Callaway Public Meeting Inspector Notes
February 27, 2002

EVENT DESCRIPTION

The purpose of the auxiliary feedwater system is to supply feedwater to the steam generators during the loss of main feedwater flow.

The NRC augmented inspection team has described the event on December 3, 2001 as a sudden loss of the "Alpha" motor driven auxiliary feedwater pump's capability to deliver feedwater to the "Bravo" and "Charlie" steam generators on demand following an anticipated automatic trip of the main feedwater pump.

SEQUENCE OF EVENTS

The sequence of events leading up to, during, and after this event were as follows:

- On the afternoon of December 3, at 1:15 pm, operations personnel commenced a normal reactor plant shutdown to perform repair maintenance on a leaking main generator bushing.

- Later that evening at 10:39 pm, the control room received a turbine bearing high vibration alarm and by 10:48 pm, the vibration level reached a point where the operators appropriately tripped the turbine.

- Following the trip of the turbine, the operators prepared to break condenser vacuum and realized that in doing so they would loose their remaining main feedwater pump and at 10:56 pm appropriately started their "Bravo" motor driven auxiliary feedwater pump followed by the "A" pump.

- At 10:57 pm, the turbine vibration level continued to rise and reached a point where the operators were required to break condenser vacuum which they did and the running main feed pump tripped as expected leaving only the two motor driven auxiliary feedwater pumps inservice to deliver water to the steam generators.

- At 10:58 pm, the control room operators realized the "Alpha" motor driven auxiliary feedwater pump was not producing any flow at all to the "Bravo" and "Charlie" steam generators and the pump's discharge pressure was lower than expected. At this point in time the control room operators started the remaining turbine driven auxiliary feedwater pump and dispatched personnel to the "Alpha" motor driven auxiliary feedwater pump room to investigate.

- At 11:01 pm, the dispatched operators found the "Alpha" motor driven auxiliary feedwater pump operating with no leak-off flow observed from the outboard shaft seal stuffing box. The operators then went across the hall to check on the turbine driven auxiliary feedwater pump which checked out satisfactorily and returned to the "Alpha" pump room where they now noticed the outboard shaft seal housing was too hot to touch and recommended to the control room to secure the pump. The pump was secured at 11:07 pm after having been run for about 10 minutes.

- At 11:47 pm, the operators vented air from the “Alpha” auxiliary feedwater pump for about 15 seconds before water was noticed. No steam was noticed while the pump was vented.

OPERATOR RESPONSE to EVENT

The team determined the control room operators responded appropriately to the event and correctly followed applicable procedures.

ROOT CAUSE of EQUIPMENT FAILURES

AFW PUMP A

For the Motor Driven Auxiliary Feedwater Pump “Alpha”, the inspection team reviewed the results of your investigation of the December 3 event to determine if your root cause was of appropriate scope including; independence, completeness, and accuracy to identify all possible causes for the pump becoming incapable of producing required discharge pressure and flow.

The team determined that your investigation into the failure of the “Alpha” motor driven feedwater pump to deliver required flow was of adequate scope and detail to conclude that the pump failure was due to foreign material in the form of a piece of foam from the condensate storage tank diaphragm seal. The inspection team concluded a piece of foam of unknown exact size entered the suction piping of the auxiliary feedwater system and became lodged in the eye of the first stage impeller of the “Alpha” motor driven pump where it created a localized low pressure area where gases came out of solution. The gases coming out of solution created voids in the “Alpha” pump casing and partially air-bound the remaining pump stages rendering the pump incapable of developing the required discharge pressure and flow.

CST DIAPHRAGM

We also reviewed the results of your investigation of the condensate storage tank diaphragm seal failure and determined it was of adequate scope and detail to conclude that the seal failure was due to low stress high cycle fatigue due to years of constant nitrogen sparging which caused nitrogen bubbles to impact the subject failed outer seal area. This failure mechanism continued to the point where the outer fabric and foam material became detached from the diaphragm and eventually settled in the bottom of the tank.

OPERATING EXPERIENCE

OVERVIEW of INFO NOTICE 91-82

The inspection team reviewed applicable industry operating experience and determined that NRC Information Notice 91-82 titled “Problems With Diaphragms in Safety Related Tanks” provided information to you in 1991 that diaphragms in safety related tanks had a finite service life and could cause various safety hazards if they should fail.

CALLAWAY RESPONSE

The inspectors determined that you appropriately responded to the information notice in 1992 and performed a detailed review of your existing tanks with diaphragms. At that time in your old corrective action system you created what was called a Callaway Action Tracking System Item

(CATS Item 31040) to develop a periodic inspection activity for the condensate storage tank diaphragm seal. Several years later in September of 1999, in response to NRC resident questions about the condensate storage tank diaphragm, you determined that your Action tracking Item had not been assigned and the record had been closed out without performing an inspection. Troy Pruett will later discuss the adequacy of your corrective actions associated with this finding and inspections of the floating diaphragm.

CONDENSATE STORAGE TANK MODIFICATIONS

NITROGEN AFFECT ON THE CST DIAPHRAGM SEAL

The inspection team reviewed the modifications you performed on your condensate storage tank which added a temporary and later permanent nitrogen sparging system to control dissolved oxygen in the tank. The inspection team determined that there was no reference made to the affect of nitrogen bubbles contacting the diaphragm seal structure in any of your CST modification documents.

NITROGEN AFFECT on NPSH

The team determined that the modification package evaluations did not address the affect of nitrogen saturated water on the auxiliary feedwater pump's available or required net positive suction head. The team determined that the failure to translate net positive suction head requirements for auxiliary feedwater pumps into design calculations was a potential violation of 10 CFR Part 50, Appendix B, Criterion III, titled Design Control. The team determined that the failure to account for nitrogen saturated water in the net positive suction head calculation for the AFW pumps had a credible impact on safety in that the available margin of net positive suction head was reduced. Using phase 1 of the Significance Determination Process, the team determined that the issue was of very low safety significance because sufficient available net positive suction head remained after accounting for the affect of dissolved nitrogen. This licensee-identified issue was entered in your corrective action system.

Adequacy of Corrective Actions

My name is Troy Pruett and I was the augmented inspection team leader.

Problem identification and resolution issues were divided into general observations and corrective action program findings associated with the root causes.

- **General Corrective Action Program Issues**

The team had several observations associated with the corrective action program. Specifically, the event review team process did not ensure that statements were obtained from all personnel involved in the event. The corrective action program did not include formal requirements or expectations on the formulation of teams to review the highest classification of significant conditions adverse to quality. Minimal resources were initially assigned to the root cause investigation and may have contributed to the delay in identifying the degraded CST diaphragm seal. Based on interviews and a review of the Corrective Action Program Procedure, the team determined that licensed operators may only be notified of equipment deficiencies if the individual discovering the condition believed there was an immediate impact on nuclear, plant,

or personnel safety. Consequently, the potential existed for initial operability decisions to be made by non-licensed personnel.

- **Adequacy of corrective actions associated with root causes.**

The team assessed the adequacy of corrective actions associated with the root causes of the event and determined that several examples of a potential violation existed. Specifically, 10 CFR Part 50, Appendix B, Criterion XVI, requires, in part, that measures be established to assure that conditions adverse to quality are promptly identified and corrected. The identification of significant conditions adverse to quality shall be documented and reported to appropriate levels of management. Between January 1992 and January 31, 2001, there were several missed opportunities to promptly identify and correct a risk significant condition adverse to quality involving foreign material in the auxiliary feedwater system and condensate storage tank. In addition, between January 25 and 30, 2002, the identification of a significant condition adverse to quality was not reported to the appropriate levels of management. Specifically:

(1) In 1992, a Corrective Action Tracking System Item, which had been initiated to generate an inspection activity of the condensate storage tank diaphragm seal, was inadvertently closed. The inspection was to have been completed in response to NRC Information Notice 91-82, "Problems With Diaphragms in Safety Related Tanks."

(2) During the Spring and Summer of 2000, the inspection of the condensate storage tank diaphragm was deferred on two occasions without adequate justification. The deferrals were based on the chemistry specifications of the condensate storage tank water and did not consider the potential for degradation of the diaphragm seal.

(3) On October 17, 2000, an inadequate inspection of the condensate storage tank diaphragm seal was performed. The inspection was of limited scope and failed to identify the degraded condition of the diaphragm seal.

(4) Between December 3 and 5, 2001, foreign material was not evaluated as a credible mechanism for the failure of auxiliary feedwater Pump A. Consequently, the pump was declared operable even though the pump technical manual and industry information suggested that the failure could have been due to foreign material.

(5) On December 14, 2001, the pump vendor recommended that an inspection for obstructions in the seal water line be completed. However, the inspections were not performed until January 15, 2002.

(6) On January 8, 2002, 35 days following the event, foreign material was formally identified as 1 of 3 potential root causes of the failure of auxiliary feedwater Pump A. However, foreign material was not considered a credible failure mechanism until January 24, 2002.

(7) On January 15, 2002, foreign material was not considered a credible failure mechanism even though foam was discovered in the seal water cooling line for auxiliary feedwater Pump A.

(8) Lastly, between January 25 and 30, 2002, a significant condition adverse to quality was not reported to appropriate levels of management in a timely manner. Information

regarding the as-found condition of the condensate storage tank diaphragm seal was incorrectly reported. Consequently, broad corrective actions to assess the extent of condition associated with the failure of the diaphragm seal were delayed.

- **Operability Evaluations**

The operability evaluation program did not implement the guidance provided in Generic Letter 91-18, “Information to Licensees regarding NRC Inspection Manual Chapter Section on Resolution of Degraded and Nonconforming Conditions.” Therefore, the operability evaluation program had several weaknesses. Examples included: (1) No guidance was provided to aid the reviewer in determining when a safety evaluation was required to be considered. (2) No requirement existed for a licensed operator to be notified when an operability evaluation was being or had been performed. (3) No guidance was provided on the amount of time required to complete an operability evaluation, (4) No guidance was provided on the required level of review of an operability evaluation. (5) No guidance was provided for the completion of safety evaluations associated with compensatory measures. (6) No guidance was provided for the periodic reviews of open operability evaluations.

- **Quality Assurance Involvement**

The team determined that quality assurance personnel were not actively involved in providing oversight of the auxiliary feedwater pump A event review team and root cause investigation process.

- **System Inspections to Demonstrate Operability**

The team observed portions of the borscopic inspections and found them to be appropriate. The team also determined that the scope of inspections were sufficient to ensure the AFW system and CST would perform their intended safety functions.

Risk Significance of Event

- **Assumptions Used in Analysis**

Phase 1 of the significance determination process described in NRC Manual Chapter 0609, required that Phase 2 analysis be performed because the finding represented an actual loss of one or more trains of the AFW system. Using the Phase 2 process, the team preliminarily determined that the failure of a single motor driven AFW pump for a period of greater than 30 days had the potential to be of substantial safety significance. The failure of all AFW pumps for a period of greater than 30 days had the potential to be of high safety significance. The team recognized that the site specific notebooks used in the Phase 2 process did not provide the best understanding of the significance of the issues because; (1) the Callaway site specific notebook had not been tested against the licensee's risk model, (2) generic values were used in the notebook which were not reflective of actual plant specific values, and (3) the site specific notebook did not account for common cause failure. Consequently, the Region IV SRA completed a Phase 3 analysis of the failure of AFW Pump A.

- **Preliminary Significance Determination**

The Region IV SRAs preliminary analysis assumed an 85 percent capacity factor, an increased likelihood that a common cause failure could occur, a 1 year duration for the condition, the likelihood that a piece of foam which separates from the diaphragm enters the AFW system 50 percent of the time, and plant operators would be able to recover a failed AFW pump approximately 95 percent of the time. With these assumptions, the Region IV SRA determined that the preliminary significance of the degraded CST diaphragm seal was low to moderate.

This concludes the summary of the teams observations and findings. I'll now turn the meeting back to Dale Powers.