Global Engineering Services

Increased Letdown/Purification Flow for Improved RCS Cleanup Times

Background

As nuclear utilities continue their efforts to drive down operating costs, there has been a renewed focus on more efficient refueling outages. Plant staffs seek to reduce the required labor force by optimizing the duration of refueling outages, increasing the predictability of refueling outages and reducing the accumulated radiological doses during the refueling outages.

A required operation to attain refueling shutdown conditions is the removal of activated corrosion products that have accumulated in the reactor coolant system (RCS) over the course of the fuel cycle. This cleanup of the RCS fluid is necessary to limit personnel radiation exposure during refueling and maintenance operations.

Activated corrosion products (primarily Co-58) are dissolved in the RCS fluid by adding an oxidizing agent (hydrogen peroxide). The corrosion crud that forms in this “crud burst” process is removed from the coolant by a feed-and-bleed process in which a fraction of the coolant passes through the purification equipment that is located in the chemical and volume control system (CVCS) letdown line to remove the corrosion products. The purified coolant is then returned to the RCS. The time required to achieve the required crud removal can be shortened by increasing the fraction of the RCS fluid diverted through the CVCS; that is, by increasing the letdown and corresponding charging flow rates.

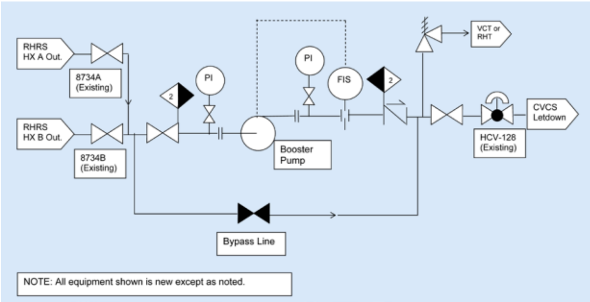
Description

Traditionally, the cleanup of the reactor coolant following the induced crud burst is on the outage critical path. Increasing the flow rate through the CVCS purification equipment beyond the current system design value has the benefit of reducing the time required to reach defined coolant activity limits before significant outage activities can be initiated.

To demonstrate safe and reliable CVCS operation at an increased flow rate, Westinghouse completes evaluations of the entire purification loop to validate the acceptability of the affected equipment under these conditions. The analyses of the CVCS mixed-bed demineralizers include an evaluation of the performance of the demineralizer resin for increased flow loading. The objective of this evaluation is to confirm that flow channeling or resin bead damage won’t occur at the increased process flow rate. The analyses of the letdown heat exchanger include a thermal analysis to verify that the temperature of the increased letdown flow exiting the heat exchanger is compatible with the CVCS system requirements for the integrity of the demineralizer resin and the reactor coolant pump seals.

As an option, Westinghouse can also prepare a 10CFR50.59 evaluation for the increased flow rate conditions in the CVCS.

Several plants have opted to install booster pumps to further augment the low-pressure purification flow rate that normally can be attained from the residual heat removal (RHR) system by using the driving head of the RHR pump alone. Westinghouse can provide the engineering services required to design and procure the necessary system modifications to install the pump booster.



Flow schematic for purification booster pump and associated equipment

Benefits

The time required to reduce the concentration of Co-58 in the reactor coolant to an acceptable level is typically considered to be critical-path time in the plant outage. By increasing the purification flow rate from 120 gpm to 180 gpm, Westinghouse can help our customers realize a time savings of up to 21 hours.

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Calculated Time Required to Reduce Co-58 Concentration to 0.05 µCi/cc*	
Purification Flow Rate (gpm)	Time (hrs)
120	64.3
180	42.8
	Time Savings ≅ 21 hrs
*Assumes: RCS Volume = 100,000 gal CVCS Mixed Bed Demin. DF = 100	

Effect of purification flow rate on Co-58 cleanup in reactor coolant (based on representative four-loop plant parameters)

Deliverables

To document the results of these evaluations, Westinghouse provides a letter report summarizing the results of the purification loop system performance under the increased letdown flow conditions.

If the optional 10CFR50.59 evaluation is accepted, Westinghouse provides, as a separate deliverable, a report of this evaluation using the screening or evaluation format of the customer's choice.

Experience

Westinghouse has provided increased purification flow rate evaluations for approximately 25% of the US PWRs.

Westinghouse Electric Company
1000 Westinghouse Drive
Cranberry Township, PA 16066