NMC-PII Project Plan & Schedule

Problem Statement

Recirculation flow on pumps AFP-38A & B degraded from 75 gpm to 65 gpm and 68 gpm, respectively.

Determine the physical cause of the degradation in flow and determine (1) whether or not this cause was sufficient enough – when combined with the assumptions used in the design basis – to render the auxiliary feedwater pump inoperable, and (2) whether or not the cause, if uncorrected, would continue to degrade the recirculation flow rate. and (3) whether or not the cause represents a common mode failure.

Failure Mechanisms Considered

- **Plugging of orifice holes by foreign materials**
- **Scaling induced blockage of orifice holes**
- **Check valve plug cocking**

Approach

1. Identify all credible causes of recirculation flow rate degradation and identify supporting or refuting evidence for each.
    a. Plugging with hematite coming from backflow of particulate laden SW through leaking AF4009 concurrent with leaking SW129 or SW130.
        i. Test frequency and review of test data and notes on each of these valves for past two cycles (PBNS)
        ii. Chemistry analyses of CST for past two cycles (PBNS)
        iii. Event details of inadvertent opening of AF4009 and subsequent inoput of SW into CST or Steam Generator. (PBNS)
        iv. Chemical analyses of SW for past two cycles. (PBNS)
        v. Pore size of the filter material being used for the SW blowdown/backflush (PBNS)
        vi. Material composition of CST (or type of metal) (PBNS)
        vii. Whether or not the inside of the CST is coated, if so, with what? (PBNS)
        viii. Is CST protected with cathodic protection (PBNS)
        ix. Is CST ever cleaned (e.g., hydrolazing), if so, when was it last performed? (PBNS)
        x. ALL makeup sources, or possible inputs into the CST (PBNS)
        xi. For the CST samples provided what percentage of the bottoms that were in the tank were collected and are in the sample bottles? (PBNS)

    b. Plugging with hematite coming from standing water in bottom of AF pump body flushed into discharge line during post maintenance test.

    i. Maintenance history of this pump in which the system was open to the atmosphere (thereby allowing formation of hematite). (PBNS)
    ii. Calculation of maximum possible volume of particulate in base of pump below casing drain. (PBNS)

c. Plugging with particulates from inlet piping to AF pump
    i. Piping material from the CST to the AF pump to the recirc lines and back to the CST, complete with the specific location of transition points between material types. (PBNS)
    ii. Is there any dielectric insulation at those transition points? (PBNS)

d. Plugging with hematite due to infrequent manipulation of (carbon steel ?) high point vents, AF 33A and 33B causing a dislodging of particulates into the AF pump discharge line (and subsequently into the recirculation line)
    i. Confirm valve material (PBNS)
    ii. Frequency of manipulation of these valves. (PBNS)
    iii. Boroscope of the valve area (PBNS)

e. Mechanical blockage due to cocked piston in check valve AF0015
    i. Radiograph of valve assembly (PBNS)
    ii. Disassembly of valve and search for chatter marks (PBNS))
f. Mechanical blockage due to partially opening of (vs full open) AF4007
    i. Operator logs/test log for verification of full open during post-maintenance test (PBNS)
g. Plugging due to foreign particulate matter direct from WT entering AF suction piping during post maintenance test.
    i. WT system lineup and operating status (with respect to CST filling operation) during post maintenance test run and 3 previous test runs. (PBNS)
h. Plugging due to scaling of orifice over time
    i. Minimum required recirculation flow for meeting design basis. (PBNS)
    ii. Calculation of the amount of blockage in the orifice needed to reduce recirculation flow below design bases requirements. (PBNS)
    iii. Calculation (using zeta potential) of time required to achieve the level of blockage required to reduce recirculation flow below design bases requirements (PII) **(Orifice material –geometry from 2.a.i below)**
    iv. Recorder chart (or computer points) of recirculation flow rate (or proxy) during post maintenance test, and the last **10** pump runs (PBNS)
i. Degradation of the pump performance including air binding.
    i. Pump curves and previous pump run data for past 2 cycles (PBNS)
    ii. Configuration/Geometry of flow element and instrument tubing (PBNS)
    iii. Similar configurations in other system in the plant. (PBNS)

2. For those causes that cannot be refuted, analytically determine the bounding conditions that will maintain the auxiliary feedwater system operable and compare those conditions to the actual conditions found in the system.
    a. For increased flow resistance due to particulates in the orifice determine maximum shearing force in comparison to structural characteristics of possible particulate matter
        i. Calculation of maximum shearing force as a function of orifice **geometry (press & temp)** and recirculation flow rate. (PII)
        ii. Structural analysis of particulate from filter (PII)
        iii. PEPSI (or equivalent) software code runs on the AF recirculation line, specifically, velocities into and out of check valve and orifice (PBNS)
    b. For increased flow resistance due to fouling determine the zeta potential of the particulates, and thereby maximum layer thickness and corresponding impact on recirculation flow degradation.
        i. Analyze sample of particulate from orifice for zeta potential, or determine zeta potential from structural analysis of particulate sample. (PII)
        ii. Calculation of the amount of blockage in the orifice needed to reduce recirculation flow below design bases requirements. (PBNS)
    c. Using the design basis assumptions for a seismic event, determine the particulate matter density distribution in the CST and its impact on recirculation flow rates as a function of the blockage of the orifice.
        i. Design basis **assumptions** for relevant seismic event. (PBNS)
        ii. Calculation of particulate dispersion during design basis seismic event. (PII) **(analysis of particles found in bottom of CST)**
    d. Using as-found dimensions on check valve AF0015 calculate potential for "cocking" of the piston, and determine the bounding conditions for the worst-case cocking of the piston.
        i. Determine as found dimensions of check valve AF00015 internals. (PBNS)
        ii. Perform flow rate calculations with a cocked check valve – one for as-found condition and the other for bounding calculation (get CV data for check valve and pump curve) (PII)

Schedule

Lab Analyses, model building, data gathering	2 weeks *	Nov 5-19
Running model with data	1 week	Nov 20-27
Writing report	1week	Dec 2-6

*** This is an estimate. Due to the lack of ample sample material the laboratory tests will have to be performed in sequence. Therefore, the duration of all laboratory tests may be extended due to scheduling issues.**