Columbia Generating Station
Main Condenser, Addendum 1

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This addendum augments the Columbia Generating Station Main Condenser white paper, providing a summary of economic impacts of condenser leakage.

The analysis is organized in two parts for clarity. The first provides an average cost per event or month. The second provides a cost breakdown over the current operating cycle, from June 2005 through May 2006.

Historical Perspective

Columbia has suffered eleven shutdowns and nine reduced power evolutions to address main condenser leakage since it began operation in 1984. The number of events speaks to the chronic nature of this costly operational challenge.

Condenser related shutdowns and down-powers would have been even more frequent if it were not for repeated plant shutdowns, extended economic dispatch periods due to river flows, and annual operating cycles. Each of those operational attributes provided opportunities to perform condenser repairs reducing the potential for even more condenser related shutdowns.

Direct Cost Impact

Chemistry Control

Columbia's condensate filter demineralizers are changed more frequently to minimize impurities reaching the reactor pressure vessel. The demineralizers are coated with a powdered resin. The costs of increased resin use, shipment, and disposal of the associated radioactive waste is included. Additionally, the circulating water system is operated to reduce the level of impurity concentration, requiring increased chemical treatment.

$124,000/month
Average chemistry-related cost for each month Columbia operates with a condenser leak.

$1,030,000
Aggregate chemistry-related cost for this operating cycle (June 05 to May 06).

Tube Plugging Evolution

A tube plugging evolution is performed at reduced power and takes about three days. Detailed planning, oversight, and around the clock coverage limit lost generation. The actual tube plugging activity involves isolating a section of the

condenser, draining it with multiple pumps, cleaning the tubes, identifying the leak(s) and inserting plugs. The evolution involves Columbia staff level of effort, overtime, and the use of contractors.

$350,000/evolution
Average incremental direct costs associated with one tube plugging evolution.

$1,400,000
Aggregate cost of the four tube-plugging evolutions this operating cycle (June 05 to May 06).

Indirect Cost Impact

Radiation Exposure

Columbia's main condenser location exposes personnel to radiation during repairs. Keeping radiation exposure 'as low as reasonably achievable' is everyone's responsibility.

Radiation exposure is closely monitored by Energy Northwest, the Nuclear Regulatory Commission, and the Institute of Nuclear Power Operations. A non-outage month at a top performing boiling water reactor is less than 2 Rem collective radiation exposure, with a total for the year of around 30 Rem. Adding one condenser repair evolution jeopardizes the annual goal of 30 Rem or less.

2.262 Rem/evolution
Collective radiation exposure to Columbia staff and contractors, per tube plugging evolution this operating cycle (June 05 to May 06).

9.048 Rem
Collective radiation exposure to Columbia staff and contractors this operating cycle (June 05 to May 06).

Replacement Power

Columbia conducts tube plugging evolutions at 65% power. Based on typical duration, a tube plugging evolution costs us the equivalent of one day of full power operation. Estimating the value of power of $32.45/megawatt hour produces the following indirect costs.

$1,000,000/evolution
Estimated cost of replacement power per tube plugging evolution.

$4,000,000
Estimated cost of replacement power for tube plugging evolutions this fiscal year (July 05 to June 06)

Costs for 2001 Heavy Oxide Layer Analysis

Columbia's staff had extensive fuel rod corrosion related concerns in the 2001 timeframe. A highly experienced industry team was formed to determine the root cause and initiate corrective actions. Condenser leakage was identified as the root cause.

$1,750,000
Cost associated with fuel scrapings, investigation, and research into heavier than expected fuel oxide layer.

One corrective action from the above investigation was to alter Columbia's chemistry controls to favor fuel protection over radiation source term mitigation. The strategy was followed until the current operating cycle. Oxide formation on the fuel during this test period was normal, thereby validating the root cause determination. Favoring fuel protection created very high radiation source term at Columbia, resulting in increased staff radiation exposure. The impact is difficult to quantify, but very real. Columbia's radiation exposure performance is in the worst quartile in the industry. Columbia is currently the worst plant based on source term measurements. To counteract this, a chemical decontamination of key piping is scheduled for our upcoming outage.

$1,700,000
Approximate cost of chemical decontamination in the upcoming outage to improve radiation source term.

Replacement Power Estimates Since 2000

Lost power generation (associated with main condenser leakage) since January 1, 2001 is equivalent to more than 12.5 days of full power operation. With an estimated value of power of $32.45/megawatt hours, the total cost is substantial.

$12,500,000
Estimated value of replacement power associated with Columbia main condenser leakage events since January 1, 2001.

Conclusion

Various conclusions can be drawn from the above data. In simple terms, the author draws the following underlying conclusion, upon which others can build.

> "The design and resulting poor performance of Columbia's main condenser has produced many direct and indirect costs and continuously challenged our ability to achieve operational performance levels expected of U.S. nuclear power plant operators.

The chronic nature of Columbia's main condenser problem is unlikely to change substantially without addressing the condenser tube material. Failure to address this issue will increase the risk of fuel damage. That fact alone is ample reason to replace the main condenser tubes. Replacement is also in the best interest of efficient financial operation of the plant as evidenced by the costly history of our present condenser equipment."