.8	103.4	77.5	107.2
39.2	24.4	35.0	49.4	100.2	75.0	104.9

5.1.2 Assessment of Existing Cooling Tower Performance

In order to access the benefit of cooling tower replacement it was important to establish the extent of performance degradation in the existing cooling towers. Current performance of the existing helper cooling tower was assessed using the parameters listed in Table 5-3. These values were obtained from the plant operating data and were based on cooling tower performance at full load with ambient conditions between 75° F and 77° F WBT.

Table 5-3 Existing Cooling Tower Performance Parameters

Circulating Water Flow, gpm	92,500
Cooling Tower Range, °F	27.1
Cooling Tower Cold Water Temperature, °F	93
DBT, °F	91.6
Inlet Relative Humidity, percent	55.6

Cooling tower modeling software was used to model the performance of the cooling tower based on these parameters. It should be noted that because the circulating water flow rate to the cooling tower is not measured, for the purpose of this study, the design flow rate has been used to assess the performance of the cooling towers. Reduced flow will tend to make the performance of the existing cooling towers even worse and, therefore, increase the benefit related to the cooling tower replacement.

Cooling tower off-design performance was estimated for different ambient and part loads conditions. Table 5-4 presents the estimated cooling tower cold water temperature. This is used to determine the condenser pressure and the expected plant performance with the existing cooling tower.

Table 5-4 Existing Cooling Tower Performance at Different Ambient and Load Conditions

LOAD CASE	COOLING TOWER CW FLOW (GPM)	RANGE (F)	DBT (F)	INLET RH (%)	COLD WATER TEMPERATURE (F)
Hot Day-100% Load	92500	27.1	91.6	56	93.2
AA Day-100%	92500	26.5	47	83	76.7
AA Day-90% Load	92500	23.7	47	83	74.8
AA Day-80% Load	92500	21.1	47	83	72.9
AA Day-70% Load	92500	18.6	47	83	70.8
AA Day-60% Load	92500	16.2	47	83	68.6
AA Day-50% Load	92500	13.9	47	83	66.3

5.1.3 Assessment of Existing Cooling Pond Performance

Determination of the actual cooling pond performance is a relatively complex analysis that was beyond the scope of this analysis. Historical plant data was used, however, to characterize the existing cooling pond performance. Approximate cooling pond cooling range was derived using the temperature difference between the circulating water temperature at the inlet of the cooling tower and the cooling pond temperature just before mixing with the cooling tower cold circulating water. For the purpose of this study it was assumed that for the existing arrangement, 50 percent of the circulating water flow is sent to the cooling pond and the remaining 50 percent goes to the cooling tower.

Based on operating data over the last 5-years, the Table 5-5 presents the cooling range of the cooling pond. It can be seen that there is an approximate 1.5° F decrease in the cooling range at the average ambient conditions compared to the 1 percent WBT condition.

Table 5-5 Cooling Range of Cooling Pond

AMBIENT WET BULB TEMPERATURE	COOLING RANGE AT 100 PERCENT LOAD
75° F	25.5 F
42.53° F	24.0 F

It should, however, be noted that the temperature differential between condenser discharge temperature and the cooling pond temperature (just before mixing with cooling tower cold water) was at least 2.5° F greater than the cooling range of the pond. While the source of this reduction was not studied in this analysis, it was assumed that this may be attributed to the colder auxiliary cooling water and to a small amount of cooling in the discharge piping/canal. Since there will be no change made to the auxiliary cooling system, it is assumed that there will be at least a 2.5° F temperature reduction between the condenser discharge and the cooling pond inlet/cooling tower intake after the overall plant upgrade under CAMP.

It was assumed that the current cooling pond flow has been reduced by approximately 3.5 percent (please refer to Subsection 5.1.4for details) based on the calculated degradation in circulating water pump performance. An increase in the capacity of the power plant from the current power generation capacity of 540 MW to the future generation capacity of 600 MW would increase the heat load on the cooling pond; therefore, the cooling range of the pond would be increased proportionally to reflect the increase in heat load.

No computational modeling was performed for the cooling pond; therefore, the predictions of performance of the cooling pond were intended for high-level characterization only. It is recommended that a cooling pond study be performed during detail design to verify the heat rejection capability of the pond.

5.1.4 Assessment of Existing Circulating Water Pump Performance

The calculated circulating water flow based on the operating plant data (average value indicated from sensors 1CC.VW.F00.C.V and 2CC.VW.F00.C.V) was approximately 179,000 gpm. This is approximately 3.5 percent lower than the design flow of 185,000 gpm.

5.1.5 Assessment of Condenser Performance

The condenser would remain unchanged after the CAMP project. The base case condenser performance was modeled using HEI procedures based on the following tube characteristics; Seacure UNS44660 tube material (Unit 2 tubes are Type 304 SS which has similar thermal conductivity,) 35.8 feet long, 1 inch OD, and 22 BWG tube wall thickness. The design circulating

flow was maintained at 185,000 gpm. As noted previously, the modeled average tube cleanliness was 75 percent vs. 90% for the original condenser design.

5.2 ISOLATED CAMP PROJECT PERFORMANCE BENEFIT IMPACT ANALYSIS

The unit turbine cycle and heat rejection system perform as an integrated system. The estimated unit capacity and efficiency improvements associated with the STG upgrade would only be achieved if the turbine cycle and heat rejection system equipment have design and operating capabilities in alignment with the upgraded STG performance. The estimated upgraded integrated turbine cycle performance has been represented by Case 1 and Case 2 Heat Balances contained in Exhibit B. Thus, while the individual potential CAMP projects for the boiler feed pumps, circulating water pumps and helper cooling tower & pumps may have an economically justified basis for refurbishment simply to recover performance degradation or to extend operating life, this optimization study also evaluated and optimized the integrated performance required to provide alignment with the integrated turbine cycle conditions required for the STG upgrade. Since each potential CAMP project for the Phase 2 CAMP Study was evaluated individually, Black & Veatch was required to break down and distribute the overall unit heat rate and capacity improvements represented by the Case 1 and Case 2 Heat Balances among the individual turbine cycle and heat rejection equipment CAMP projects. This section discusses the methodology used to achieve this objective.

Heat Balance Case 2 shows the upgraded full load turbine cycle performance at average annual ambient conditions. The following sections summarize how B&V estimated isolated equipment impact and/or benefit of the individual CAMP projects. With that information, the same heat balance simulation model could be rerun, adjusting the model performance characteristics solely for the equipment impact to be isolated. By keeping turbine cycle heat input constant between the two simulations, the comparison between the two heat balances provides a basis for isolated estimated unit heat rate and capacity benefits.

5.2.1 Isolated Net Plant Output and Heat Rate Impacts for Helper Cooling Tower Replacement and Refurbished Cooling Tower Pumps

First step was to estimate the isolated change to the Case 2 Heat Balance if the helper cooling tower replacement and cooling tower pump refurbishments weren't performed. This required estimating monthly average overall heat rejection system performance, based on the estimated degraded performance capability of the existing cross-flow cooling towers and cooling tower pumps. With this information, the heat balance simulation was rerun for this condition to generate the net unit output vs heat rate curve shown in Figure 5-1. The Case 5 Heat Balance in Appendix B shows the overall heat balance simulation result for this case. Comparing this heat balance to the Case 2 Heat Balance isolates the unit capacity and heat rate benefit of the proposed helper cooling tower replacement and the cooling tower pump refurbishment/upgrade. The unit capacity and heat rate benefit at full load are provided in a summary table in Appendix C.

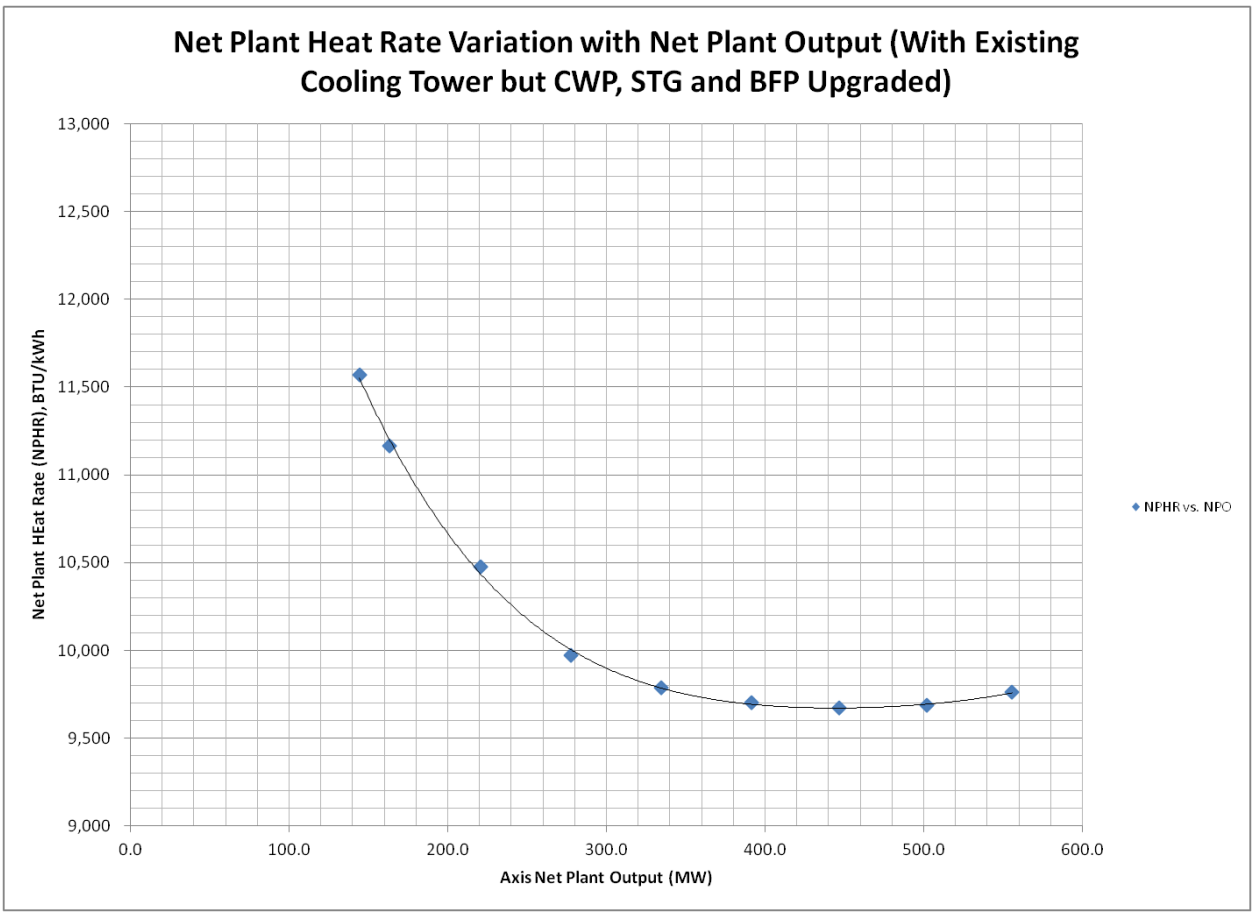


Figure 5-1 Net Plant Output and Heat Rate Estimates of Existing Cooling Tower

5.2.2 Isolated Net Plant Output and Heat Rate Impacts for the Circulating Water Pump Refurbishment and Upgrade

Starting from the heat balance simulation performed for the Case 5 Heat Balance, the model was further adjusted to remove the benefit associated with the circulating water pump refurbishment and upgrade. The primary modeled effect was to reduce the modeled circulating water flow by 3.5 percent. The heat balance simulation was rerun for this condition to generate the net unit output vs. heat rate curve shown in Figure 5-2. The Case 6 Heat Balance shows the overall heat balance simulation result for this case. Comparing this heat balance to the Case 2 Heat Balance as well as the Case 5 Heat Balance isolates the unit capacity and heat rate benefit of the proposed circulating water pump refurbishment/upgrade. The unit capacity and heat rate benefit at full load are provided in a summary table in Appendix C.

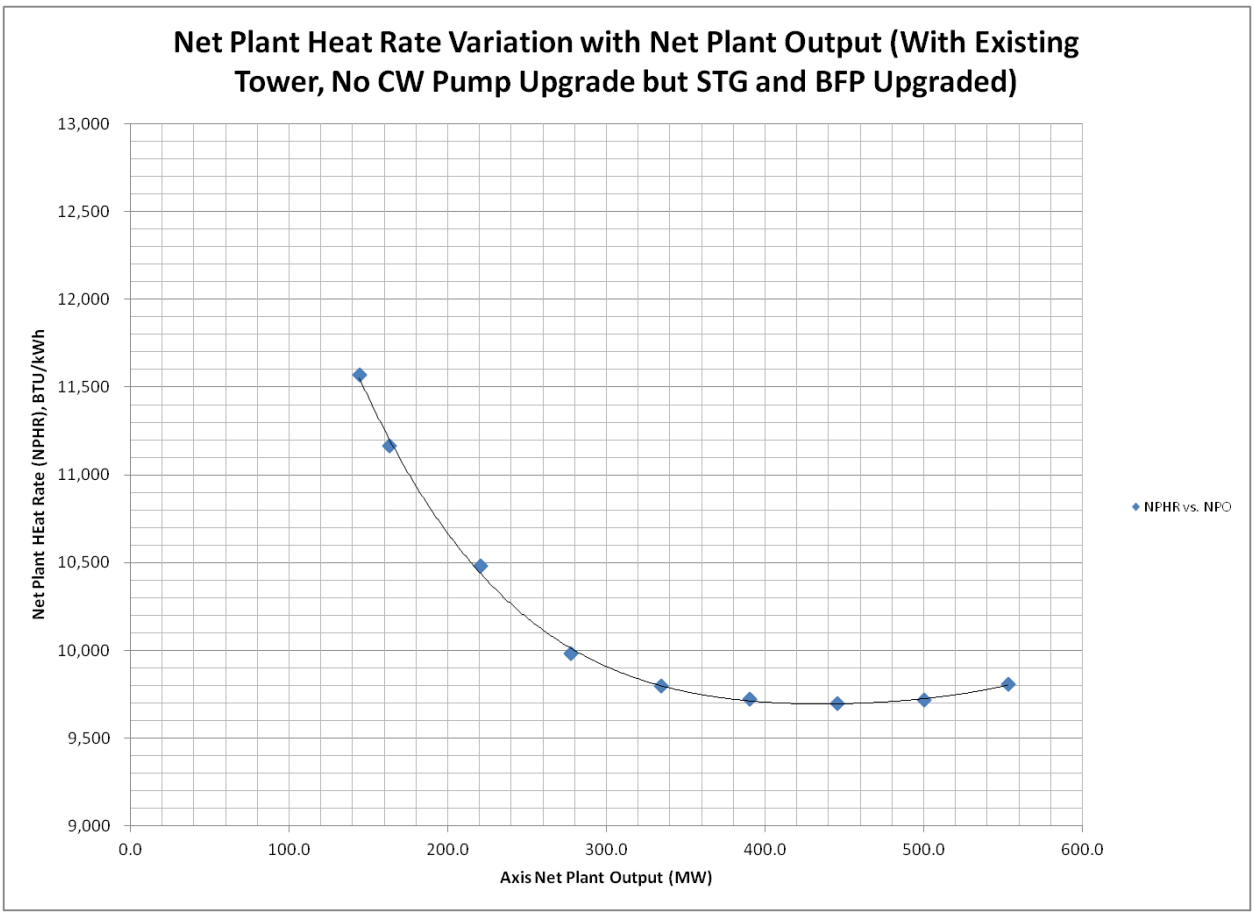


Figure 5-2 Net Plant Output and Heat Rate Estimates with Upgraded Heat Rejection System

5.2.3 Isolated Net Plant Output and Heat Rate Impacts for the Boiler Feed Water Pump Refurbishment and Upgrade

For this CAMP project, the BFP internals would be upgraded and/or replaced to recover degradation in pump operating efficiency. Since there is a small increase in boiler feed water flow rate because of the CAMP steam turbine upgrade, it is expected that refurbishing the pumps will restore the design point efficiency at slightly higher boiler feed flow rate.

For Boiler Feed Pump 1A, test data provided by WPL indicates that the BFP 1A has approximately 16 percent degradation. According to WPL the degradation on BFP 1B, BFP2A and BFP 2B is estimated to be around 5 percent. While the high degradation in Pump 1A can be attributed to larger seal ring clearances, the degradation of other pumps is likely due to normal wear.

Based on discussion with WPL, an average degradation of 5 percent was conservatively assumed to determine the benefit that will be achieved due to pump refurbishment project. This is because it was yet not decided if the BFP 1A will be included in CAMP projects or refurbished separately as a separate project on an urgent basis.

It is expected that the upgrade of Unit 2 pump elements will improve the pump efficiency 1% over the design efficiency. However, conservatively this has not been included in the benefit to discount the uncertainty in the pump degradation estimates.

Using a similar methodology as for the preceding sections, the Case 2 Heat Balance simulation model was adjusted to remove the benefit associated with the boiler feed water pump refurbishment and upgrade. The primary modeled effect was to reduce the modeled boiler feed water flow by 5 percent. The heat balance simulation for this condition was used to generate the net unit output vs. heat rate curve shown in Figure 5-3. The Case 7 Heat Balance shows the overall heat balance simulation result for full load, average ambient conditions. Comparing this heat balance to the Case 2 Heat Balance isolates the unit capacity and heat rate benefit of the proposed boiler feed water water pump refurbishment/upgrade. The unit capacity and heat rate benefit at full load are provided in a summary table in Appendix C.

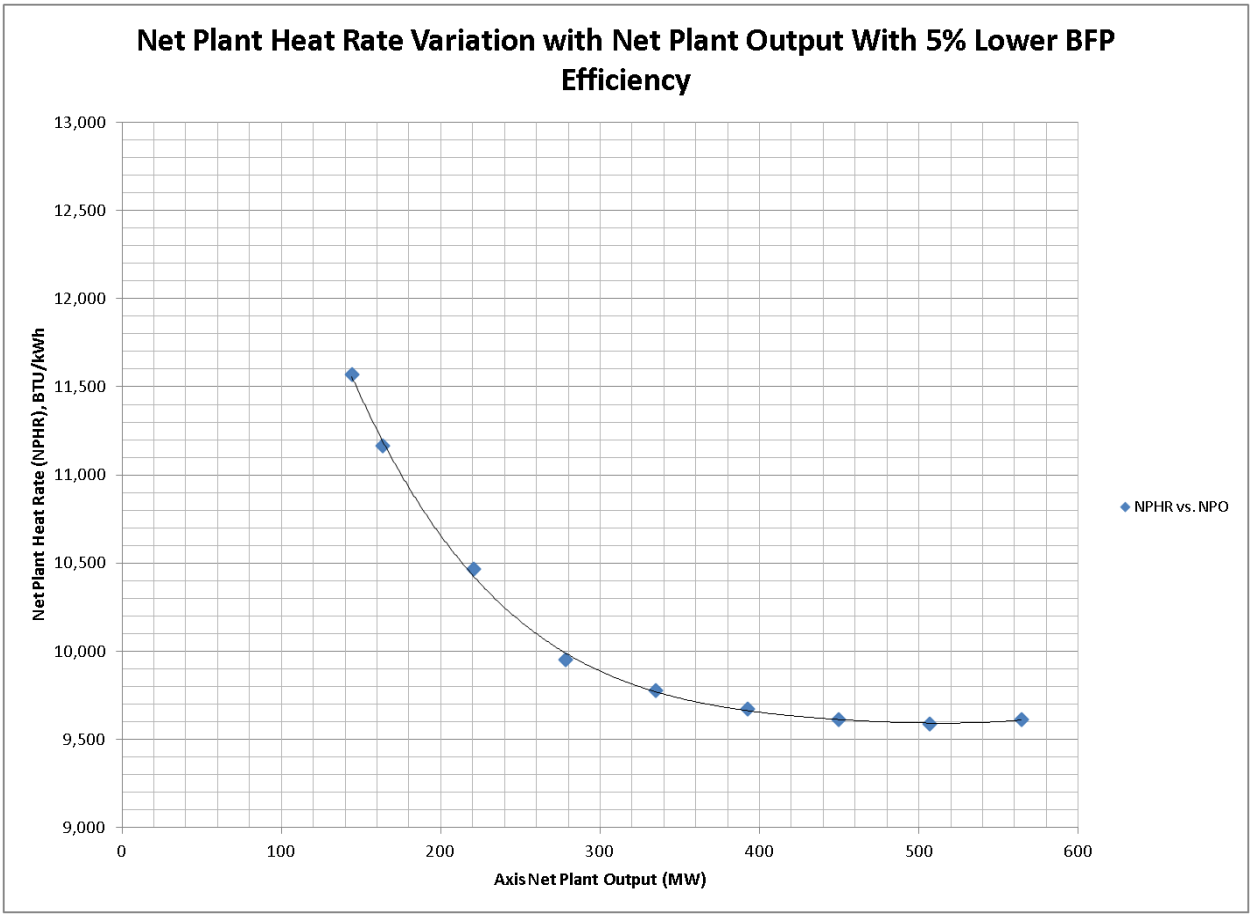


Figure 5-3 Net Plant Output and Heat Rate with Degraded Boiler Feed Pump Efficiency at Average Ambient Conditions

6.0 Summary and Conclusions

The goal of the Steam Turbine Upgrade analysis was to determine an economically optimized design basis for a major STG upgrade, including associated heat rejection system major equipment modifications and/or upgrades, to significantly improve overall station electrical output and efficiency.

6.1 STEAM TURBINE UPGRADE ANALYSIS AND OVERALL TURBINE CYCLE AND UNIT PERFORMANCE ESTIMATES

The steam turbine upgrade portion of the analysis was performed to screen potential steam turbine upgrade options from leading turbine OEM's that would achieve the primary Columbia CAMP goals for improvements in unit heat rate and capacity. Major activities included the following.

- Based on the results of the Phase 1 CAMP Study, a short-form procurement specification for the steam turbine upgrade was developed with the goal of increasing the steam turbine gross output up to the practical limits of the existing generator; about 600MW gross output. The increase in STG output was envisaged to be a result of both steam turbine efficiency improvement as well as a small increase in main steam flow.
- Based on the budgetary proposals received from STG original equipment manufacturers (OEMs), it was determined upgrading the low pressure turbine section last stage blade length from 26 to 30 inches would be technically and commercially feasible for this upgrade.
- A heat balance simulation model was used to evaluate turbine cycle and overall unit heat rate and capacity benefits of the steam turbine upgrade. The steam turbine efficiency used in the simulation model was reflective of the budget estimates from the OEM's.
- The turbine cycle mechanical BOP systems were reviewed to confirm that the design basis of existing major components would support the upgraded unit performance.

WP&L requested that the upgraded unit capacity be achievable at peak summer conditions so the performance estimates were based on achieving the steam turbine gross output of 600 MW with station ambient conditions coincident with the local one percent wet bulb temperature. The peak summer upgraded unit performance estimate is shown as the Case 1 Heat Balance in Appendix B. This heat balance also established the preliminary design basis for heat rejection system modifications and upgrades required to achieve the upgraded unit capacity.

The upgraded turbine cycle performance was also modeled at annual average ambient conditions which correspond to approximately 47° F DBT and 42.53 °F WBT at the Columbia Station site. The full load, average ambient heat balance was identified as Case 2 in Appendix B and the 75 percent load case is shown as Case 3. These heat balances also incorporate the required heat

rejection system modifications and upgrades required to achieve the upgraded unit capacity noted above. Figure 6-1 presents the average ambient day net plant output and heat rate variation as a function of load. It can be seen that the full load unit heat rate at average ambient conditions would be about 9,600 Btu/kWh. Thus, the CAMP project goal of heat rate of 9,800 Btu/kWh would be accomplished with the upgraded steam turbine, upgraded BFP, and the upgraded heat rejection system identified in this study. For comparison purposes, based on the results of the Phase 1 CAMP Study, the current average net unit output is about 515 MW and the current average full load net plant heat rate is about 10,400 BTU/kWh.

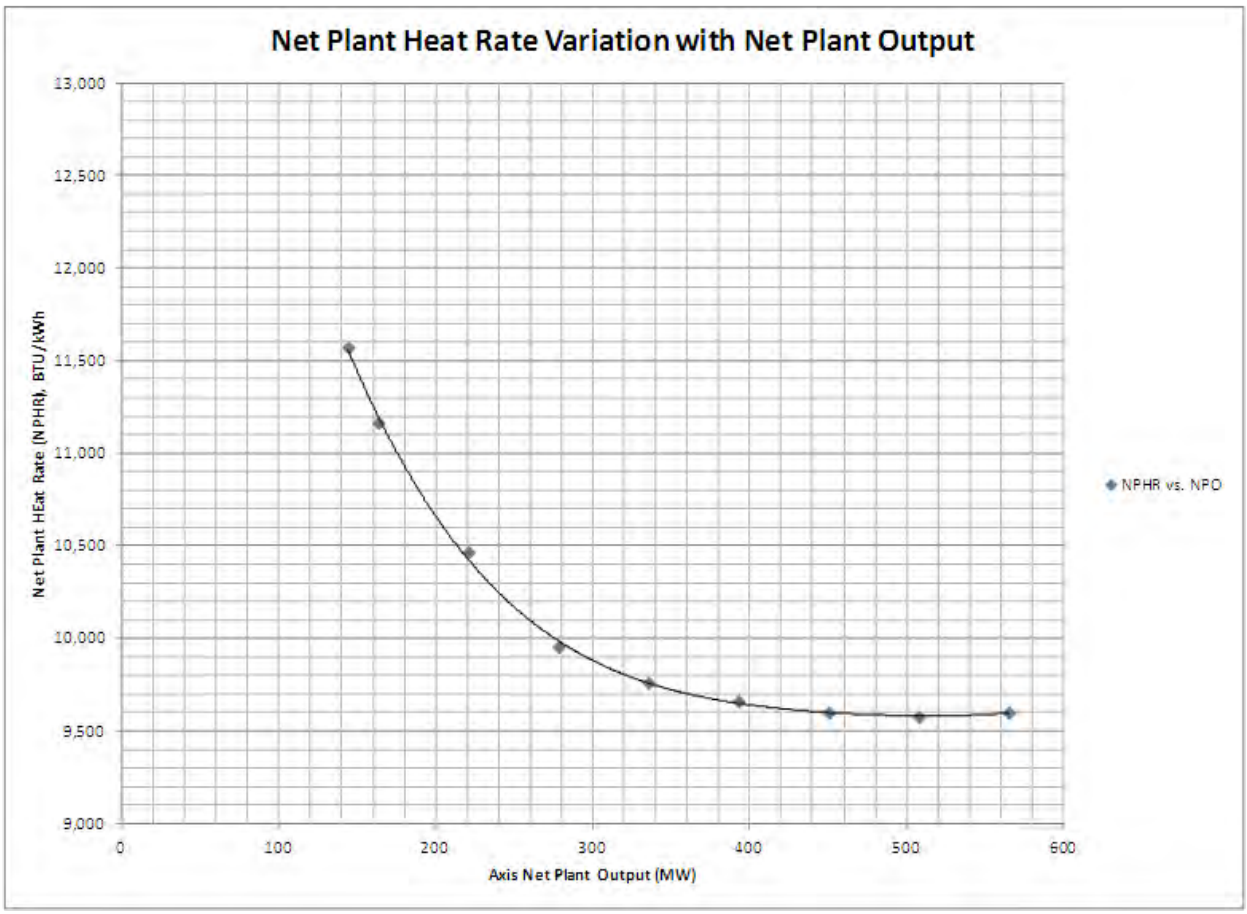


Figure 6-1 Net Plant Output and Heat Rate with Cumulative Upgrades at Average Ambient Conditions

6.2 HEAT REJECTION SYSTEM OPTIMIZATION

The unit turbine cycle and heat rejection system perform as an integrated system. The estimated unit capacity and efficiency improvements associated with the STG upgrade analysis can only be achieved if the heat rejection system equipment have design and operating capabilities in alignment

with the upgraded STG performance. The heat rejection system optimization analysis was performed to identify and economically optimize the scope of heat rejection system equipment modifications and/or upgrades required to support the upgraded turbine cycle performance. This included providing for increased overall system cooling capacity so that the 600 MW gross steam turbine output could be achieved at a 1 percent summer wet bulb temperature. The optimization also determined the best overall match-up of heat rejection equipment sizing to the upgraded steam turbine low pressure section exhaust conditions, based on the 30 inch last stage blade exhaust loss curve, for plant operating conditions throughout the year. Major activities included the following.

- The design and current performance of all major heat rejection system equipment was evaluated to determine the extent of existing performance degradation to establish performance refurbishment needs. The range of potential equipment modifications and upgrades was also established. Finally, key equipment performance parameters were reviewed to identify those that could be economically optimized as well as those that required limits and/or constraints.
- An economic optimization was conducted using an in-house financial proforma that varied the identified design parameters within allowable constraints to economically compare and determine the optimum modified and/or upgraded heat rejection system configuration.
- Based on the results of the heat rejection optimization, the upgraded design basis for the heat rejection system equipment was incorporated into short-form procurement specifications to obtain budgetary pricing from potential equipment OEM's.
- Since each potential CAMP project for the Phase 2 CAMP Study was evaluated individually, Black & Veatch was required to break down and distribute the overall unit heat rate and capacity improvements represented by the Case 1 and Case 2 Heat Balances among the individual turbine cycle and heat rejection equipment CAMP projects.

6.3 CONCLUSIONS AND RECOMMENDATIONS

Overall Steam Turbine Upgrade Study conclusions include the following:

- It appears to be technically and economically feasible to upgrade the steam turbine generator and heat rejection system major equipment to achieve the Columbia Station CAMP goals for unit efficiency (heat rate) and capacity.
- The boiler full load fuel heat input (burn rate) would typically increase in proportion to load if increasing from the current maximum continuous rating (MCR) of 550 MW gross output to 600 MW gross output with the existing STG. The increased isentropic efficiency of the upgraded STG, however, would reduce the boiler burn rate per MW of gross generation. In addition, the higher efficiency HP turbine will result in lower temperature steam exhausting from the HP turbine and

returning to the boiler reheater, so additional steam generator reheater surface could be required. This will require further OEM evaluation.
The heat rejection system optimization included upgrades to overall system capacity to support achieving the steam turbine gross output of 600 MW goal with station ambient conditions coincident with the local one percent wet bulb temperature.

- The unit turbine cycle and heat rejection system perform as an integrated system. The estimated unit capacity and efficiency improvements associated with the STG upgrade would only be achieved if the turbine cycle and heat rejection system equipment have design and operating capabilities in alignment with the upgraded STG performance. It is recommended that the steam turbine upgrade as well as the boiler feed pump, circulating water pump and helper cooling tower & pump CAMP projects be bundled and evaluated as a single project.

In addition, here are some of the detailed BOP engineering activities to address during the detailed design phase:

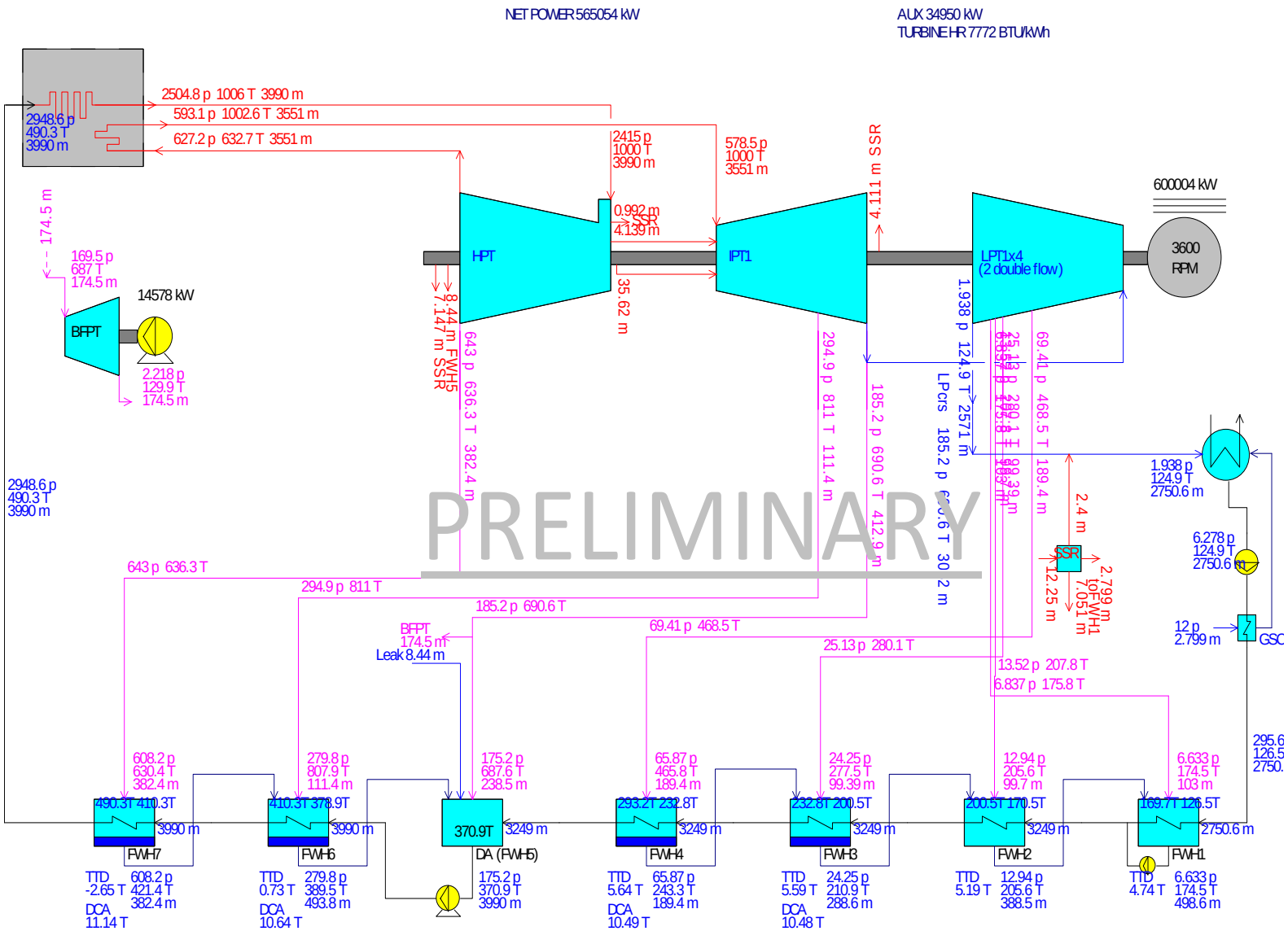
- Verify each unit's BPVC Section 1 and ASME B31.1, Power Piping Code, design code years.
- Have safety valves inspected and tested by valve supplier.
- Have safety valve operating margins over set-pressure and closing pressure verified with the valve supplier for acceptable operation.
- Review reheat steam safety valves to determine if existing valves can be reset for greater relieving capacity to meet increased flow relieving capacity requirements. If not, design new safety valve to meet relieving capacity shortfall.
- Have upgraded Unit 2 deaerator performance reviewed and guaranteed by deaerator manufacturer and modify/replace as required.
- During a planned outage, the Units 1 & 2 deaerators and storage tanks be inspected by the OEM suppliers (shell damage, spray nozzle pluggage, trays, etc.) and any remedial recommendations be reviewed.
- It is recommended that Unit 1 high pressure and low pressure heaters and Unit 2 low pressure heaters be inspected at next available outage if recent test reports are not located.
- Continue evaluating the physical condition of the deaerator heaters and the need for replacement.
- Perform detailed feedwater and condensate system pressure drop/pump curve modeling. Analyze historical pump operating conditions and/or perform field testing to develop "as operating" pump curves.
- Verify performance of the existing condensate pumps to determine if refurbishment is needed to satisfy the upgraded operating condition.
- Verify operating range of condensate control valves in condensate system analysis.
- Complete a high energy piping and support evaluation.

- Complete a deaerator/BFP NPSH transient analysis to confirm deaerator/pump performance, deaerator storage volume and deaerator level set-points during detailed design.
- Complete a turbine water induction protection (TWIP) review.

Appendix A. Economic Criteria

	CAMP Economic Criteria	Baseline (Initial Screening Only)
1	Capacity (MW net)	535
2	Capacity Factor (%)	80%
3	Net Unit Heat Rate (Btu/kWh)	10500
4	Annual Heat Input (MBtu)	39,367,440
5	SO2 (lbm/Mbtu)	0.7
6	Nox (lbm/Mbtu)	0.14
7	*Hg (lbm/TBtu)*	*N/A*
9	10 year average Fuel Cost ($/Mbtu)	2.69
10	Fixed Charge Rate (%)	8%
11	10 yr average SO2 ($/ton)	780
12	10 yr average Nox ($/ton)	1193
13	Hg ($/lbm)	N/A
14	Discount Rate Pretax (%)	12%
15	Discount Rate After Tax (%)	7%
16	Fuel HHV (Btu/lbm)	8600
17	Evaluation Length (Years)	30
19	Annual Capital Escalation Factor (%)	3%
20	Annual Fuel Escalation Factor (%)	2%
21	Generation Cost Escalation Factor (%)	2%
22	Purchasing Cost of Ammonia ($/gallon)	N/A
23	Purchasing Cost of Lime(stone) ($/ton)	60
24	Sale of Ash ($/ton)	Not available at this time
Avg. Energy Price Schedule ($/MWh)		
25	2011	$32.71
26	2012	$38.95
27	2013	$41.63
28	2014	$48.12
29	2015	$50.69
30	2016	$49.91
31	2017	$51.23
32	2018	$51.73
33	2019	$54.82
34	2020	$56.99
35	2021	$60.65
36	2022	$64.62
37	2023	$65.32
38	2024	$61.00
39	2025	$63.96
40	2026	$66.68
41	2027	$68.70
42	2028	$70.72
43	2029	$72.74
44	2030	$74.76
45	2031	$76.77
46	2032	$78.79
47	2033	$80.81
48	2034	$82.83
49	2035	$84.85
50	2036	$86.87
51	2037	$88.88
52	2038	$90.90
53	2039	$92.92
54	2040	$94.94
55	2041	$96.96
56	2042	$98.98
57	2043	$101.00
58	2044	$103.01
59	2045	$105.03
60	2046	$107.05
61	2047	$109.07
62	2048	$111.09
63	2049	$113.11
64	2050	$115.13
65	Base (2011) Cost of Generation	$25.00
66	Base (2011) Forced Outage Replacement Power Cost ($/MWh)	$60.00
67	Wage Escalation Rate	2.30%

Appendix B. Heat Balances



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ALLIANT ENERGY
COLUMBIA PHASE 2 CAMP SUPPORT

CASE 1
100% LOAD_1% WBT
STG, BFP, CWP, CTP and CT Upgraded

REV B

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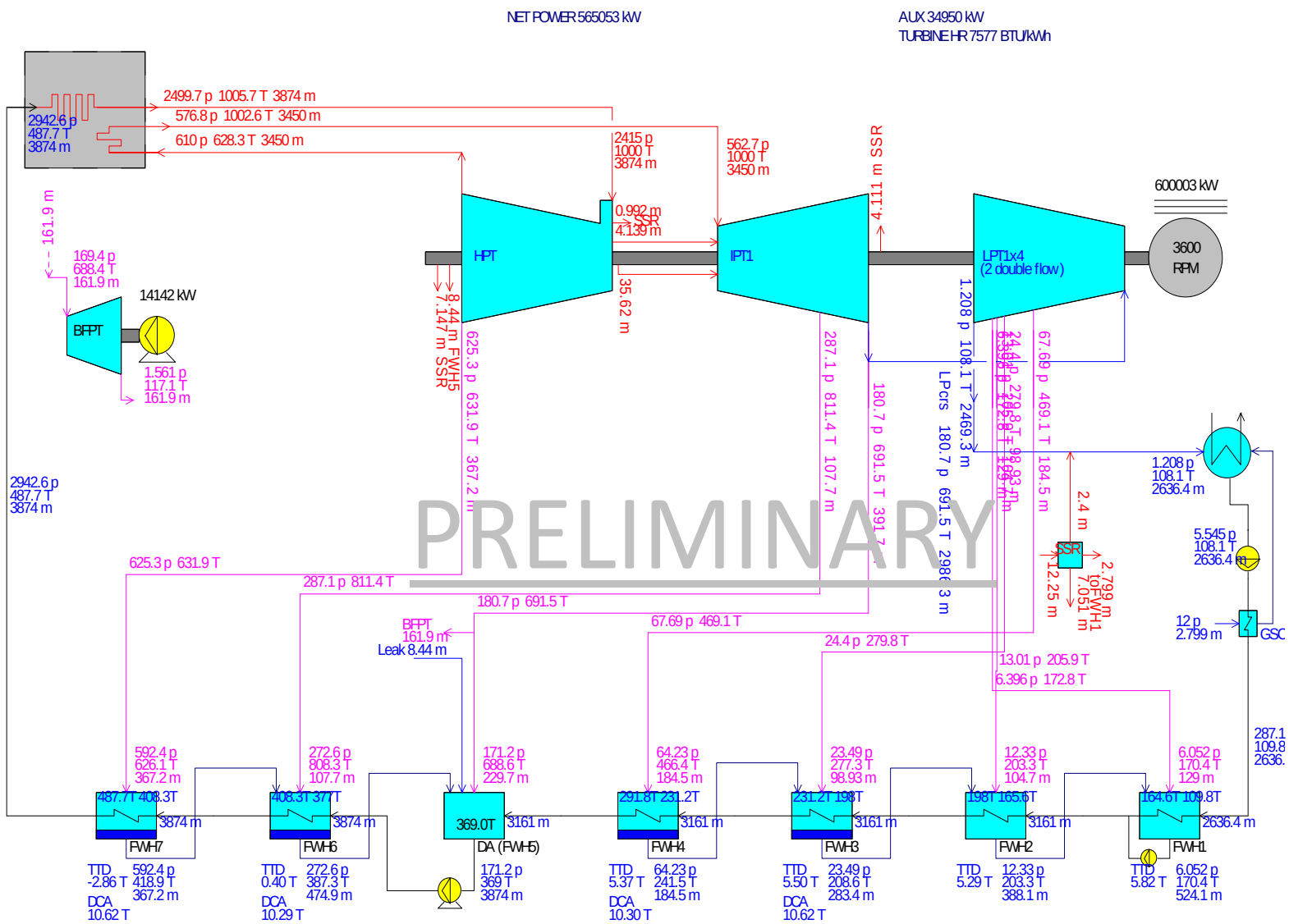

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COLUMBIA PHASE 2 CAMP SUPPORT

CASE 2
100% LOAD_AVERAGE AMBIENT CONDITIONS
STG, BFP, CWP, CTP and CT Upgraded

REV B

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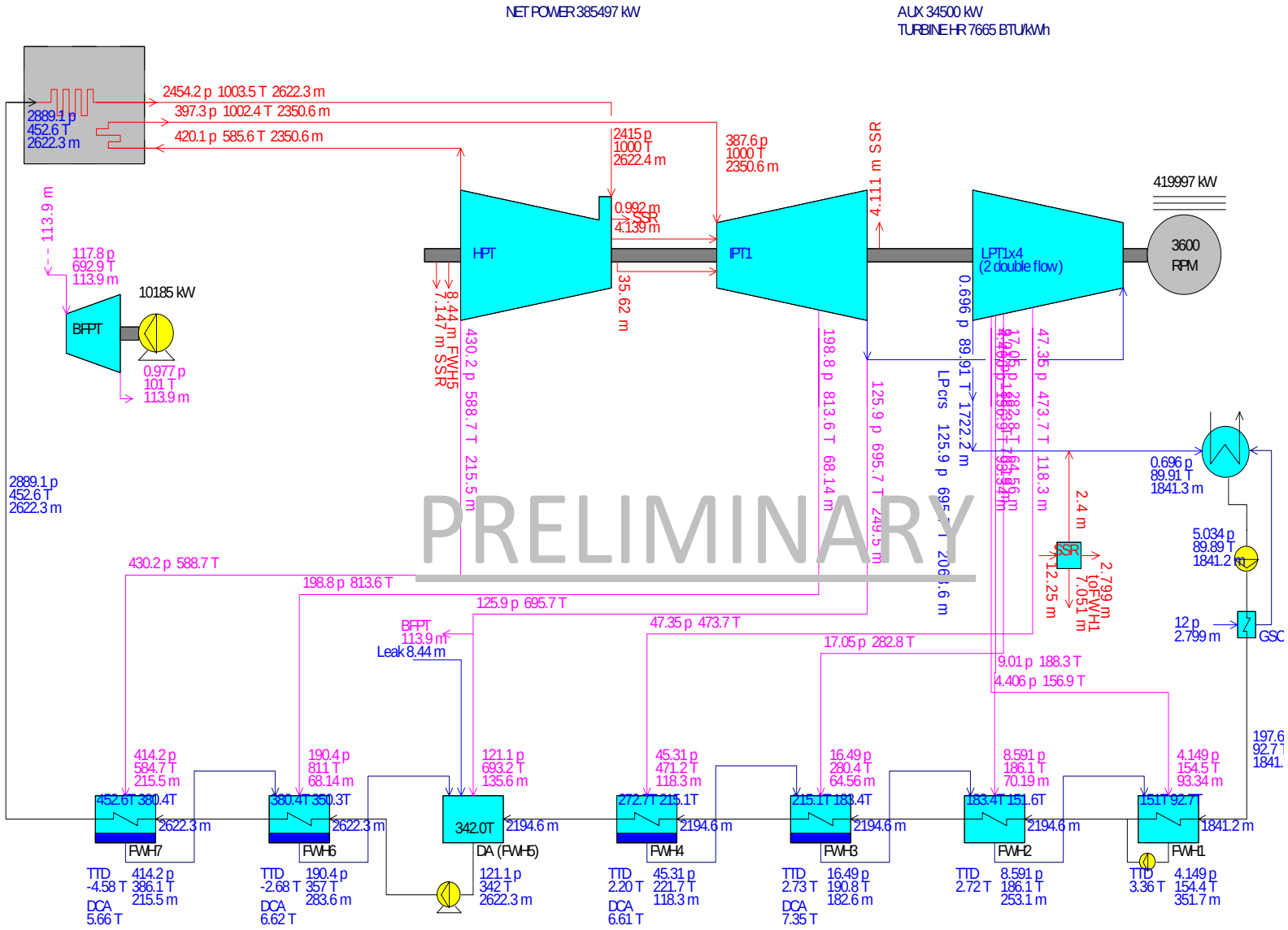

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COLUMBIA PHASE 2 CAMP SUPPORT

CASE 3
70% LOAD_AVERAGE AMBIENT CONDITIONS
STG, BFP, CWP, CTP and CT Upgraded

REV B

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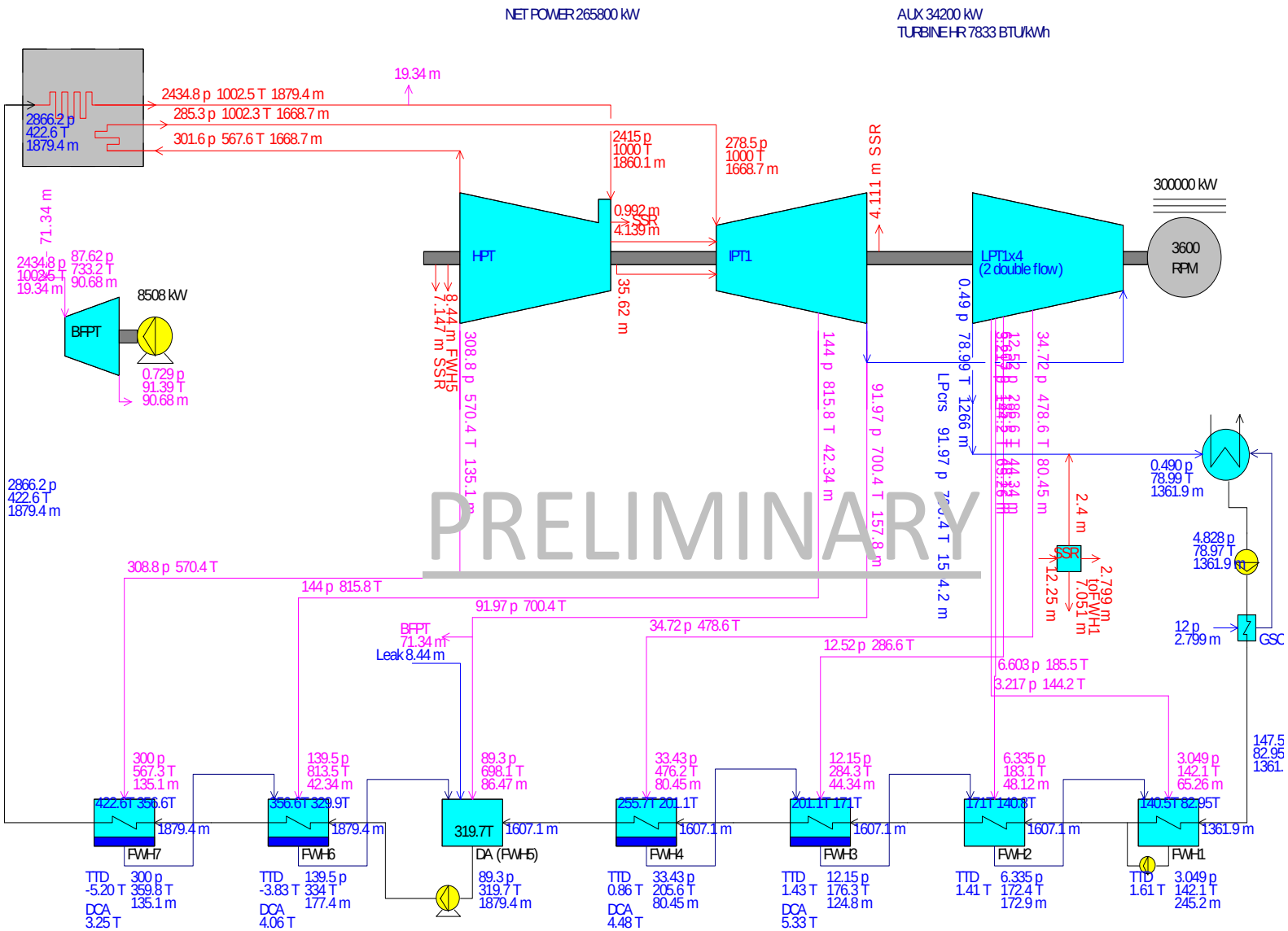

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ALLIANT ENERGY
COLUMBIA PHASE 2 CAMP SUPPORT

CASE 4
50% LOAD_AVERAGE AMBIENT CONDITIONS
STG, BFP, CWP, CTP and CT Upgraded

REV B

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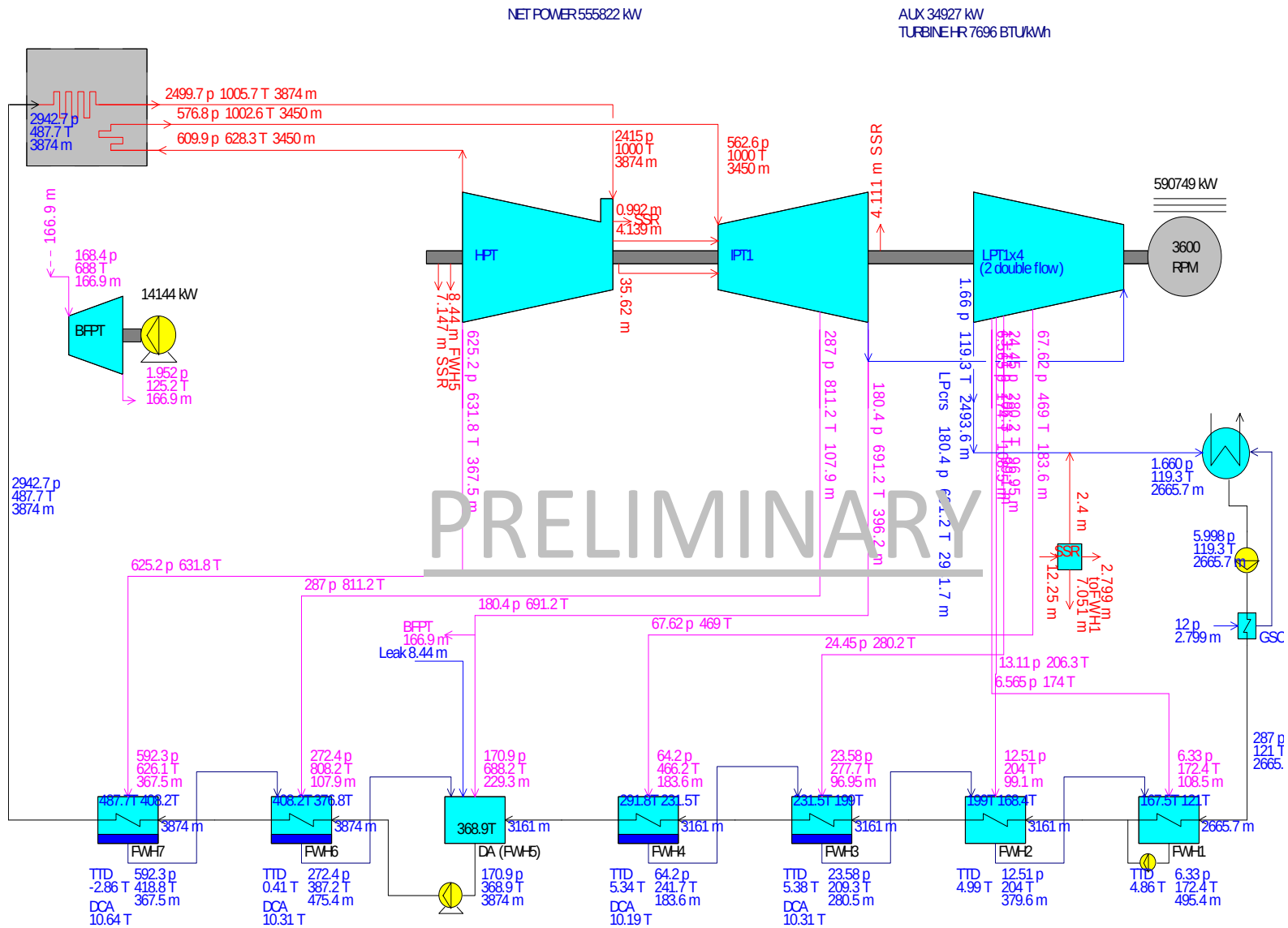

STEAMMASTER 21.0 Black & Veatch 0 10-20-2011 15:39:07 Steam Properties: IFC-67

p[psia], T[F], m[kpph], h[BTU/lb]

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CASE 5
100% LOAD_AVERAGE AMBIENT CONDITIONS
STG, BFP and CWP Upgraded but CTP and CT Not Upgraded

REV B

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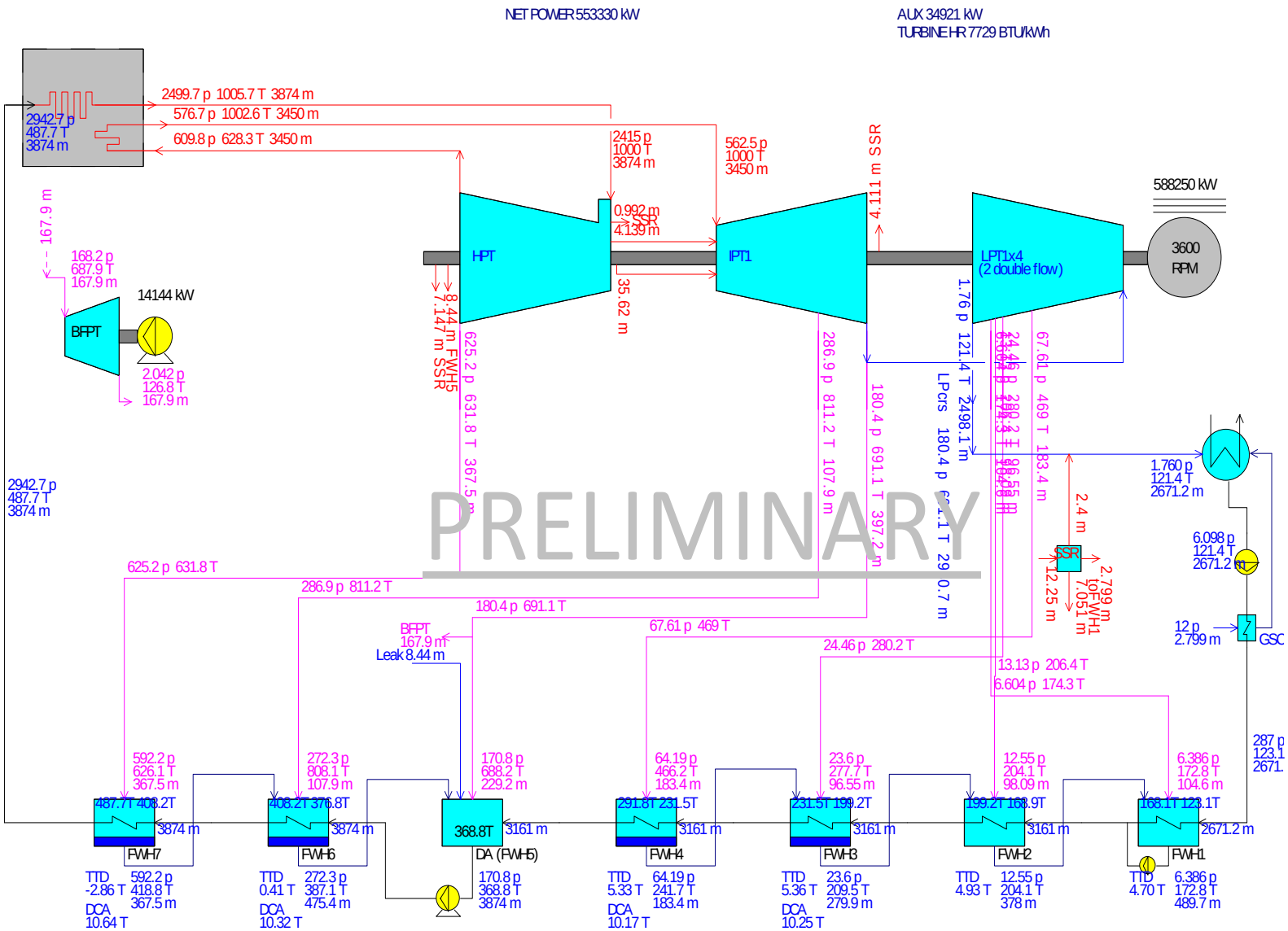

PRELIMINARY

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PROJECT NO.: 173118 | FILE NO.:

ALLIANT ENERGY
COLUMBIA PHASE 2 CAMP SUPPORT

CASE 6
100% LOAD_AVERAGE AMBIENT CONDITIONS
STG and BFP Upgraded but CWP,CTP and CT Not Upgraded

REV B

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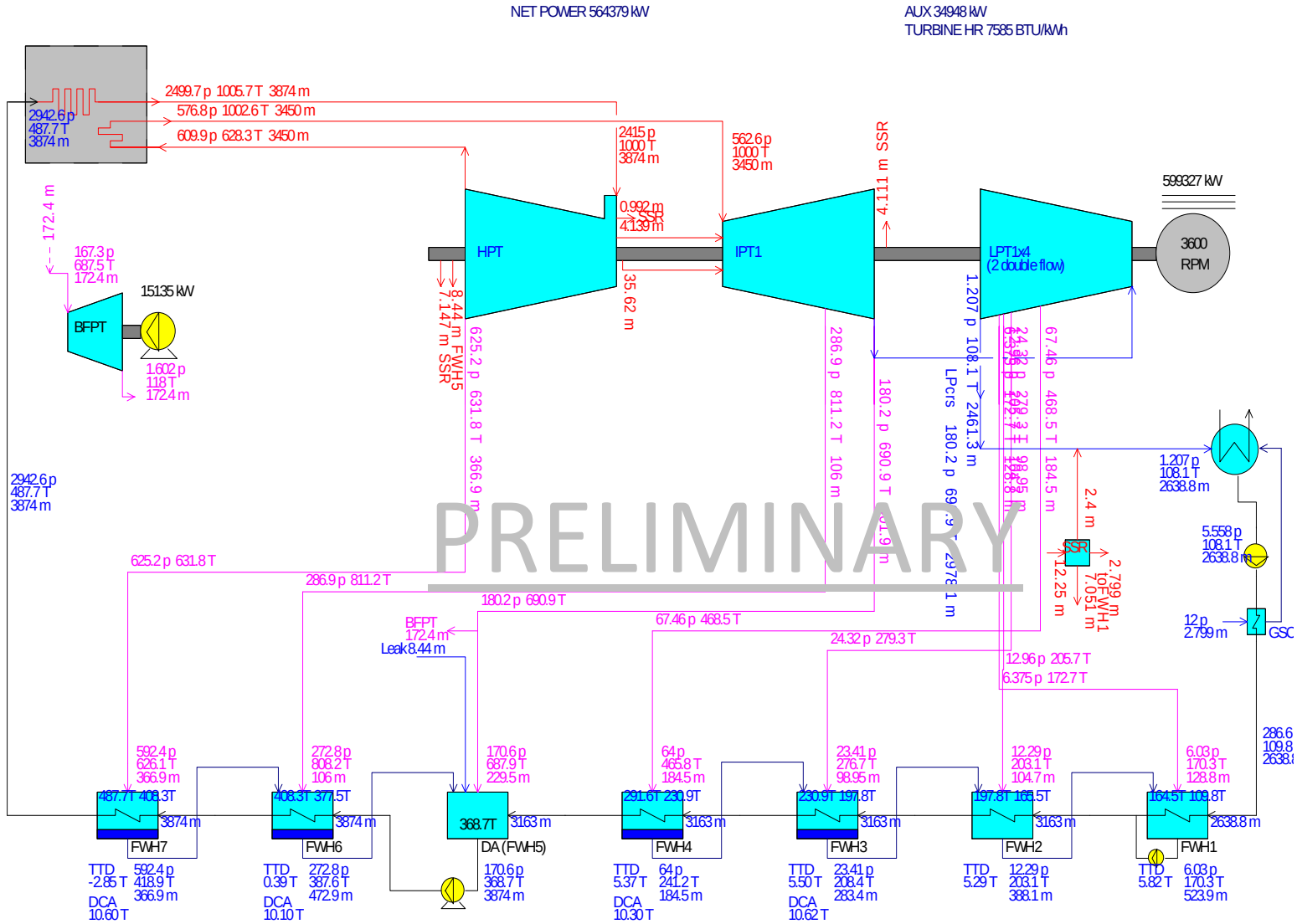

PRELIMINARY

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p[psia], T[F], m[kpph], h[BTU/lb]

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C	13-Dec-12	CLIENT'S COMMENT INCORPORATED	CL		
B	01-Nov-11	ISSUED FOR CLIENT REVIEW	CJ	CL	

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PROJECT NO.: 173118 | FILE NO.:

ALLIANT ENERGY
COLUMBIA PHASE 2 CAMP SUPPORT

CASE 7
100% LOAD_AVERAGE AMBIENT CONDITIONS
STG, CWP,CTP and CT Upgraded but BFP Not Upgraded

REV C

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Appendix C. Unit Capacity and Heat Rate at Full Load Average Ambient Conditions

Unit Capacity and Heat Rate at Full Load Average Ambient Conditions

Unit 1 & Unit 2	Projects	Throttle Pressure	Main Steam Flow	Reheat Spray Flow	Gross Output	Boiler Heat Input (HHV)	Condenser Pressure	Aux Power	Net Unit Heat Rate (HHV)
		psia	(KPPH)	(KPPH)	(MWg)	(MMBtu/hr)	inHg	MW	Btu/kWh
Heat Balance Case 2	STG, BFP, CWP, CTP, CT	2415	3,874	-	600.0	5,424	2.46	35.0	9,600
Heat Balance Case 5	STG, BFP, CWP	2415	3,874	-	590.7	5,425	3.38	35.0	9,761
Heat Balance Case 6	STG, BFP	2415	3,874	-	588.3	5,425	3.58	35.0	9,806
Heat Balance Case7	STG, CWP, CTP, CT	2415	3,874	-	599.3	5,424	2.46	35.0	9,611
Existing Plant Performance from Historic Data	none				540.0			25.0	10,400

Notes:
1) For Case 2, the plant gross output of 600 MW is limited by generator rating.
2) For Case 5 and Case 6, the condenser pressure is limited by the existing heat rejection system performance.
3) Case 7 is identical to case 2 except for the BFP efficiency being lower by 5%.
4) For case 5, case 6 and case 7, the main steam flow is kept constant to isolate the effect the specific CAMP project on the plant output and heat rate.
5) Existing plant performance is established based on high level assessment of historic plant data.

Denotes the limiting factor

Denotes the parameter held constant from the previous case