Containment Atmosphere Control System (CAC)

Summary of Issues

Washington Public Power Supply System

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CONTENTS

1.0 Introduction

This report is a summary of recent Containment Atmosphere Control (CAC) activities at WNP-2. It is a compilation of several Supply System identified reportable events that occurred in 1991 and early 1992. It also includes NRC issued Notices of Violation associated with the CAC System. The compilation of these events in one place provides increased visibility of the solutions to past problems, lessons learned, and the status of corrective actions associated with the system. As a result of these extensive activities we believe the CAC system was operable prior to plant startup on March 18, 1992 and will remain operational as needed to support WNP-2 power operation.

Nine man-months were spent by Supply System and Consultants on a review of the CAC system. The Supply System CAC SSFI Team consisted of a group of six individuals from various disciplines. The response to the concerns uncovered by the SSFI was prepared by a team of ten Supply System Engineering and Consultant (Bechtel and United Catalyst) personnel. In addition, the WNP-2 Plant Technical staff had a team of five individuals involved in CAC testing and management of modifications to the system.

2.0 Description of the CAC System

At WNP-2 the CAC System includes redundant catalytic hydrogen/oxygen recombiners provided to control oxygen concentrations in the Primary Containment during degraded post LOCA conditions. This is achieved by recombination of the oxygen with hydrogen. It is expected that hydrogen will be available in sufficient amounts to not limit the removal of oxygen. The recombiner subsystems (A and B) are located adjacent to the Primary Containment in the Reactor Building (Secondary Containment). Each redundant subsystem consists of a wet scrubber, blower, electric heater, catalyst vessel, after cooler, moisture separator and associated instrumentation, valves and piping. A constant speed blower is used to draw the atmosphere from the Primary Containment, process it through the equipment and return it back to the Containment. The amount of recombination is controlled by the amount of recycle flow that is directed back through the unit. The amount of recycle flow is controlled by Recycle Flow Control Valve, CAC-FCV-6A/B. As the amount of recycle flow is increased the rate of recombination decreases. If CAC-FCV-6A/B is fully closed the system functions with single pass flow through the unit resulting in maximum recombination from the containment.

Each CAC train drains water through a loop seal to the

Suppression Pool. The drain is required to dispose of the wet scrubber water flow of up to 10 gpm plus any steam condensed from the gas stream. In addition, water collected in the moisture separator due to the recombination of hydrogen and oxygen is also drained to the Suppression Pool.

The CAC trains are provided with Class 1E power and contain equipment that is environmentally qualified.

3.0 CAC Issues

3.1 Summary

Appendix A to this summary provides a chronology of CAC related events. This chronology begins with a number of precursors to events discovered during that past year that were caused by actions taken during the later phases of plant construction. For most chronological items a reference to a Licensing Event Report (LER) or Inspection Report (IR) is given. These documents should be consulted for additional detail.

On December 2, 1991 Plant Management requested a Technical Review of the CAC System by the Nuclear Safety Assurance Division. This review was in response to problems discovered with the recycle flow control loop. This review identified a number of additional concerns and resulted in further reviews by the Supply System Engineering organization supported by Bechtel Power Corporation. In addition, a recognized expert from United Catalyst was employed to review selected aspects of the design.

As a result of this scrutiny and associated testing the plant was forced to shutdown on February 25, 1992 when problems were discovered with the CAC drain piping. Design modifications to correct these problems were implemented during early March. Reviews by various support organizations were used to support plant startup on March 18, 1992.

During the R-7 refueling outage of 1992 a number of CAC related corrective actions were implemented. The Technical Assessment SSFI Final Report was issued and the Bechtel evaluation of the CAC System was reviewed.

The following discussion is a topical summary of activities associated with the CAC System.

3.2 Design

The SSFI Team followed the standard approach for performing the inspection. The system regulatory and code requirements were identified. The CAC design basis was established by reviewing the Licensing Basis Documents and this was used as a baseline for the remainder of the review.

In addition, Bechtel was tasked to "Perform a technical review of the design of the CAC system to establish its ability to perform its intended function." The Bechtel

evaluation was subsequently reviewed and verified by Engineering.

3.2.1 Control

On August 7, 1991 a contract engineer, performing a setpoint calculation review, discovered that incorrect Containment Atmospheric Control (CAC) Recycle Flow Control controllers (CAC-FC-67A/B) were installed for both divisions in the control room. The plant design and operating procedures required these instruments to be used in the automatic mode of operation to control recombiner recycle flow. If these incorrect controllers had been used in the automatic mode, they would not have controlled recycle flow which could have resulted in a reduced recombination rate or possible system shutdown due to excessive recombination.

Corrective action was taken to change plant procedures requiring operation of these instruments in the manual mode. This allowed plant operators to control recycle flow from the control room by manually positioning the Recycle Flow Control Valve (CAC-FCV-6A/B).

The SSFI team questioned the manual method being used to control the CAC recycle flow. They believed that manual control based on recombiner exit temperature was not acceptable. The instantaneous reaction rate associated with recombination could lead to high recombiner exit temperatures resulting in system shutdown at the trip setpoint of 1150°F. This concern was verified by the consultants (Bechtel and United Catalyst). Due to the transient nature of Post-LOCA operation, oxygen or hydrogen fluctuations could come from a) localized pockets of unmixed gases, b) over compensating recycle flow control by the operator or c) increasing scrubber dehumidification capacity from resetting water flow. These fluctuations would be especially critical if the recombiners were operated near their upper temperature limits. As a result of this concern, Plant Procedures were changed to simplify operation of the CAC system. This change was performed with an appropriate

50.59 review and analysis. PPM 2.3.3A/B, System Operating Procedures for Containment Atmospheric Control (Division I/II) were changed to require the Plant Operators to place the CAC units on a constant 60 percent recycle flow under post-LOCA conditions. The Emergency Operating Procedures (EOPs) provide for early startup of the CAC System at 0.5 percent hydrogen by volume. This low hydrogen concentration combined with high recycle flow will provide a large margin between the operating point and the high temperature trip.

There is one open issue on the subject of control that needs to be resolved.

a. The SSFI and Bechtel Teams both recommend testing be performed to validate the accuracy of the CAC flow orifices. Duplicate flow orifices have been manufactured and test data for the orifices is expected to be obtained by December 1992.

3.2.2 Capacity

The oxygen removal capacity, flow rate, and scrubber heat transfer capacity were reviewed by Bechtel. The evaluation verified adequate performance of the system.

3.2.3 Catalyst

The SSFI review questioned the operability of the catalyst. These questions involved potential halogen poisoning during postulated accident conditions; possible water damage due to wetting during past testing; and adequacy of the surveillance test to determine catalyst operability. The consultants reviewed past data on halogen testing and the system design. The CAC system is designed with preheaters and operates with the feed temperature at 500°F. At this temperature halogen poisoning is not a concern because these gases are driven from the catalyst bed. Additional margin is provided by the fact that the surveillance testing is performed at a lower temperature (less than 300 degrees F).

The consultants also re-reviewed past test data to determine the condition of the existing catalyst. Heat and mass balances were performed to estimate the amount of conversion in different sections of the catalyst bed for seven years of test data. This analysis showed that the bulk of the reaction was occurring in the top half of the catalyst bed as it should for a healthy configuration. The performance of the two units was slightly different but within expected parameters. The analysis did show that the "A" bed performance was less efficient when compared to the "B". However, variation in the process variables and instrumentation inaccuracies on the two sub-system would also account for this difference.

On March 11 and March 12, 1992 the normal 18 month surveillance procedures for the catalyst, PPM 7.4.6.6.1.4/5, CAC-HR-1 A/B Functional Test and Visual Examination, were performed as part of the plant restart effort. During this test the "A" catalyst achieved a 102°F per percent hydrogen temperature rise. Thus, it did not meet the Technical Specification required 120°F per percent hydrogen.

The test results and associated analysis made it evident that the acceptance criterion of the Technical Specification was very dependent on the analytical methods of calculating the input parameters and measurement of performance indicators; hydrogen concentration, process flows and temperatures. Depending on the data, the temperature rise could vary significantly. The review had led to refinements in input parameter determination. As a result, during this review the temperature rise acceptance criterion required by the Technical Specifications was identified as suspect. Test results showed variations are primarily due to instrument uncertainty and the inability to set initial conditions and input parameters. Consideration was given to other factors such as heat removed by the gas flow, heat capacity of the catalyst bed and the vessel, losses through vessel insulation, supports, and piping, time lag, heat loss

caused by temperature sensors, and uncertainties in flow determination during testing. This led to a conclusion that the present temperature rise acceptance criterion was not an accurate reflection of catalyst operability.

The Bechtel consultants concluded that sampling of the inlet and effluent gases for hydrogen concentration would be a more direct indication of catalyst efficiency. This was confirmed with the assistance of industry experts in catalyst bed design and operation. An appropriate acceptance criterion would be the sampling of the effluent gas stream for hydrogen concentration for a defined input volume percent of hydrogen. A sample retaining less than 25 parts per million by volume (ppmV) hydrogen after passing through the catalyst bed would indicate acceptable recombiner operation for a feed of at least one percent hydrogen by volume. In response to this recommendation, the normal 18 month surveillance procedures for the catalyst, PPMs 7.4.6.6.1.4/5, CAC-HR-1 A/B Functional Test and Visual Examination, were modified to require sampling of hydrogen at both the inlet and outlet of the recombiner. In addition, a second set of procedures were written and performed, PPM 8.3.246/247, CAC-HR-1A/B Two Percent Hydrogen Test, to inject two percent hydrogen by volume in the inlet gas stream. A comparison of the temperature profiles for the one and two percent tests allows a prediction of catalyst health and ability to process higher percentages of hydrogen. The sampling performed on March 11 and 12 showed 6 ppm volume hydrogen concentration in the effluent stream of both recombiner trains with the "A" train showing slightly better performance. It was these test results that led the Supply System to conclude that the catalyst efficiency was acceptable and capable of performing its intended function.

A Technical Specification amendment has been requested to surveillance requirement 4.6.6.1.b.3. The requirement checks effluent hydrogen concentration as follows: "Verify during a recombiner system functional test that, upon introduction of at least 1% by

volume hydrogen into the catalyst bed preheated to a temperature not to exceed 300 degrees F, the effluent stream has a hydrogen concentration of less than 25 ppm by volume." The NRC requested additional temperature profile data be collected in the surveillance to allow trending of catalyst bed efficiency. The temperature profile data collection requirement has been added.

3.2.4 Drawings

On January 23, 1992 CAC Circulating Fan (CAC-FN-1B) failed to start during the performance of a routine surveillance test. Plant operators discovered the fan did not operate because of tripped overloads. It was then determined that Train B of the Containment Atmosphere Control (CAC) System had been inoperable longer than the 30 days allowed by the Technical Specifications. Plant Technical conducted an investigation that revealed the overloads most likely tripped during the performance of a special one-time test (PPM 8.3.229TP) to verify flow control valve CAC-FCV-6B could be controlled manually from the control room. The test resulted in cycling the fan motor on and off three times under low flow conditions, causing the overloads to trip. The investigation also found a discrepancy between the elementary diagram and Electrical Wiring Diagram (EWD) which lead Plant Operators to erroneously conclude the overloads were not tripped following the performance of the special one-time test. This event is described in LER 92-003 and the following corrective actions were identified to correct the drawing problems:

(a) Perform an as-built inspection to verify the field wiring on each CAC skid (LER 92-003). This inspection was completed prior to the end of the R-7 refueling outage.

(b) Update applicable drawings to reflect the actual field wiring configuration of the CAC system (LER 92-003). This action will be completed by November 1, 1992.

(c) Upgrade the as-built corrected elementary drawing for the CAC skid to Top Tier status (LER 92-003). This action was completed prior to the end of the R-7 refueling outage.

(d) Perform a review of drawings for similar safety related equipment/systems and correct any discrepancies. From criteria previously established the following systems will be considered in the review; main steam leakage control, control room chillers, acoustic monitors, process-post accident sampling, and process radiation monitors (LER 92-003). These reviews are ongoing and will be completed by December 31, 1992

3.3 Modifications

Five plant modifications have been or will be implemented to address issues identified during the CAC review.

3.3.1 RHR Interface

The Licensing Basis Documents have a requirement for simultaneous operation of CAC and Containment Suppression Pool Cooling during Emergency Operations that could not be met during plant operation. This situation was discovered simultaneously by the SSFI team and the System Engineer. The review discovered a precaution in the plant procedures stating the isolation valve (RHR-V-134A/B) in the drain line from the CAC system to the RHR system must be closed to prevent flooding of the CAC system during testing of the RHR system. Flooding would occur because the drain line for the CAC equipment was connected through a loop seal to the RHR line that returns flow to the suppression pool. The back-pressure in this line with RHR running would be approximately 90 psig which would flood the CAC equipment unless the interface isolation valves (RHR-V-134A/B) were closed. During CAC System operation the RHR-V-134A/B valves must be open to allow the scrubber (CAC-AW-1A/B) and the recombination water to drain to prevent

flooding the CAC units. Further investigation showed this interaction between CAC and RHR would also occur when RHR was operated in the suppression pool cooling mode during postulated accident conditions.

Further evaluation showed restricting orifices (RHR-RO-8A/B and RHR-RO-9A/B) were installed in the RHR returns to the Suppression Pool during the later phases of construction by the Architect Engineer/Construction Contractor. Design change PED 215-M-N002 was written in April 1983 to move the restricting orifices because of excessive cavitation and vibration. The change moved the orifices from a point upstream of the CAC drain line to a point downstream of the CAC drain. Calculation 5.17.26 requires a RHR pump head of 267 ft at a flow rate of 7450 gpm through the RHR heat exchanger. When the orifice, sized to this requirement, was moved downstream of the CAC drain line, the two systems could not be operated at the same time without flooding the CAC system.

An Urgent Plant Modification (92-0056) was initiated to correct the interface problem between CAC and RHR. The drain line for each recombiner was rerouted from the RHR return line to the suppression pool using piping that is part of the deactivated steam condensing mode of RHR. This change prevents water from backing up from RHR into the CAC equipment (LER 92-007). This work was completed and the system was tested prior to plant restart on March 18, 1992.

3.3.2 Loop Seal Drains

Concurrently with the investigation of the RHR drain interface issue, additional actual flooding problems were realized. As a result of an SSFI concern that a full integrated CAC system test had never been performed, a special test, PPM 8.3.230TP, "CAC-HR-1B Recycle Flow Verification from Drywell," was being performed on February 25, 1991. This test required operation of the 'B' recombiner (CAC-HR-1B) with the CAC scrubber (CAC-AW-1B) in operation. The scrubber drains through the loop seal to the RHR system and is the

main source of water from CAC as a result of system operation. During the performance of this test erratic cyclic operation of the CAC system air flow was noted and the 'B' unit blower (CAC-FN-1B) and motor were wetted. The wetting resulted when the scrubber drain water backed up into the CAC units. Further investigation and testing of the 'A' recombiner unit on February 27, 1992, showed the drain problem was also present on the redundant unit.

A review of the Preoperational Test Summary (PT 22.0-A) showed that drainage problems were experienced on CAC during testing in November 1983. On November 28, 1983 the test summary remarks note that after scrubber flow was established the temperatures dropped rapidly due to the fan pumping water. It was noted that no water was draining and the fan, CAC-FN-1B, tripped on overload. The remarks note that prior to tripping cyclic filling and draining was occurring in the moisture separator.

The SSFI review of the design documents associated with CAC showed two design changes (S215-M-7001 and S215-M-7097) were issued in January 1984 to eliminate water carryover to the blowers of the CAC units. These design changes were implemented by Plant Modification Record 84-304 in March 1984. Changes were made in the piping associated with the CAC drains but no record could be found where a functional test was performed to verify the drains worked correctly.

An Urgent Plant Modification (92-0057) was initiated to correct the CAC drainage problem. The inlet side of the loop seal was vented to the incoming line from primary containment. This change provided a path for the gas trapped in the loop seal to escape when scrubber flow begins to flow into the loop seal. It also precluded the formation of a vacuum that could hinder drainage from the scrubber.

Following implementation of the plant modification, the two test procedures, PPM 8.3.248TP and PPM 8.3.230TP, CAC-HR-1A/B Recycle Flow Verification from Drywell, were

again performed to verify proper operation of the CAC system. These tests confirmed the proper functioning of the manual recycle flow controller from the control room and proper draining of the system with the CAC scrubber in operation (LER 92-007). This testing was completed prior to plant restart on March 18, 1992.

3.3.3 Blower Overload BISI Indication

During the January 23, 1992 event described in section 3.2.4 above, the Plant Operators discovered the CAC blower motor overloads were tripped, but the BISI did not indicate CAC was out-of-service. The CAC system design was changed to modify the control power and BISI circuits to provide positive indication of system power alignment (LER 92-003). This work was completed prior to the end of the R-7 refueling outage.

3.3.4 Pushbutton

PER 292-231 was written when it was discovered the CAC test pushbutton could create a primary containment bypass leakage path if a hot short were to occur. This issue was evaluated to be not reportable as the amount of bypass leakage was below the analyzed value. A temporary modification is currently in place to mitigate this design deficiency. PMR 92-0085 was issued on March 18, 1992 to replace the pushbutton with a maintained contact switch and a second switch in series.

3.3.5 Blower Seal Replacement

PER 292-480 was written when it was discovered that the installed CAC blower labyrinth seals contained teflon which was not environmentally qualified and could deteriorate when exposed to high radiation. This would lead to degraded blower performance.

New seals were designed, manufactured and installed. Subsequent testing showed the blower performance was satisfactory with the new seals. Both CAC blowers were modified under PMR 92-0162 prior to the end of the R-7

refueling outage.

3.4 Maintenance and Operation

3.4.1 CAC Material Condition

On September 11, 1991 one train of CAC was found to be inoperable due to the loss of lubricating oil causing the blower shaft to seize. The oil had leaked out due to a loose drain plug.

In October 1991 an NRC Inspector noted problems with the material condition of the CAC skids (missing or loose nuts on hangers and uncertainty about the environmental qualification of CAC-PT-1A). Technical Specification 4.6.6.1.b.4 requires a visual examination of abnormal conditions every eighteen months. The Supply System acknowledges the existing surveillance did not provide physical verification of fastener tightness. Further Supply System reviews identified additional problems. As a result of these two findings on material condition the following corrective actions were completed or initiated:

(a) Lockwires have been installed on the drain plugs of the Recombiner blowers (LER 92-025-1, IR 91-44).

(b) The appropriate documentation has been changed to require the drain plugs in each recombiner blower to be properly installed and lockwired (LER 92-025-1, IR 91-44).

(c) A Maintenance and Operations Bulletin was issued to appraise craft and system engineers of the necessity to ensure positive locking ability for critical pipe plugs in vibrating equipment (LER 92-025-1, IR 91-44).

(d) Procedures were reviewed to evaluate how fasteners and pipe supports were addressed. The review (SS2-PE-92-0047) recommended that enhancements be made to two procedures. Plant procedures PPMs 10.2.10 and 10.2.29 were deviated to provide improved guidance on instal-

lation of pipe fasteners and supports (IR 91-44).

(e) An evaluation, including a review of recommendations in the manufacture's literature was performed on the CAC blowers to determine the appropriate interval for shaft rotation to prevent shaft damage due to system vibration (IR 91-44). The evaluation was completed June 26, 1992, and concluded there was no specific need for rotating the blowers more frequently than what is required to satisfy other existing surveillance requirements.

(f) Plant Procedures PPMs 7.4.6.6.1.4/5 were revised to more clearly define the required visual examinations with the System Engineer Program Weekly Field Walkdown results.

3.4.2 Surveillance Program/Testing

Various surveillance tests are performed on equipment associated with the CAC system. This includes an 18-month surveillance (PPM 4.6.6.1.b.1) which requires performing a CHANNEL CALIBRATION of all recombiner operating instrumentation and control circuits. Plant Procedures PPMs 7.4.6.6.1.3C/D, H2 Recombiner 1A/B Flow Instrumentation Channel Calibration, are the channel calibration procedures. However, on November 21, 1991, it was discovered that this surveillance had not tested the operation of the Recycle Flow Control Valve, CAC-FCV-6 A/B, from the Remote Master Flow Controller, CAC-FC-67 A/B in the manual mode of operation. A trouble shooting plan was formulated and implemented that demonstrated operation of the CAC-FCV-6 A/B from the control room.

As a result of the deficiencies found in the Surveillance procedures, the following corrective actions were identified:

(a) Plant Procedures PPMs 7.4.6.6.1.3C/D were to be revised to incorporate a test of the CAC-FC-67A/B to CAC-FCV-6A/B instrument control loop (LER 91-029-1).

Since the CAC system has to be operational to obtain a meaningful test this surveillance requirement was instead incorporated into Plant Procedures PPM 7.4.6.6.1.1 and 7.4.6.6.1.2, Preheater Operability Tests. This item was completed prior to the end of the R-7 refueling outage.

(b) CAC surveillance procedures were validated and verified to assure all Technical Specification functions are being performed (LER 91-029-1). This item was completed prior to the end of the R-7 refueling outage.

(c) The process and direction used for system walkdowns has been strengthened and walkdowns on the CAC system are performed on a weekly basis. This item was considered closed as of May 1, 1992.

(d) The CAC system was run every 30 days until the SSFI was complete and its recommendations were evaluated (LER 92-003, IR 91-44). This item was considered closed as of May 1, 1992.

(e) The plant procedures for verifying recycle flow from the drywell will be performed on a periodic basis. Performance of these integrated tests provides additional assurance all aspects of the CAC system function properly.

3.4.3 Operating Procedures

For the recycle flow controller problem, plant System Operating Procedures, PPMs 2.3.3A/B, Containment Atmospheric Control, were revised to require operation of CAC with CAC-FC-67A/B in the manual mode. The CAC operating procedures were validated and verified (LER 91-029-1). These actions were completed prior to startup following the R-7 refueling outage (LER 91-029-1, IR 91-44).

4.0 Conclusions on CAC Operability

Nine man-months were spent by Supply System and Consultants on a review of the CAC system. The Supply System CAC SSFI Team consisted of a group of six individuals from various disciplines. The response to the concerns uncovered by the SSFI was prepared by a team of ten Supply System Engineering and Consultant (Bechtel and United Catalyst) personnel. In addition, the WNP-2 Plant Technical staff had a team of five individuals involved in CAC testing and management of modifications to the system.

As discussed above, Bechtel was given a scope of work that included an overall review of the CAC system. In addition, the extensive focus by all the SSFI team members resulted in design reviews, system testing, and system walkdowns, which provided confidence that the system was operational prior to the March 18, 1992 startup. Specifically, quantitative analysis of the catalyst performance based on effluent hydrogen concentration, full flow testing of the recycle ratio control using the drywell atmosphere and maximum scrubber flow, and verification of the catalyst high temperature shutdown safety function all provided confidence that the system was fully capable of performing its intended safety function.

During the R-7 refueling outage outstanding corrective actions were implemented to provide further assurance of CAC operability. This included an as-built inspection of the field wiring on each CAC skid. In addition, the various reports associated with the CAC review were finalized.

Following resolution of the blower seal (Teflon) issue, the CAC system was declared operable following successful post-modification testing and surveillance testing prior to restart at the end of the R-7 refueling outage.

5.0 Root Causes

The dominant features in the root cause analyses performed to date on significant CAC issues have been less than adequate design analysis and/or design review.

Inadequate design analysis has resulted in system interaction problems (CAC-RHR, Pushbutton), unworkable drain configuration, incorrect controller selection, faulty control methods (operator controlled recycle) and inaccurate monitoring of equipment condition. Design review failures in the form of inadequate testing precluded discovery of the errors from the analysis/design process and allowed fundamental design deficiencies from the construction phase of the project to continue.

The root cause of the unqualified Teflon seals being installed in the CAC blowers was less than adequate work practices and procedures. Corrective actions have been implemented.

6.0 Safety Significance

We believe the events associated with CAC had safety significance because the operability of both divisions of one of the WNP-2 Engineered Safety Features was impacted. However, the actual safety significance is mitigated by the very low probability of the need for the system.

With an inerted containment, combustible gas control is based on the amount of oxygen in the containment. In the design basis analysis, the probability of oxygen production following a large LOCA event has been assessed by the Supply System PRA effort. A large LOCA can be due to pipe break or due to failure of sufficient SRV's to open when needed. On the basis of generic failure rate for pipes and plant-specific failure rate for SRV's, the probability of a large LOCA has been determined. A large LOCA event can be mitigated as long as any one of the ECCS systems operate. Plant-specific system unavailabilities have also been determined. The oxygen production (or a LOCA without coolant injection) probability can be assessed by multiplying the LOCA probability by the ECCS System unavailabilities. This number is approximately 1E-7/year. The NRC's proposed safety goal is 1E-4/year for core damage and 1E-6/year for containment failure resulting in a large release to the environment (SECY-91-270). Although oxygen production does not mean there is a subsequent burn or containment failure, the oxygen production probability already meets the safety goal for containment failure.

Severe accident studies done in support of Individual Plant Evaluation (IPE) work has shown that the amount of oxygen generated and surviving as a gas in a degraded core scenario is very small. With an inerted containment the oxygen is not likely to exceed the flammability limits precluding the need for the recombiners. In addition, the initial work being done on the WNP-2 IPE concludes that CAC is a negligible contributor toward accident mitigation. For core melt accidents, the exothermic metal water reaction, once started, generates large quantities of hydrogen. Since there is a limited amount of oxygen that can be reacted the CAC system is of marginal value. Hydrogen combustion is not a credible containment failure mechanism for an inerted containment (Reference: FAI/91-110, Deflagration and Detonation of Hydrogen, July 1991).

7.0 Open Items

Many CAC issues have been closed as noted in the discussion above. However, the following open items are still in the process of resolution:

7.1 The SSFI and Bechtel Teams both recommend testing be performed to validate the accuracy of the CAC flow orifices. Duplicate flow orifices have been manufactured and test data is expected to be obtained by December 1992.

7.2 Applicable drawings will be updated to reflect actual field wiring configuration of the CAC system (LER 92-003). This will be completed by November 1, 1992.

7.3 An engineering evaluation and drawing review will be performed on four similar safety related equipment/systems. The evaluations and reviews are ongoing and will be completed by December 31, 1992.

7.4 The Supply System SSFI team issued a total of 25 Quality Finding Reports (QFRs), which mainly identified programmatic concerns and deficiencies in documentation associated with the CAC system. Only one of the QFRs involved an operability issue. This issue is associated with the CAC flow orifices. A Basis for Continued Operation, which was approved by POC, addresses this issue. Currently the QFRs are being dispositioned by the responsible organizations.

8.0 Similar System Reviews

A concern was raised when it was discovered that a design change had been issued (February 1982), but not implemented, to correct an identified problem with the recycle flow controllers.

The design change process in place during construction depended on contractors to implement changes that were issued by the Architect-Engineer. It is concluded, based on the turnover process put in place at the end of construction, that the failure to implement the design change was an isolated occurrence. The construction design change process in place when this event occurred was completely changed when the plant went into operation. Therefore, no further corrective action is warranted (LER 91-029-1, IR 91-44).

A more general action being taken in response to the problems associated with the CAC System involves the identification of other systems that may have characteristics similar to those which are believed to have contributed to the CAC situation. This evaluation considered seven criteria: 1) Late additions to plant design, 2) Not fully testable, 3) Not fully designed by Burns and Roe, 4) Not fully designed by General Electric, 5) Importance of the system to plant organizations, and 6) Current status of system deficiencies. The results of this evaluation recommended four systems for consideration of additional reviews: Control Room Chillers, Post Accident Sampling, Main Steam Leakage Control and Process Radiation Monitors. An engineering evaluation will be performed for each system which will include a drawing review. This will include a limited team inspection. These evaluations and inspections are ongoing and will be completed by December 31, 1992 (LER 91-029-1, LER 92-003, IR 91-44).

9.0 Reportability Evaluation Timeliness (IR 91-44)

An additional issue associated with the reporting of the CAC flow controller problem, was the timeliness of reporting. Corrective actions have been taken and planned to deal with this concern as follows:

(a) Action was taken to reduce the backlog of items requiring a reportability evaluation to less than ten. A goal has been established to maintain the number of items at a reasonably low level.

(b) A survey was performed of the process/methods used by other utilities to manage reportable items. Information has been obtained from fourteen utilities on the process used to evaluate reportability and the average backlog. See item (d) below.

(c) The responsibility for root cause analyses in response to Notices of Violation has been transferred from the Compliance group (those responsible for performing reportability evaluations) to the Operating Event Analysis & Resolutions group. This has freed up resources to perform reportability evaluations.

(d) An independent assessment was performed on the Reportability Evaluation process. This evaluation looked at resources verses tasks and determined how improvements can be made in the overall process. The evaluation took into account information obtained from other utilities. The assessment was completed July 1, 1992. The evaluation recommendations are being evaluated for implementation.

Appendix A

Chronology of CAC Events

June 2, 1981	Startup Problem Report identifies the wrong recycle flow controllers have been installed (See August 7, 1991 below) (LER 91-029-1).
February 11, 1982	Design Change (PED 218-I-3923) issued to procure and install the correct ratio setpoint controller. (See August 7, 1991 below.) (LER 91-029-1)
April 1983	A system lineup test was performed on the wrong controller. The test was limited to a functional test of the wrong device. The procurement process failed to procure the correct flow control device for recycle flow control. (See August 7, 1991 below.) (LER 91-029-1)
April 1983	Design Change (PED 215-M-N002) written to move the RHR restricting orifices in the RHR return line to the suppression pool. This was later realized to precluded simultaneous operation of CAC and RHR Suppression Pool Cooling mode of operation. (See February 25, 1992 below.) (LER 92-007)
November 1983	During the CAC Preoperational Test drainage problems were experienced. Cyclic filling and draining occurred followed by blower flooding. A design change was initiated to increase the size of the loop seal to prevent flooding. (See February 25, 1992 below.) (LER 92-007).
December 1983	The Preoperational test performed on the CAC system. The test did not discover the fact that the incorrect flow control device was installed in the control room nor was the scrubber retested to determine if the draining problem was solved. (See August 7, 1991 below.) (LER 91-029-1)
February 13, 1984	An event occurred where both hydrogen recombiner fan (CAC-FN-1A/B) motors tripped on electrical overload during preoperational testing at 18 psig containment pressure (LER 84-013).

1984-1990	Routine surveillance testing was performed on the CAC system.
May 24, 1990	The CAC 'A' skid was flooded when stroke time testing was performed on the CAC drain valve, RHR-V-134A, simultaneously with the operation of RHR 'A' in the Suppression Pool Cooling mode of operation (LER 92-007).
December 8, 1990	During the CAC 'A' surveillance test, the blower oil drain plug vibrated loose causing CAC 'A" to be inoperable during four months of power operation. (See September 11, 1991 below.) (LER 91-025-1)
August 7, 1991	A contract engineer working on the setpoint evaluation program discovered the wrong instrument was installed for CAC recycle flow control (LER 91-029-1).
August 29, 1991	CAC operating procedures revised to control CAC recycle flow in the manual mode prior to plant startup. Plant operators were directed to monitor recombiner catalyst temperature and drywell pressure to maintain minimum recycle ratio (maximum recombination) (LER 91-029-1).
September 11, 1991	CAC 'A' blower found seized with oil drain plug lying at the bottom of the blower-motor assembly container (LER 91-025-1).
October 1991	The NRC Inspector noted problems with the material condition of the CAC skids (missing or loose nuts on hangers and uncertainty about the environmental qualification of CAC-PT-1A) (IR 91-44).
October 31, 1991	Reportability Evaluation completed that concluded the problem identified with the recycle flow controller on August 7, 1991 was reportable (LER 91-029-1).
November 21, 1991	A review of the surveillance procedures discovered the remote manual control of the recycle valve from the control room had never been tested. Movement of recycle valve was demonstrated (LER 91-029-1).

November 27, 1991	Further evaluation found a Safety Evaluation was not performed for the change to the CAC Operating procedures performed on August 29, 1991. The Safety Evaluation required a dedicated operator to be placed at the recombiner panel in the Control Room within six hours following a LOCA (LER 91-029-1).
December 2, 1991	Plant Management requested a Technical Assessment (SSFI) be performed on the CAC System by the Nuclear Safety Assurance Division (LER 91-029-0).
December 17, 1991	A recycle flow verification test (PPM 8.3.229TP) was performed to verify manual control on Train B. This test resulted in cyclic operation of the CAC blower which caused an undetected trip of the phase A and C overloads. (See January 23, 1992 below.) (LER 92-003).
December 20, 1991	Enforcement Conference regarding CAC system problems.
January 23, 1992	During the performance of the routine CAC preheater operability test the CAC 'B' blower failed to start due to tripped overloads (LER 92-003).
January 31, 1992	Supply System SSFI team presents preliminary concerns. Bechtel contracted to evaluate the preliminary concerns raised by the SSFI review.
February 6, 1992	Notices of Violation and Civil Penalty issued (IR 91-44).
February 6, 1992	Plant Operations Committee (POC) approved Test Procedure TP 8.3.230, CAC-HR-1B Recycle Flow Verification From Drywell, for use during Mode 1 operation. (See March 30, 1992 below.) (IR 92-03)
February 12, 1992	A review of surveillance procedures performed to show operability of the catalyst since plant startup showed three tests did not meet Technical Specification requirements for flow and temperature rise (LER 91-029-1).
February 25, 1992	WNP-2 is required to shutdown because of requirement to have the capability to operate CAC and Suppression Pool Cooling mode of RHR

	simultaneously. Operating both systems during accident conditions would result in flooding of CAC (LER 92-007).
February 25, 1992	Actual flooding of CAC 'B' occurred when a test was performed to prove CAC scrubber operation in response to an SSFI concern. The problem was traced to incorrect venting of the drain loop seal (LER 92-007).
February 27, 1992	Further evaluation showed the CAC scrubber drainage problem was also present in CAC 'A' (LER 92-007).
March 12, 1992	During functional testing of the CAC 'A' catalyst, Technical Specification temperature rise requirements were not met. Measurement of the hydrogen concentration to verify catalyst performance, as recommended by the Catalyst Consultant, met performance criteria (LER 91-029-1).
March 13, 1992	WNP-2 requested relief from the Technical Specification requirement to verify catalyst operation by measuring temperature rise.
March 15, 1992	A request was made to change the Technical Specifications to require verification of catalyst performance by measuring hydrogen concentration (LER 91-029-1).
March 15, 1992	Operating procedures were revised to require a constant 60 percent recycle flow under post LOCA conditions. This change was made in response to the SSFI concerns (PER 292-229) about the manual method being used for control the CAC system (LER 91-029-1).
March 18, 1992	CAC Operational - Plant Startup
March 30, 1992	NRC issued a Notice of Violation (NOV) for approving the use of Test Procedure 8.3.230 during power operation. Performance of the test would have been a violation of the Technical Specification limit on Primary Containment Bypass Leakage. (See February 6, 1992 above.) (IR 92-03)
May 14, 1992	CAC blower labyrinth seals were found to contain Teflon which was not environmentally qualified (LER 92-022).

May 29, 1992	Supply System Technical Memorandum TM-2022 was issued conveying the Bechtel CAC System Review report.
June 11, 1992	CAC System SSFI final report was issued.
June 24, 1992	Completed installing modified blower seals.
July 1, 1992	CAC operational following post-maintenance testing and surveillance testing.