May 15, 1991

Docket No. 50-344

LICENSEE: Portland General Electric Company

FACILITY: Trojan Nuclear Plant

SUBJECT: SUMMARY OF MAY 9, 1991, MEETING WITH PORTLAND GENERAL ELECTRIC COMPANY AND BABCOCK AND WILCOX FUEL COMPANY

On May 9, 1991, the NRC staff met with representatives of Portland General Electric Company (PGE) and Babcock and Wilcox Fuel Company (B&W). The meeting was held to discuss questions regarding use of B&W fuel in the Trojan reactor during the upcoming operating cycle. Enclosure 1 is a list of attendees at the meeting. Enclosure 2 is a list of questions and comments that had arisen during the review of the topical reports, Mark-BW Reload LOCA Analysis for Trojan Nuclear Plant, BAW-10177, October 1990 (Trojan-specific), and BEACH, BAW 10166P, Revision 3 (Generic). During the meeting, the items listed were discussed and a few items were deleted as not being appropriate for the Trojan-specific review. The remainder of the items will be officially transmitted to the licensee and to B&W for their responses. Enclosure 2 is marked up to indicate those items for which responses are required.

It was agreed that a tight schedule must be maintained in order for the NRC staff to complete its review and issue the necessary reload license amendment by early June 1991.

Original signed by

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ENCLOSURE 1

ATTENDANCE LIST

MEETING WITH PORTLAND GENERAL ELECTRIC COMPANY

LOCA ANALYSIS AND RELATED MATTERS FOR B&W FUEL FOR TROJAN

MAY 9, 1991

NAME	ORGANIZATION
Roby Bevan	NRR/PDV
Robert C. Jones	NRR/SRXB
James Dyer	NRR/PDV
Frank Orr	NRR/SRXB
Larry Kopp	NRR/SRXB
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Tom Walt	PGE
Don Swanson	PGE
Gus Alberthal	PGE
Roger Powers	BWFC
George Meyer	BWFC
Niru Shah	BWFC
John Biller	BWFC
Bert Dunn	B&W
Cliff Fineman	INEL
Len Ward	INEL

Questions on Trojan Nuclear Plant
Mark-BW Reload LOCA Analyses
BAW-10177

1. The Babcock & Wilcox Fuel Company (BWFC) Loss-of-Coolant Accident (LOCA) Evaluation Model (EM)[1] review identified the fuel and cladding conductivities and gap heat transfer coefficient used in REFLOD3B as items that would be justified in the plant specific submittals. Based on a review of the information in BAW-10177,[2] the above items were not addressed. Therefore, justify the fuel and cladding conductivities and gap heat transfer coefficient used in the Trojan REFLOD3B analyses.

2. The fuel Doppler coefficient and moderator void and temperature coefficients were identified in the BWFC LOCA EM as items that would be justified on a plant specific basis. The Trojan report, BAW-10177, did not address these items. Therefore, what were the Doppler and moderator void and temperature coefficients used in the Trojan analyses? Justify the values used in the analysis for moderator void and temperature coefficients were the most positive or least negative possible, including uncertainties. For the Doppler coefficient, compare the end-of-life coefficient used to that at beginning-of-life to verify it is the most negative possible, including uncertainties. Clarify how the reactivity versus fuel temperature and moderator density and temperature curves were calculated and used in the analysis.

3. Table 3-1 in Reference 2 stated that the gamma flattening factor assumed in the Trojan analyses was 0.974. Because this value is different from the 0.95 approved in the BWFC RSG LOCA EM, justify the value used in the Trojan analyses.

4. The Trojan submittal stated that rod insertion was not credited in the BWFC LBLOCA EM (page 4.5). However, BWFC's response to question 4, Reference 3, on the EM stated that control rod insertion was credited after blowdown. Information was supplied in the Catawba and McGuire

review showing control rod insertion was not needed (question 4, Reference 4), but the response used information that was specific to Catawba. Therefore, this response cannot be directly applied to Trojan without further justification. Also, the Standard Review Plan[5] (SRP) requires rod insertion be justified by an appropriate analysis before rod insertion can be credited. Considering the above history, clarify the status of rod insertion in the Trojan analysis. As appropriate, provide a blowdown load and structural analysis that justifies the core and upper vessel geometry will permit rod insertion at the time credited in the Trojan analyses or provide information similar to that submitted for Catawba and McGuire to show control rod insertion is not needed.

5. On page 4.8, the Trojan submittal stated appropriate time delays were used to account for delays in the activation of the emergency core cooling system (ECCS). Provide the time delays used and compare them to best-estimate time delays or technical specification limits to verify the conservatism of the delays used in the analyses. Clarify if delays accounting for ECC header fill time and hot wall delay were included in the delay times used in the analyses. If they were not included, justify not including them in the analyses. Provide the same information for other signals used in the analyses such as reactor trip, secondary isolation, etc.

6. (delete) On page 4.9, the submittal stated the liquid in the vessel at the end-of-blowdown (EOB) was transferred from the RELAP5/MOD2 - B&W model and placed in the lower plenum of the REFLOD3B model. If this includes non-lower plenum liquid from RELAP5/MOD2 - B&W, justify this transfer and demonstrate it does not shorten the calculated refill time for the plant. Clarify the effect of steam generation in the lower plenum as a result of ECC hitting hot internal structures and walls on the draining of non-lower plenum liquid. Justify this steam generation does not invalidate the assumption of placing all liquid in the vessel at the EOB in the lower plenum of the REFLOD3B model.

7. Information is provided on page 5.7 on why the initial fuel rod conditions at 10,000 MWD/Mtu are bounded by the conditions at 41,000 MWD/Mtu. The information includes the fact that the cladding temperature during blowdown for the 0 MWD/Mtu case is 300°F below the rupture temperature. Regarding the initial fuel rod conditions at 10,000 MWD/Mtu, it is noted the initial fuel pressure at 10,000 MWD/Mtu has increased by less than 15% of the difference between the 0 and 41,000 MWD/Mtu cases, but the initial fuel temperature has decreased by 50% of the difference between the 0 and 41,000 MWD/Mtu cases. The following statement is then made on page 5.7. "With the substantial margins to rupture of the 0 MWD/Mtu case, the 10,000 MWD/Mtu conditions are also bounded by the conditions at 41,000 MWD/Mtu." Clarify why the substantial margin at 0 MWD/Mtu necessarily leads to the conclusion the initial fuel rod conditions at 10,000 MWD/Mtu are bounded by the conditions at 41,000 MWD/Mtu.

8. The BWFC LOCA EM identified containment pressure as an item to be justified on a plant specific basis. The following questions relate to the containment pressure used in the Trojan submittal.

    a. A partial justification of the containment pressure was discussed on page 4.10. The justification referred to a submittal made for McGuire and Catawba, BAW-10174,[6] and a comparison of the mass and energy releases to containment for the Westinghouse and BWFC EMs. However, a plant specific comparison should be provided for Trojan. Therefore, provide a comparison of the mass and energy releases to containment for the Trojan FSAR and B&W LOCA EM calculations cases analyzed. This comparison should include break flow and spillage from both the maximum and minimum ECCS cases. Justify the differences between the calculations are small enough to allow the use of the Westinghouse calculated containment pressure with the BWFC EM.

    b. Justify how the use of the Trojan FSAR containment pressure adequately accounts for changes to containment heat transfer surfaces and structures since the Trojan FSAR containment pressure calculation was completed.

c. The latest FSAR amendment that updated the LBLOCA analyses for Trojan, Amendment 11 dated September 29, 1989,[7] did not include a containment pressure analysis for a LBLOCA with $C_D = 1.0$. The largest discharge coefficient included in the amendment was 0.8. Therefore, clarify the source of the maximum and minimum containment pressures for $C_D = 1.0$ in BAW-10177 (Figures 6-4 and 6-15).

d. Reference 8 included a number of adjustments to the LBLOCA PCT based on differences in actual plant conditions and FSAR analysis assumptions. Clarify the effect of these differences on the containment pressure analysis. Clarify how the effect of those that would influence the containment pressure were included in the containment pressures used in the Mark-BW reload analyses.

e. Delete Clarify the assumptions made regarding the operation of the containment pressure reducing systems in the containment pressure analysis that resulted in the containment pressure used for the Mark-BW reload analyses. Clarify if those assumptions are consistent with Containment System Branch (CSB), Branch Technical Position CSB 6-1, Minimum Containment Pressure Model for PWR ECCS Performance Evaluation.

9. These questions relate to the analyses presented in Chapters 6 and 7.

a. The LOCA Limits analyses (Chapter 7) showed the axial power shape with the peak at 9.7 ft had the highest PCT. However, all sensitivity cases and the break spectrum in Chapter 6 used an axial power shape with the peak at 6.3 ft. Could this difference affect the sensitivity studies or the break spectrum analyses?

b. Based on past experience, the initial temperature of the cold leg can affect the overall analysis of LBLOCAs and the calculated PCT. This experience has shown the initial cold leg temperature should be set to the minimum cold leg temperature allowed minus instrument uncertainty to maximize the PCT. Clarify whether this effect was considered in setting the cold leg temperature to

551°F (see Table 3-1). If not, provide the basis for the temperature selected and clarify how this temperature is incorporated into the plant operating limits.

c. Page 6.4 discussed the differences between guillotine and split breaks and noted the split break heat transfer is reduced relative to the guillotine break between 70 and 220 s. However, comparison of the heat transfer coefficients for these cases showed little difference. Clarify the statement made in the report and compare the heat transfer coefficients for the two cases on the same plot with an expanded scale to show the heat transfer effects referred to in the report.

d. The worst case ECC assumption for the Trojan plant using the Westinghouse EM was the minimum ECCS case. For the BWFC LOCA EM, the worst case was the maximum ECCS case. Clarify the reasons for this difference.

e. Clarify why the $C_D = 0.6$ case had slightly better blowdown cooling.

f. In Figures 7-9 and 7-17 for the LOCA Limits analyses, clarify why some of the nodes (Node 9, Figure 7-9 and Nodes 14 and 15, Figure 7-17) show a heatup after approximately 325 s not calculated for other nodes.

g. Chapter 7 discussed the analysis for the power shape with the axial peak at 2.9 ft. The text stated the peak local oxidation for this case occurred at the ruptured node, Node 8. However, Table 7-1 shows the peak local oxidation occurring at the PCT node, Node 11. Clarify this difference.

h. What caused the oscillations in the calculated fluid temperature, heat transfer coefficient, and cladding temperature for many of the calculations presented in Chapters 6 and 7. Did these oscillations affect the calculation of PCT? If so, justify the PCT was not underpredicted.

10. The Trojan submittal in Chapter 6.3 compared only the guillotine and split breaks with a discharge coefficient of 1.0. However, Appendix K requires the discharge coefficient be varied from 1.0 to 0.6 for both types of breaks. Therefore, provide the results of split break analyses with discharge coefficients of 0.8 and 0.6 to verify the worst case break type/discharge coefficient combination for Trojan was identified. Alternately, provide additional information to justify the worst case break type/discharge coefficient combination for Trojan was identified in BAW-10177.

11. Due to the slope of the axial shape on either side of the peak power location, the power at the PCT location was less than at the peak power location (see Figure 7-3). Clarify if a worst case axial shape could be defined within Trojan operational limits so that the axial shape was flatter in the vicinity of the axial peak and the power was higher at the PCT location. For example, in the 9.7 ft axial peak case, the axial peak was in node 17 and the PCT occurred in node 15, at 8.6 ft. Would a higher PCT have been calculated if the axial shape was flatter around the peak power location so that additional power was applied at the 8.6 ft elevation? A similar question applies to all other cases.

12. For the local and core wide cladding oxidation calculations discussed in Chapters 7 and 8, clarify when the temperature of the maximum oxidation node dropped below 1000°F or when the maximum oxidation node quenched as calculated by REFLOD3B. Also, provide the time the whole core was quenched as calculated by REFLOD3B.

13. In Chapter 9, the Trojan submittal discussed the effects of LOCA and seismic loads on the the fuel bundle geometry and stated only mechanical loads were considered because only the outer two or three rows of fuel assemblies are affected and these assemblies do not achieve rupture conditions. To verify this statement, provide a comparison of the average core temperature to the rupture temperature for the LOCA Limit cases analyzed in Chapter 7. Also, clarify whether the possibility of a rod in the second or third row of assemblies having a power approximately 80% of the core hot rod was considered

in the analysis of the combined LOCA/seismic loads. At this power, the PCT on this rod would be higher than an average core calculated PCT. If this situation was considered, describe the effect of combining LOCA/seismic loads and fuel rod swelling on the coolability of the resulting geometry. If not, justify that power levels for fuel rods in the second or third row of assemblies are bounded by average core calculations or provide the appropriate analysis.

14. Chapter 9 stated the core flow area reduction in the outer rows of fuel assemblies due to a combined seismic/LOCA load was 35%. This is the same value provided in the Catawba and McGuire submittal (Reference 6). Clarify if the core flow area reduction provided in both submittals is based on a bounding analysis for all Westinghouse plants or clarify why the same flow area reduction was calculated for both plants.

15. To justify use of the FSAR SBLOCA analyses for the Mark-BW fuel reload, clarify whether ECCS pump flows (including net positive suction head concerns), ECC water temperatures, boron concentrations, tube plugging, flow resistances, bypass flows, etc. have been reviewed to determine if they are consistent with technical specification limits or requirements or changes to the system geometry since the FSAR analyses were completed.

16. Clarify if the purge system is used during power operation at Trojan. For containment isolation in general and specifically for the purge system if it used during power operation, provide the following information:

    [delete] a. Verify the actual containment isolation valve closure times are supported by an analysis of the reduction in the containment pressure resulting from the partial loss of containment atmosphere during a LOCA for ECC backpressure determination. See SRP Branch Technical Position CSB 6-4. Also, verify the effect on valve closure times of the containment pressure transient during the LOCA was included in the containment pressure analysis.

b. (delete) If the purge system is used during power operation, verify the containment pressure analysis assumed the purge valves were initially open. See SRP Branch Technical Position CSB 6-1.

17. The NRC safety evaluation report (SER) on BEACH required that certain plant parameters be within the limits specified in the SER. Additional information is needed to determine whether the Trojan analyses met that requirement. The following table lists the parameters and limits from the SER and the values for Trojan that could be determined from BAW-10177. Verify the information for the Trojan LOCA limits analyses that is shown in the table and provide the information that is missing. If any of the Trojan values are outside the bounds specified in the BEACH SER, justify the applicability of BEACH to the Trojan analyses.

PARAMETER	SER LIMITS	TROJAN VALUES
1. Peak Power (kW/ft)	0.4 - 1.0	
2. Pressure (psia)	15 - 73	14.7 - 51.8
3. Cladding Temp. (^{o}F)	950 - 1640	~1350 - 1500
4. Inlet Subcooling (^{o}F)	0 - 188	
5. Flooding Rate (in/s)	0.5 - 10	
6. Grid blockage (%)	0 - 55	
7. Rupture flow blockage (%)	0 - 60	50

18. Portland General Electric Company (PGE) in Reference 8 submitted an update on ECCS model changes. The referenced letter included a list of adjustments to the FSAR limiting PCT for LBLOCAs and SBLOCAs. Some of the adjustments are specific to the Westinghouse EM and do not have a bearing on the BWFC EM used to do the LOCA limits analyses in Reference 2. Some, however, are system boundary condition and geometry dependent and should be accounted for in the current Trojan analyses. For both LBLOCAs and SBLOCAs, clarify how the analyses in

Reference 2 accounted for these items. If they were not included in the analyses in Reference 2, justify not including them. Also, for SBLOCAs, clarify what effect the change to Mark-BW fuel would have on the adjustments and quantify the effect on the reported SBLOCA PCT.

19. Small-break LOCAs with BWFC reload fuel are discussed in Chapter 11. The approach taken was to justify the previous analyses for Westinghouse fuel remain bounding for Mark-BW reload fuel. One difference between the Westinghouse and Mark-BW fuel that PGE discussed was the fuel rod internal pressure. On page 11.6, PGE stated the Mark-BW reload fuel will have a slightly higher internal pressure initially and during the transient; this would result in the Mark-BW reload fuel rupturing earlier than the Westinghouse fuel. The discussion continued by stating the earlier rupture was conservative for the Mark-BW reload fuel relative to the Westinghouse analysis. This was because the additional oxide layer built up on the inside surface of the Mark-BW reload fuel would lower the heat addition at the time of PCT compared to the Westinghouse fuel. Therefore, PGE concluded the Westinghouse evaluation would bound the Mark-BW reload fuel. However, this discussion assumes both the Westinghouse and Mark-BW fuel rupture, and it is not clear the Westinghouse fuel ruptures during a SBLOCA. The SBLOCA analyses reported in the Trojan FSAR (Reference 7) do not show fuel rod rupture with a SBLOCA PCT of 1925°F. In Reference 8, PGE reported the SBLOCA PCT for Trojan had increased to 2139°F but did not discuss rupture. Therefore, it is not clear whether Westinghouse fuel ruptures during a SBLOCA. Also, with the Mark-BW reload fuel having the higher internal pressure, the possibility of rupture in the Mark-BW reload fuel but not the Westinghouse fuel needs to be considered. In this case, it is not clear (with a reported SBLOCA PCT of 2139°F) whether compliance to 10 CFR 50.46 for the Mark-BW reload fuel would be maintained with the additional heat load on the cladding from the oxidation of the inside cladding surface. To clarify the above situation, provide the following information:

    a. The discussion in Reference 8 did not include a PCT margin allocation for the increased cladding oxidation and energy

release that would result from the reported PCT change (1925°F to 2139°F). Provide a revised SBLOCA PCT that includes this effect or justify not including the effect of increased oxidation in the reported PCT.

b. Clarify whether Westinghouse fuel rupture is calculated during SBLOCAs with a reported PCT of 2139°F (or as provided in part a). If rupture is not calculated, clarify whether an end-of-life condition, with its high internal fuel rod pressure, was considered in choosing the worst case initial rod conditions.

c. If rupture is calculated for Westinghouse fuel during SBLOCAs, quantify what effect this would have on the SBLOCA PCT reported in Reference 8. This should include the competing effects that result from cladding rupture - enhanced heat transfer but increased oxidation from the cladding inside surface, especially at the reported SBLOCA PCT of 2139°F (or as provided in part a).

d. If Westinghouse fuel is not calculated to rupture, clarify whether Mark-BW reload fuel with its higher internal pressure would rupture under the same SBLOCA conditions.

e. If Mark-BW reload fuel is calculated to rupture in a case where Westinghouse fuel does not rupture, provide a quantitative discussion to show the overall effect on PCT as in part b of this question.

20. The LBLOCA mixed core effects discussed in Reference 2 and Reference 6 were slightly different. In Reference 2, the blowdown effect of the core flow diversion was said to be approximately 30°F; in Reference 6, the blowdown effect of the core flow diversion was said to be approximately 30 to 50°F. During reflood, the whole core pressure drop effect was said to be approximately 30 to 50°F in Reference 2; it was said to be 30°F in Reference 6. Clarify the correct way to apply the values and ranges discussed above to the different phases of the LBLOCA.

21. Clarify which two-phase pump degradation multipliers were used in the pumps on/off study discussed on page 5.3 of Reference 2. Justify that the two-phase degradation multipliers used resulted in the worst case pump conditions being identified.

22. Clarify the effect of pump operation, pumps on or locked, on the single failure chosen for use in the Trojan reload analyses. Clarify whether a different single failure would be identified if the pumps were not tripped at the start of the accident.

23. The NRC Safety Evaluation Report (SER) on BEACH, Revision 2, stated the fuel rod gap conductance multiplier model in Revision 1 of BEACH could not be used without further justification as specified in the staff SER on BEACH, Revision 1. Clarify if this model was used in the Trojan Mark-BW reload analyses.

24. The Trojan FSAR indicated that SBLOCA analyses were performed for 2-, 3-, and 4-inch breaks. The approximate PCTs for these breaks in the FSAR were 1060, 1925, and 1400°F, respectively. Based on these results, the FSAR identified the 3-inch break as the worst case SBLOCA. The following questions are related to that choice.

    a. With the large PCT difference between the 2- and 3-inch breaks (1060°F versus 1925°F), could a worst case break be found between the 2- and 3-inch breaks? Provide sufficient information to justify your response.

    b. Clarify whether PGE considered a severed injection line break as a possible worst case break. This case could be worse than the cold-leg break because, with the broken line having an atmospheric boundary condition, the ECC flow into the intact loop cold leg may be less than 75% of the total ECC flow. If the severed injection line case was not considered, justify the worst case SBLOCA was identified for Trojan or analyze a severed injection line.

REFERENCES

1. Babcock & Wilcox Nuclear Power Group, B&W Loss-of-Coolant Accident Evaluation Model for Recirculating Steam Generator Plants, BAW-10168P, Rev. 1, September 1989.

2. Babcock & Wilcox Fuel Company, Mark-BW Reload LOCA Analysis for the Trojan Nuclear Plant, BAW-10177, October 1990.

3. J. H. Taylor, B&W, ltr to J. A. Norberg, NRC, "RSG LOCA Topical Report BAW-10168P," JHT/89-66, March 31, 1989.

4. Letter from H. B. Tucker, Duke Power Company, to USNRC Document Control Desk, "McGuire Nuclear Station, Docket Numbers 50-369 and -370, Catawba Nuclear Station, Docket Numbers 50-413 and -414, Response to Request for Additional Information Regarding BAW-10174 (TACS 75138/75139/75140/75141)," August 8, 1990.

5. U.S. Nuclear Regulatory Commission, Standard Review Plan, NUREG-0800.

6. Babcock & Wilcox Fuel Company, Mark-BW Reload LOCA Analysis for the Catawba and McGuire Units, BAW-10174, Rev. 1, November 1990.

7. Letter from D. W. Cockfield, PGE, to USNRC Document Control Desk, "Final Safety Analysis Report, Amendment 11," Trojan Nuclear Plant, Docket 50-344, September 29, 1989.

8. Letter from J. E. Cross, PGE, to USNRC Document Control Desk, "Update of Emergency Core Cooling System (ECCS) Model and Application Changes," Trojan Nuclear Plant, Docket 50-344, November 8, 1990.

Questions on BEACH, Revision 3

1. The benchmark provided in Appendix F for BEACH, Version 13, described in Revision 3 of the BEACH topical report, was for FLECHT-SEASET Test 31504. As discussed in Appendix F, this test used electrically-heated rods without gaps. The benchmark results in Appendix F showed the use of heat transfer option 1 did not change the previous results for Test 31504. Therefore, Babcock & Wilcox Fuel Company (BWFC) concluded Option 1 had no impact on the calculated results for tests with electrically-heated rods without gaps. Babcock & Wilcox Fuel Company then noted the previous BEACH analysis of Test REBEKA-6 (a test using electrically-heated rods with pressurized gaps) did not show any cladding temperature oscillations. Therefore, BWFC concluded all BEACH benchmarks using the base heat transfer option are valid for heat transfer option 1. The following questions are related to the final conclusion.

   a. Clarify why the fact the REBEKA-6 benchmark did not show any cladding temperature oscillations allows BWFC to conclude all BEACH benchmarks using the base heat transfer option are valid for heat transfer option 1.

   Delete

   b. Heat transfer option 1 was a modification of the surface heat transfer model at the nucleate boiling-dispersed film boiling boundary. The benchmark provided, Test 31504, did not simulate rupture or include mixing vane grids. As a result, that benchmark did not demonstrate the models used to simulate rupture (and axial conduction) and mixing vane grid effects on surface heat transfer would be unaffected by heat transfer option 1. Therefore, additional benchmarks (such as the G-2 test series and REBEKA-6) are requested to verify heat transfer option 1 does not affect the rupture and mixing vane grid models in BEACH.