PSEG Nuclear LLC
P.O. Box 236, Hancocks Bridge, NJ 08038-0236

PSEG
Nuclear LLC

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LAR H17-03

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Hope Creek Generating Station
Renewed Facility Operating License No. NPF-57
NRC Docket No. 50-354

Subject: **RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION REGARDING LICENSE AMENDMENT REQUEST FOR MEASUREMENT UNCERTAINTY RECAPTURE POWER UPRATE (CAC NO. MF9930)**

References

1. PSEG letter to NRC, "License Amendment Request for Measurement Uncertainty Recapture (MUR) Power Uprate," dated July 7, 2017 (ADAMS Accession No. ML17188A260)

2. NRC e-mail to PSEG, " Hope Creek MUR - Final Request for Additional Information – (MCCB)," dated November 17, 2017 (ADAMS Accession No. ML17348A628)

In the Reference 1 letter, PSEG Nuclear LLC (PSEG) submitted a license amendment request for Hope Creek Generating Station (HCGS). The proposed amendment will increase the rated thermal power (RTP) level from 3840 megawatts thermal (MWt) to 3902 MWt, and make TS changes as necessary to support operation at the uprated power level.

In Reference 2, the U.S. Nuclear Regulatory Commission staff provided PSEG a Request for Additional Information (RAI) to support the NRC staff's detailed technical review of Reference 1.

PSEG has determined that the information provided in this submittal does not alter the conclusions reached in the 10 CFR 50.92 no significant hazards determination previously submitted. In addition, the information provided in this submittal does not affect the bases for concluding that neither an environmental impact statement nor an environmental assessment needs to be prepared in connection with the proposed amendment.

No new regulatory commitments are established by this submittal. If you have any questions or require additional information, please do not hesitate to contact Mr. Brian Thomas at (856) 339-2022.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on 12/19/17
(Date)

Respectfully,

Eric Carr
Site Vice President
Hope Creek Generating Station

Attachment

1. Response to Request for Additional Information Regarding MUR Power Uprate

cc: Mr. D. Dorman, Administrator, Region I, NRC
Ms. L. Regner, Project Manager, NRC
NRC Senior Resident Inspector, Hope Creek
Mr. P. Mulligan, Chief, NJBNE
Mr. L. Marabella, Corporate Commitment Tracking Coordinator
Mr. T. MacEwen, Hope Creek Commitment Tracking Coordinator

Response to Request for Additional Information Regarding MUR Power Uprate

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
REGARDING LICENSE AMENDMENT REQUEST FOR
MEASUREMENT UNCERTAINTY RECAPTURE POWER UPRATE

Hope Creek Generating Station
Docket No. 50-354
CAC No. MF9930

Protective Coatings in Containment:

Protective coating systems (paints) provide a means for protecting the surfaces of facilities and equipment from corrosion and contamination from radionuclides, and also provide wear protection during plant operation and maintenance activities. Coatings are also used due to their suitability for, and stability under, design basis LOCA accident conditions, considering radiation and chemical effects. The NRC's acceptance criteria for protective coating systems is based on: (1) 10 CFR Part 50, Appendix B, which states quality assurance requirements for the design, fabrication, and construction of safety-related structures, systems, and components (SSCs); and (2) Regulatory Guide (RG) 1.54, Revision 3, Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants. Specific review criteria are contained in SRP Section 6.1.2, Protective Coating Systems (Paints) - Organic Materials Review Responsibilities.

Consistent with the regulatory requirements stated above, the license amendment request (LAR) dated July 7, 2017 (Agencywide Documents Access Management System (ADAMS) Accession No. ML17188A260), TSAR Section 4.1.5, "Containment Coatings" stated that the service level 1 coatings in containment are qualified to 340 degrees Fahrenheit (F), 70 pounds per square inch (psig), and 1.1 x 10^6 absorbed radiation dose (rads).

MCCB RAI-1:

In order for the NRC staff to determine whether the coatings will continue to perform their safety function and not be adversely impacted by the power uprate conditions, the staff requests the licensee confirm the qualification limit for radiological dose. The current radiological dose qualification appears to be low for service in containment compared to similar epoxy coatings at other plants. In addition, provide the maximum post-accident primary containment conditions for temperature, pressure, and radiation at the measurement uncertainty recapture (MUR) power uprate conditions.

Response:

The design basis accident containment temperature and pressure conditions were determined for EPU using a core thermal power of 4031 MWt (1.02 x 3952 MWt), with the exception of peak bulk suppression pool temperature, which was determined at 3917 MWt (1.02 x 3840 MWt). The results are documented in Table 4-1 of NEDC-33076P, "Safety Analysis Report for Hope Creek Constant Pressure Power Uprate," submitted as Attachment 4 to the Hope Creek EPU license amendment request (ADAMS Accession No. ML062680447) and are shown below.

Peak Drywell Airspace Pressure (psig)	50.6
Peak Drywell Airspace Temperature (°F)	298
Peak Bulk Pool Temperature (°F)	212.3
Peak Wetwell Airspace Pressure (psig)	27.7
Peak Wetwell Airspace Temperature (°F)	212.2

These results bound operation at TPO conditions, and are bounded by the qualifications of the containment coatings.

Hope Creek's normal and accident dose analyses were performed for the EPU uprate at a bounding power level of 3952 MWt for normal doses and 4031 MWt (3952 x 1.02) for accident dose. The radiation dose applicable to containment coatings is:

Total 60-year Normal Integrated Dose	7.90E+07
Total Post-LOCA EQ Dose	6.29E+08
Total Integrated Dose (TID)	7.08E+08
Qualified Dose of Coatings	1.00E+09

During the review of the requested information, PSEG identified that the Service Level 1 qualification for integrated dose stated in TSAR Section 4.1.5 contained a typographical error. The statement is corrected to:

The Service Level 1 coatings are qualified to 340°F, 70 psig, and 1x10^9 rads. Therefore, the containment coatings continue to bound the DBA temperature, pressure, and radiation at TPO conditions.

Flow-Accelerated Corrosion (FAC):

FAC is a corrosion mechanism occurring in carbon steel components exposed to single-phase or two-phase water flow. Components made from stainless steel are immune to FAC, and FAC is significantly reduced in components containing even small amounts of chromium or molybdenum. The rates of material loss due to FAC depend on the system flow velocity, component geometry, fluid temperature, steam quality, oxygen content, and pH. During plant operation, it is not normally possible to maintain all of these parameters in a regime that minimizes FAC; therefore, loss of material by FAC can occur and the rate of material loss needs to be predicted so that repair or replacement of damaged components could be made before reaching a critical thickness. The NRC's acceptance criteria are based on the structural evaluation of the minimum acceptable wall thickness for the components undergoing degradation by FAC.

MCCB RAI-2:

The MUR power uprate will affect several process variables that influence FAC. The licensee states that for the TPO the evaluation of predicted wall thinning of the balance of plant piping will be minimal. However, the licensee also states that the TPO will change some parameters affecting FAC in systems associated with the turbine cycle and appropriate changes to piping inspection frequency will be made. Provide the areas where changes may be made to the piping inspection frequency and discuss the impacts of operating parameters (e.g. planned changes in water chemistry, power level, steam cycle data, etc.) that lead to the changes in inspection frequency.

Response:

The table and flow chart below provide the results of the CHECWORKS™ SFA Model Update for MUR at HCGS. The model was updated to predict changes in FAC wear rate at various plant locations when operating at the MUR power level. The CHECWORKS™ model is updated after every refueling outage with inspection information, plant conditions, and water treatment data (dissolved oxygen and pH) from the chemistry department.

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Table C.1 – Anticipated Changes in FAC Wear Rates due to MUR

Location			Wear Rate Change[1]				Avg Post Wear Rate[2] (mils/yr)	Temperature[3]		Steam Quality[4]		Velocity[5]		Notes
No.	Steam Cycle Location	No. of Comps Analyzed[6]	Avg Change (%)	Max Change (%)	Min Change (%)	Avg ECF		Post Temp (deg F)	Temp Change (deg F)	Post Quality	Quality Change	Post Velocity (ft/s)	Velocity Change (%)	
1	Condensate: Upstream of Primary Condensate Booster Pump	66	2%	2%	2%	1.015	2.1	115.5	-4.3	0.00	0.00	2.2	2%	
2	Condensate: Secondary Condensate Booster Pumps to FW Heaters 1	127	1%	2%	1%	1.010	4.4	115.5	-4.3	0.00	0.00	13.1	2%	
3	Condensate: FW Heaters 1 to Drain Coolers	36	5%	5%	5%	1.052	2.3	155.9	4.1	0.00	0.00	9.9	2%	
4	Condensate: Drain Coolers to FW Heaters 2	30	4%	4%	4%	1.035	2.8	179.2	2.8	0.00	0.00	10.2	2%	
5	Condensate: FW Heaters 2 to FW Heaters 3	111	-5%	-4%	-5%	0.953	3.2	212.4	-8.1	0.00	0.00	11.1	1%	
6	Condensate: FW Heaters 3 to FW Heaters 4	36	1%	1%	1%	1.011	5.4	291.5	0.2	0.00	0.00	10.3	2%	
7	Condensate: FW Heaters 4 to FW Heaters 5	39	3%	3%	3%	1.028	4.1	332.1	-1.4	0.00	0.00	10.6	2%	
8	Feedwater: FW Heaters 5 to FW Pumps	148	4%	5%	4%	1.043	4.6	378.7	-2.1	0.00	0.00	12.2	2%	
9	Feedwater: FW Pumps to FW Heaters 6	112	4%	5%	3%	1.041	2.2	380.7	-1.9	0.00	0.00	20.9	2%	
10	Feedwater: FW Heaters 6 to Reactor Vessel	279	1%	2%	1%	1.015	5.1	432.9	1.3	0.00	0.00	21.5	2%	
11	Heater Drains: FW Heaters 6 to FW Heaters 5	69	13%	13%	3%	1.130	5.4	391.8	-0.8	0.00	0.00	5.8	8%	Wear rate increase > 10%.
12	Heater Drains: FW Heaters 5 to FW Heaters 4	39	5%	5%	4%	1.049	4.1	346.3	2.6	0.00	0.00	6.2	3%	
13	Heater Drains: FW Heaters 4 to FW Heaters 3	48	1%	1%	1%	1.009	3.4	298.1	-3.5	0.00	0.00	7.0	1%	
14	Heater Drains: FW Heaters 3 to FW Heaters 2	77	-1%	-1%	-2%	0.988	4.2	223.4	-7.2	0.00	0.00	8.5	4%	
15	Heater Drains: FW Heaters 2 to Drain Coolers	36	8%	8%	8%	1.083	5.8	227.7	1.2	0.00	0.00	4.9	1%	
16	Heater Drains: Drain Coolers to Condenser	39	11%	11%	11%	1.114	2.3	166.0	4.1	0.00	0.00	5.3	1%	Wear rate increase > 10%.
17	Heater Drains: FW Heaters 1 to Condenser	45	8%	8%	8%	1.083	1.7	161.1	0.3	0.00	0.00	3.6	18%	
18	MSR: Moisture Separators to FW Heaters 5	198	-6%	-6%	-6%	0.944	5.2	390.6	2.9	0.00	0.00	4.4	-0.3%	
19	Extraction Steam: HP Turbine to FW Heaters 6	121	-1%	1%	-3%	0.992	4.7	443.2	1.4	0.91	0.00	43.0	8%	

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Location			Wear Rate Change[1]				Avg Post Wear Rate[2] (mils/yr)	Temperature[3]		Steam Quality[4]		Velocity[5]		Notes
No.	Steam Cycle Location	No. of Comps Analyzed[6]	Avg Change (%)	Max Change (%)	Min Change (%)	Avg ECF		Post Temp (deg F)	Temp Change (deg F)	Post Quality	Quality Change	Post Velocity (ft/s)	Velocity Change (%)	
20	Extraction Steam: HP Turbine to FW Heaters 5	86	-1%	-1%	-2%	0.991	8.5	391.3	2.2	0.88	0.00	41.7	0.5%	
21	Extraction Steam: LP Turbine to FW Heaters 4	11	8%	15%	3%	1.082	15.7 (see notes)	341.3	-1.2	0.96	-0.008	28.0	15%	Wear rate increase > 10%. Greater flow rate through low pressure extraction system at MUR compared to pre-MUR. There are 6 carbon steel valves and 3 carbon steel pipe/fittings in this location (one is tee with multiple sections), all other components are non-susceptible material. The presence of so few carbon steel components (and majority valves) skews the Avg Post Wear Rate column compared to other locations. The Pass 2 predictions are heavily influenced by inspections in 1994. There were considerable inspections done in 1994 with a high measured wear compared to low predicted wear (low predicted wear due to only 5 cycles of operation at the time of inspection). These components were replaced with non-susceptible material and no further inspections are needed, but the historical 1994 inspections are overly influencing the current components. Thus the Pass 2 predictions are not recommended for determining wear rates at this location; instead the Pass 1 predictions are recommended and the Avg Post Wear Rate value shown is the Pass 1 Avg Post Wear Rate.
22	Extraction Steam: LP Turbine to FW Heaters 3	6	12%	12%	12%	1.125	43.1 (see notes)	301.1	1.3	0.93	-0.005	29.9	26%	Wear rate increase > 10%. Greater flow rate through low pressure extraction system at MUR compared to pre-MUR. There are only 6 carbon steel valves in this location; all other components are non-susceptible material. The presence of so few carbon steel components (and majority valves) skews the Avg Post Wear Rate column compared to other locations. As there are only valves and no pipe/fittings at this location, the change in wear rates are not of concern to the FAC Program.
23	Extraction Steam: LP Turbine to FW Heaters 2	87	14%	35%	0%	1.145	10.0	277.1	0.8	0.83	-0.020	27.8	-7%	Wear rate increase > 10%. This location is predicted to have the greatest percent increase in wear rate following the MUR.
24	Extraction Steam: LP Turbine to FW Heaters 1	90	10%	27%	4%	1.098	9.4	172.9	-0.6	0.55	0.046	32.4	30%	Wear rate increase > 10%. Greater flow rate through low pressure extraction system at MUR compared to pre-MUR.

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Location		No. of Comps Analyzed(6)	Wear Rate Change[1]				Avg Post Wear Rate[2] (mils/yr)	Temperature[3]		Steam Quality[4]		Velocity[5]		Notes
No.	Steam Cycle Location		Avg Change (%)	Max Change (%)	Min Change (%)	Avg ECF		Post Temp (deg F)	Temp Change (deg F)	Post Quality	Quality Change	Post Velocity (ft/s)	Velocity Change (%)	
25	Main Steam: HP Turbine to Moisture Separator	4	-1%	-1%	-1%	0.987	26.4	391.3	2.2	0.88	0.00	37.9	-0.4%	There are only 4 carbon steel nozzles in this location; all other components are non-susceptible material (0.15% chromium). The presence of so few carbon steel components, and all nozzles which are generally high predicted wear rate, skews the Avg Post Wear Rate column compared to other locations.
26	Steam Seal: Steam Seal Evaporator to FW Heaters 3	29	1%	1%	1%	1.008	2.6	296.3	0.0	0.05	-0.001	13.1	-1%	
27	Steam Seal: Steam Seal Evaporator to PCV 2000	17	5%	5%	5%	1.053	0.5	307.3	0.0	0.99	0.000	0.2	6%	
28	Extraction Steam: HP Turbine Packing Leakoff Steam to FW Heaters 3	39	-1%	0%	-2%	0.992	1.4	391.3	2.2	0.88	-0.001	7.2	1%	
29	Feedwater: Minimum Flow Lines	75	3%	3%	3%	1.034	34.6	381.9	-2.1	0.00	0.00	5.1	-0.1%	High Avg Post Wear Rate due to infrequent, but severe conditions in feedwater minimum flow lines to the condenser.
30	RWCU: Reactor to Regen Heat Exchanger C	267	0%	0%	0%	1.000	8.8	533.2	0.0	0.00	0.00	6.4	0%	The MUR will not change operating conditions in the RWCU system, so there is no FAC wear rate changes predicted.
31	RWCU: Regen Heat Exchanger C to Regen Heat Exchanger B	5	0%	0%	0%	1.000	7.6	434.0	0.0	0.00	0.00	9.4	0%	The MUR will not change operating conditions in the RWCU system, so there is no FAC wear rate changes predicted.
32	RWCU: Regen Heat Exchanger B to Regen Heat Exchanger A	5	0%	0%	0%	1.000	8.0	333.0	0.0	0.00	0.00	8.7	0%	The MUR will not change operating conditions in the RWCU system, so there is no FAC wear rate changes predicted.
33	RWCU: Regen Heat Exchanger A to Non-Regen Heat Exchanger A	16	0%	0%	0%	1.000	5.9	233.0	0.0	0.00	0.00	8.2	0%	The MUR will not change operating conditions in the RWCU system, so there is no FAC wear rate changes predicted.
34	RWCU: Non-Regen Heat Exchanger A to Non-Regen Heat Exchanger B	5	0%	0%	0%	1.000	6.4	177.0	0.0	0.00	0.00	8.1	0%	The MUR will not change operating conditions in the RWCU system, so there is no FAC wear rate changes predicted.
35	RWCU: Non-Regen Heat Exchanger B through Demin to Regen Heat Exchanger A	221	0%	0%	0%	1.000	15.2	120.0	0.0	0.00	0.00	6.9	0%	The MUR will not change operating conditions in the RWCU system, so there is no FAC wear rate changes predicted.
36	RWCU: Regen Heat Exchanger A to Regen Heat Exchanger B	0	0%	0%	0%	1.000	0.0	226.0	0.0	0.00	0.00	9.0	0%	All components at this location are made of non-susceptible material hence FAC wear rates are zero.
37	RWCU: Regen Heat Exchanger B to Regen Heat Exchanger C	5	0%	0%	0%	1.000	9.5	332.0	0.0	0.00	0.00	9.5	0%	The MUR will not change operating conditions in the RWCU system, so there is no FAC wear rate changes predicted.

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Location			Wear Rate Change[1]				Avg Post Wear Rate[2] (mils/yr)	Temperature[3]		Steam Quality[4]		Velocity[5]		Notes
No.	Steam Cycle Location	No. of Comps Analyzed[(6)]	Avg Change (%)	Max Change (%)	Min Change (%)	Avg ECF		Post Temp (deg F)	Temp Change (deg F)	Post Quality	Quality Change	Post Velocity (ft/s)	Velocity Change (%)	
38	RWCU: Regen Heat Exchanger C to Feedwater	95	0%	0%	0%	1.000	10.4	436.2	0.0	0.00	0.00	10.7	0%	The MUR will not change operating conditions in the RWCU system, so there is no FAC wear rate changes predicted.

Total Components Analyzed= 2719

(1) Values in GREEN show where FAC has decreased while values in RED show where FAC has increased. In the wear rate change columns negative values are GREEN and positive values are RED.

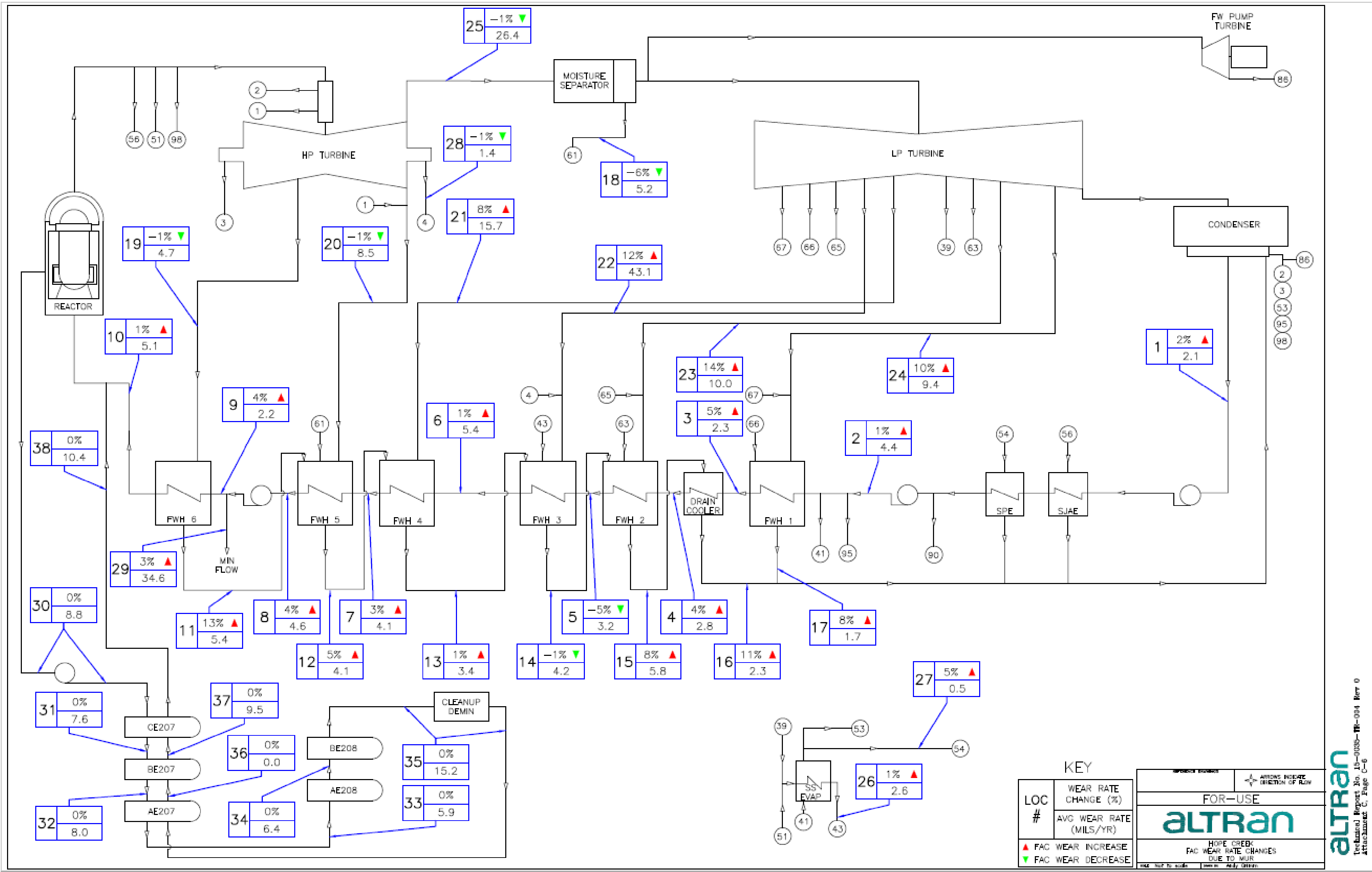
(2) Average Post wear rate is based on Pass 2 predictions (calibrated to inspection data).

(3) In the temperature change field, values that move toward the FAC peak (at ~275 deg F for 1-phase and 300 deg F for 2-phase) are RED while those that move away from the peak are GREEN. Values that are near the FAC peak where the impact is unknown are black.

(4) In the quality change field, values that move toward the FAC peak (at ~50%) are RED while those that move away from the peak are GREEN. Values that are near the FAC peak where the impact is unknown are black.

(5) Values in GREEN show where velocity/flow rate has decreased while values in RED show where flow rate has increased. FAC rates increase with increasing flow rates and decrease with decreasing flow rates.

(6) The number of components analyzed count includes the upstream, downstream main, and branch for applicable components such as tees, reducers, expanders, etc.


FW PUMP TURBINE
MOISTURE SEPARATOR
HP TURBINE
LP TURBINE
CONDENSER
REACTOR
FWH 6
FWH 5
FWH 4
FWH 3
FWH 2
FWH 1
DRAIN COOLER
SPE
SJAE
MIN FLOW
CLEANUP DEMIN
CE207
BE207
AE207
BE208
AE208
SS EVAP
25 −1% 26.4
28 −1% 1.4
18 −6% 5.2
21 8% 15.7
19 −1% 4.7
20 −1% 8.5
22 12% 43.1
10 1% 5.1
23 14% 10.0
24 10% 9.4
1 2% 2.1
9 4% 2.2
6 1% 5.4
3 5% 2.3
2 1% 4.4
38 0% 10.4
29 3% 34.6
30 0% 8.8
11 13% 5.4
8 4% 4.6
7 3% 4.1
5 −5% 3.2
4 4% 2.8
17 8% 1.7
12 5% 4.1
13 1% 3.4
14 −1% 4.2
15 8% 5.8
16 11% 2.3
27 5% 0.5
31 0% 7.6
37 0% 9.5
36 0% 0.0
35 0% 15.2
33 0% 5.9
34 0% 6.4
32 0% 8.0
26 1% 2.6
KEY
LOC #
WEAR RATE CHANGE (%)
AVG WEAR RATE (MILS/YR)
FAC WEAR INCREASE
FAC WEAR DECREASE
FOR−USE
altran
HOPE CREEK
FAC WEAR RATE CHANGES
DUE TO MUR