Department of Energy
Washington, D.C. 20545

Docket No. 50-537
HQ:S:82:065

JUL 07 1982

Mr. Paul S. Check, Director
CRBR Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Check:

RESPONSES TO REQUEST FOR ADDITIONAL INFORMATION

Reference: Letter, P. S. Check to J. R. Longenecker, "CRBRP Request for Additional Information," dated April 30, 1982

This letter formally responds to your request for additional information contained in the reference letter.

Enclosed are responses to Questions CS760.6, 35, 49, 50, 113, 116, and 131; which will also be incorporated into the PSAR Amendment 69; scheduled for submittal later in July.

Sincerely,

John R. Longenecker

John R. Longenecker
Acting Director, Office of the
Clinch River Breeder Reactor
Plant Project
Office of Nuclear Energy

Enclosures

cc: Service List
Standard Distribution
Licensing Distribution

D001

Question CS760.6

"With respect to Reg. Guide 1.97, 'Instrumentation for Light Water Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident' needed by the operator to monitor and respond to accidents or postulated ocurrences, identify the system or event most closely related to each instrument; the section of the PSAR in which use of the instrument is described; the significance of the information provided by the instrument; and the basis for required accuracy, redundancy, range, and qualification."

Response

The CRBRP Project has committed to provide Accident Monitoring Instruments in accordance with Reg. Guide 1.97, Revision 2 as applied to CRBRP. This commitment is in Appendix H to the PSAR. Functional requirements and top level hardware design requirements have been established and are included in ammended Section 7.5.11 of the PSAR. Further preliminary information describing the current specifics of the Accident Monitoring design is included in this response in Table CS760.6-1. A description of the final Accident Monitoring instrumentation will be provided in the FSAR.

RESPONSE TO NRC QUESTION CS760.6

CRBRP ACCIDENT MONITORING VARIABLES
TABLE CS760.6-1

This table contains the following preliminary information describing the CRBRP Accident Monitoring design.

DEFINITION OF VARIABLE TYPES A, B, C, D, AND E

VARIABLES ASSOCIATED WITH EACH VARIABLE TYPE A, B, C, D, AND E

DESCRIPTIVE PURPOSE OF EACH VARIABLE

RANGE AND RANGE RATIONALE FOR EACH VARIABLE

INSTRUMENT LOOP ACCURACY AND RATIONAL FOR EACH VARIABLE

PSAR LOCATION WHERE EACH VARIABLE IS DISCUSSED

TYPE A MANUAL ACTIONS FOR INITIATION OF SAFETY SYSTEMS

Those variables to be monitored that provide the primary information required to permit the control room operator to take specific manually controlled actions for which no automatic control is provided and that are required for safety systems to accomplish their safety functions for Design Basis Accident events. Primary information is information that is essential for the direct accomplishment of the specified safety functions; it does not include those variables that are associated with contingency actions that may also be identified in written procedures. All Type A variables for CRBRP are indicated by design and qualification as Category I.

A.1 TITLE: Instrumentation Leading to Actuation of DHRS

A.1.A PHTS Hot Leg Temperature CATEGORY 1

PURPOSE: THE PHTS Hot Leg Temperature, together with the PHTS IHX Outlet Temperature (i.e. Cold Leg) provides the operator with information relating to shutdown heat rejection from the PHTS to the IHTS. If this temperature exceeds a predetermined value, in conjunction with a collapse of the IHX primary side ΔT, the operator will take the appropriate manual action of initiating the direct heat removal service (DHRS).

RANGE: 300°F - 1200°F

RATIONALE FOR RANGE: This range was chosen to cover the normal temperature range plus a minimum of 10% margin.

INSTRUMENT LOOP ACCURACY: ±3.1%

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This is based on the best accuracy commercially available with reliable instrumentation, and is adequate for this accident monitoring function.

LOCATION IN PSAR: SECTION 7.5.2.1.1, 7.5.3.1.2, Table 7.5-1

A.1.B IHX Outlet Temperature CATEGORY 1

PURPOSE: The IHX Outlet Temperature (i.e. Cold Leg), together with the PHTS Hot Leg Temperature provides the operator with information relating to Shutdown heat rejection from the PHTS to the IHTS. If this temperature exceeds a predetermined value, in conjunction with a collapse of the IHX primary side ΔT, the operator will take the appropriate manual action of initiating the direct heat removal service (DHRS).

RANGE: 300°F - 1200°F

RATIONALE FOR RANGE: The range was chosen to cover the normal temperature range plus a minimum of 10% margin.

INSTRUMENT LOOP ACCURACY: ±3.1%

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This is based on the best accuracy commercially available with reliable instrumentation, and is adequate for this accident monitoring function.

LOCATION IN PSAR: Section 7.5.2.1.1, 7.5.3.1.2, 7.5.11, Table 7.5-1

TYPE B: VERIFICATION THAT SAFETY FUNCTIONS ARE BEING ACCOMPLISHED

Those variables that provide information necessary to indicate whether plant safety functions are being accomplished. The variables are listed with designated ranges and category for design and qualification.

B.1 TITLE: Reactor Shutdown

B.1.A Neutron Flux CATEGORY 1

PURPOSE: The neutron flux indication provides the fastest response to reactor power level change and the most direct indication of control of reactivity in the core.

RANGE: 10^{-6}% to 100% full power

RATIONALE FOR RANGE: The instrument range is intended to encompass all neutron flux levels from reactor full power down to shutdown power level and to provide indication of any significant deviation from shutdown power level.

INSTRUMENT LOOP ACCURACY: The loop is compossed of two overlapping logarithmic ranges wherein the worst case minimum accuracy over the range from 10^{-6}% to 100% reactor power is ±3.2% of linear equivalent full scale accuracy.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The stated loop accuracy provides indication to the operator of reactor power level to better than ±50% of point over the ten decade range from reactor full power to shutdown power. This accuracy is verification adequate to fulfill the purpose of monitoring the variable, that is, indication of accomplishment of control of reactivity.

LOCATION IN PSAR: Section 7.5.1

B.1.B Primary Control Rod Position CATEGORY 3

PURPOSE: The Primary Rod "Bottom" Light which is located on the Main Control Panel illuminates when the primary rod position as measured by the Absolute Rod Position Indication (ARPI) System is less than 1.5 inches withdrawn. The illumination of all 9 "Bottom" lights signifies that all 9 primary control rods are fully inserted and shutdown has been accomplished.

RANGE: Full In or Not Full In

RATIONALE FOR RANGE: This is positive indication of rod position (Rod Bottom)

INSTRUMENT LOOP ACCURACY: The accuracy of the transducer and signal conditioning electronics is $\pm$0.2 inches. The accuracy of the rod bottom bistable which illuminates the indicating light is $\pm$0.1 inches.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Accuracy requirements have been established consistent with the capabilities of this type of measuring system. The levels will be verified to be achievable during the component tests. The maximum error of 0.3 inches is consistent with the purpose of this instrument for verification that shutdown has been accomplished.

LOCATION IN PSAR: SECTION 7.7.1.3.2

B.1.C Secondary Control Rod Position CATEGORY 3

PURPOSE: A latched indication on the Main Control Panel indicates that the secondary rod is coupled to the secondary control rod driveline. Confirmation of rod insertion following unlatching is accomplished by the operator driving the carriage downward while it contacts the top of the control assembly. Carriage position thus provides indication of rod insertion and accomplishment of the shutdown function.

RANGE: Latched or Unlatched

RATIONALE FOR RANGE: NA

INSTRUMENT LOOP ACCURACY: NA

RATIONALE FOR INSTRUMENT LOOP ACCURACY: NA

LOCATION IN PSAR: SECTION Paragraph 4.2.3.5.2.3, Scram Latch Indication System

B.2 TITLE: Core Cooling

B.2.A PHTS Hot Leg Temperature — CATEGORY 1

PURPOSE: The PHTS Hot Leg Temperature provides the operator with direct indication of reactor heat removal and core cooling. During reactor operation, and following reactor shutdown, this parameter, combined with the IHX outlet temperature, provides the ΔT across the IHX, which is a verification of PHTS heat rejection.

RANGE: 300^{o}F to 1200^{o}F

RATIONALE FOR RANGE: This range was chosen to cover the normal temperature range plus a minimum of 10% margin.

INSTRUMENT LOOP ACCURACY: $\pm$3.1%

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This is based on the best accuracy commercially available with reliable instrumentation, and is adequate for this accident monitoring function.

LOCATION IN PSAR: SECTION 7.5.2.1.1, 7.5.3.1.2, Table 7.5-1

B.2.B IHX Outlet Temperature — CATEGORY 1

PURPOSE: The IHX Outlet Temperature provides the operator with direct indication of reactor heat removal and core cooling. During reactor operation, and following reactor shutdown, this parameter, combined with the PHTS Hot Leg Temperature, provides the ΔT across the IHX, which is verification of PHTS heat rejection.

RANGE: 300^{o}F - 1200^{o}F

RATIONALE FOR RANGE: This range was chosen to cover the normal temperature range plus a minimum of 10% margin.

INSTRUMENT LOOP ACCURACY: $\pm$3.1%

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This is based on the best accuracy commercially available with reliable instrumentation, and is adequate for this accident monitoring function.

LOCATION IN PSAR: SECTION 7.5.2.1.1, 7.5.3.1.2, Table 7.5-1

B.2.C PHTS Flow — CATEGORY 3

PURPOSE: The PHTS Flow provides a direct verification of the capability to cool the reactor.

RANGE: -1500 to +6000 GPM

RATIONALE FOR RANGE: This range was chosen to cover the flow rate while operating on pony motors or on natural circulation. The reverse flow measurement covers the case of two pony motors operating and the third pony motor idle.

INSTRUMENT LOOP ACCURACY: ≤6.1%

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This is based on the state-of-the-art accuracy available for this type of instrumentation, and is adequate for this accident monitoring function.

LOCATION IN PSAR: SECTION 7.2.1.2, 7.5.2.1.1

B.2.D Core Exit Temperature CATEGORY 3

PURPOSE: The temperature of the sodium as it exits the reactor core is measured by 338 thermocouples distributed uniformly above the fuel and blanket assemblies. By the use of these thermocouples information regarding the condition of individual core assemblies may be obtained. This measurement is used for diagnosis of fuel cladding condition and in flow distribution through the core by monitoring change.

RANGE: 300°F to 1700°F

RATIONALE FOR RANGE: The instrument range, 300°F to 1700°F, includes the minimum sodium temperature which is expected during cold shutdown and the maximum temperature which is expected to occur for any accident condition. Above 1700°F the indication would not be indicative of the core or clad condition.

INSTRUMENT LOOP ACCURACY: ±11°F

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Accuracy levels have been established consistent with the capabilities of this type of measuring system which are adequate for Accident Monitoring.

LOCATION IN PSAR: SECTION 7.5.3.1.2

B.2.E Coolant Level in Reactor CATEGORY 3

PURPOSE: This instrument verifies continuing core cooling capability. The information is used to verify that the sodium level is above the level of the outlet nozzle, and that the core is covered.

RANGE: These wide range Reactor vessel level instruments measure from 6" above the operating level to 6" below the top of the outlet nozzle.

RATIONALE FOR RANGE: The level range includes the maximum sodium level which is expected for any event and the lowest level at which primary loop flow can be maintained. There is minimum margin however. Loop flow is the back up indication for level for this function.

INSTRUMENT LOOP ACCURACY: The accuracy of the instrument channel is ±5% of range or ±9.5 inches. The indicator accuracy is ±1% of range ±1.9 inches.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Accuracy levels have been established consistent with the capabilities of this type of measuring system which are adequate for accident monitoring. Loop flow is the back up for the level.

LOCATION IN PSAR: SECTION 7.5.3.1.1

B.3 TITLE: Maintaining Reactor Coolant System Integrity (Coolant Inventory)

B.3.A Coolant Level in Reactor Vessel CATEGORY 1

PURPOSE: This instrument directly measures Reactor sodium inventory and is used to verify cooling system integrity. The information is used to verify that the core is covered, that the sodium level is above the level of the outlet nozzle and that the integrity of the primary heat transport loops is maintained.

RANGE: These wide range Reactor vessel instruments measure from 6" above the operation level to 6" below the top of the outlet nozzle

RATIONALE FOR RANGE: The level range includes the maximum sodium level which is expected for any event and the lowest level at which primary loop flow can be maintained. There is minimum margin however.

INSTRUMENT LOOP ACCURACY: The accuracy of the instrument channel is ±5% of range or ±9.5 inches. The indicator accuracy is ±1% or range ±1.9 inches.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Accuracy levels have been established consistent with the capabilities of this type of measuring system, and are adequate for accident monitoring.

LOCATION IN PSAR: SECTION 7.5.3.1.1

B.3.B Sodium Leaks

B.3.B.1. Sodium Aerosols — CATEGORY 3

PURPOSE: These parameters verify that the safety function of the primary sodium-to-gas pressure boundary integrity is maintained. Absence of sodium aerosols in cells containing primary sodium components provides this verification.

RANGE: Greater than 100 grams/hour sodium leak

RATIONALE FOR RANGE: The lower end of leak detection range is established in PSAR Section 1.6 Reference 2. Requirements for leak detection to assure sodium inventory to support core cooling capability and to detect a breach of the boundary to radio-nuclide release are bounded by the 100 gram/hr threshold of detectability. The capability to detect a 100 gram/hour sodium leak is related to the amount of aerosols the leak generates, dependent on temperature, oxygen, and water concentration, etc. and the concentration in a particular cell, depending on cell size, gas recirculation rate, etc.

INSTRUMENT LOOP ACCURACY: The sensitivity of these instruments is such that they will detect aerosol concentrations greater than 5×10^{-11} grams/cc.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Instrument loop accuracy is not applicable to this function. Capability to detect sodium leaks has been demonstrated by experimental data taken from small sodium leak tests in an integrated test cell. Leak detection is provided by an alarm from one or both of two types of aerosol leak detection.

LOCATION IN PSAR: SECTION 7.5.5.11

B.3.B.2 Sodium Particulate Radioactivity — CATEGORY 3

PURPOSE: Particulate radiation monitors are used to detect radioactive sodium aerosol in the atmosphere of inerted cells containing PHTS piping in order to detect a PHTS breach.

RANGE: Greater than 100 grams/hr sodium leak

RATIONALE FOR RANGE: Range has been selected so as to detect a concentration of 10^{-16} grams/cc of Na^{24}.

INSTRUMENT LOOP ACCURACY: Accuracy will be within a factor of 2 over the entire range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Instrumentation is similar to that used on LWR, accuracy is consistent with Reg. Guide 1.97.

LOCATION IN PSAR: SECTION 11.4.2.2.6

B.4 TITLE: Maintaining Containment/Confinement Integrity

B.4.A Containment Isolation Automatic Valves Position Indication CATEGORY 2*

PURPOSE: These indications provide the operator indication that the containment automatic isolation valves have closed and that the containment isolation function is accomplished.

RANGE: Closed/Not Closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: Not applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: SECTIONS 9.5.5.1, and 7.3

*The containment isolation indication will be Class 1E.

B.4.B Annulus Pressure CATEGORY 2

PURPOSE: To monitor the containment confinement integrity, the annulus pressure which is kept sub-atmospheric is being monitored by these instruments.

RANGE: ± 15" W. G.

RATIONALE FOR RANGE: The range of these differential pressure instruments is selected based on the maximum pressure which can be created by annulus cooling fans (positive), annulus filter and pressure maintenance fans (negative).

INSTRUMENT LOOP ACCURACY: Within 2.5%

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of the instrument Loop is based on the accuracy of its individual components. Pressure differential transmitters have accuracy within ± 0.5% and the indicators ± 2.0%. So the overall accuracy of the instrument loop comes within ± 2.5%.

LOCATION IN PSAR: SECTION 7.6

TYPE C: Containment of Fission Products

Those variables that provide information to indicate the potential for, and/or the actual breach of barriers to fission product releases. The barriers are (1) fuel cladding, (2) primary coolant pressure boundary, and (3) containment.

C.1 TITLE: Fuel and/or Fission Gas-----------to be determined

C.2 TITLE: Reactor Coolant Pressure Boundary (Coolant Inventory)

C.2.A Coolant Level in Reactor Vessel CATEGORY 1

PURPOSE: This instrument verifies cooling system integrity. The information is used to verify that the integrity of the primary heat transport loops is maintained and that the sodium level is above the level of the reactor vessel outlet nozzle.

RANGE: These wide range reactor vessel level instruments measure from 6" above the operating level to 6" below the top of outlet nozzle

RATIONALE FOR RANGE: The level range includes the maximum sodium level which is expected for any event and the lowest level at which primary loop flow can be maintained. There is minimum margin however. Loop flow is the back up indication for level.

INSTRUMENT LOOP ACCURACY: The accuracy of the instrument channel is ±5% of range or ±9.5 inches. The indicator accuracy is ±1% of range or ±1.9 inches.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Accuracy requirements have been established consistent with the capabilities of this type of measuring system. Loop flow is the back up for the level.

LOCATION IN PSAR: SECTION 7.5.3.1.1

C.2.B Reactor Cover Gas CATEGORY 1

PURPOSE:

The operator uses these data channels to follow the cause of an incident which results in abnormally high cover gas pressure (i.e. greater than 1/2 psig). The operator monitors these channels to confirm the results of actions taken to limit the rise and reduce the level of the pressure. Should this pressure increase to more than 7 psig the operator uses this data to confirm that the pressure relief valves have actuated. After the incident has been brought under control, these channels provide data throughout the past-incident surveillance period.

RANGE: 0-15 psig

RATIONALE FOR RANGE: The range selected covers the full design pressure of the Reactor Vessel and provides over 100% margin beyond the value at which the pressure relief valves are set to actuate. This assures that data are available in the very unlikely event that the relief valves actuate at pressures higher than that for which they are set.

INSTRUMENT LOOP ACCURACY: 10% of Full Scale or ± 1.5 psi

RATIONALE FOR INSTRUMENT LOOP ACCURACY: These channels are designed primarily to provide indications of trends rather than to allow precise control of reactor cover gas pressure. The specified accuracy is sufficient to indicate to the operator that the relief valves have actuated prior to the reactor vessel pressure limit being approached.

LOCATION IN PSAR: To Be Provided later.

C.2.C Sodium Leaks CATEGORY 3

C.2.C.1 Sodium Aerosols

PURPOSE: These parameters verify that the safety function of the primary sodium-to-gas pressure boundary integrity is maintained. Absence of sodium aerosols in cells containing primary sodium components provides this verification.

RANGE: Greater than 100 grams/hour sodium leak

RATIONALE FOR RANGE: The lower end of leak detection range is established in PSAR Section 1.6 Reference 2. Requirements for leak detection to assure sodium inventory to support core cooling capability and to detect a breach of the boundary to radionuclide release are bounded by the 100 grams/hour threshold of detectability. The capability to detect a 100 grams/hour sodium leak is related to the amount of aerosols the leak generates, dependent on temperature,

oxygen, and water concentration, etc. and the concentration in a particular cell, depending on cell size, gas recirculation rate, etc.

INSTRUMENT LOOP ACCURACY: The sensitivity of these instruments is such that they will detect aerosol concentrations greater than 5×10^{-11} grams/cc.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Instrument loop accuracy is not applicable to this function. Capability to detect sodium leaks has been demonstrated by experimental data taken from small sodium leak tests in an integrated test cell. Leak detection is provided by an alarm from one or both of two types of aerosol leak detection.

LOCATION IN PSAR: SECTION 7.5.5.11

C.2.C.2 Sodium Particulate Radioactivity CATEGORY 3

PURPOSE: Particulate radiation monitors are used to detect radioactive sodium aerosol in the atmosphere of inerted cells containing PHTS piping in order to detect a PHTS breach.

RANGE: Greater than 100 grams/hour sodium leak

RATIONALE FOR RANGE: Range has been selected so as to detect a concentration of 10^{-16} grams/cc of Na^{24}.

INSTRUMENT LOOP ACCURACY: Accuracy will be within a factor of 2 over the entire range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Instrumentation is similar to that used on LWR, accuracy is consistent with Reg. Guide 1.97.

LOCATION IN PSAR: SECTION 11.4.2.2.6

C.2.D Overflow Vessel Level CATEGORY 3

PURPOSE: This parameter verifies that the safety function of the primary sodium boundary integrity is maintained. The overflow vessel serves as an expansion tank for the primary sodium system. A loss of sodium anywhere in the reactor vessel or PHTS loop would be reflected by low sodium level in this overflow vessel.

RANGE: 0.5 - 17 feet

RATIONALE FOR RANGE: The range of this instrument is based on the depth of the overflow vessel.

INSTRUMENT LOOP ACCURACY: +/-5% full range with a repeatability of +/-2.5% full range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The state-of-the-art capability of hardware has been employed, and these accuracies are satisfactory to allow the operator to detect a significant loss of sodium inventory.

LOCATION IN PSAR: SECTION 7.6.3.1

C.3 TITLE: Containments

C.3.A Containment Pressure — CATEGORY 1

PURPOSE: This parameter provides indication in the Control Room of the pressure inside the containment above the operating floor and is used to indicate potential for a breach of containment integrity.

RANGE: To 40 psig

RATIONALE FOR RANGE: Consistent with RG 1.97 the instrument range was chosen to include significant margin over design pressure (15 psig) of the containment.

INSTRUMENT LOOP ACCURACY: ±2 psig

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The instrument loop accuracy supports determination of potential or breach of containment integrity.

LOCATION IN PSAR: SECTION 7.5.9

C.3.B Containment Temperature (Bulk Atmosphere) — CATEGORY 1

PURPOSE: This parameter provides indication in the Control Room of the atmospheric temperature inside the containment building and is used to indicate challenges to containment integrity.

RANGE: 0 - 300°F

RATIONALE FOR RANGE: The instrument range was chosen to cover maximum containment design temperature plus margin.

INSTRUMENT LOOP ACCURACY: ±50°F

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The instrument loop accuracy adequately meets accident monitoring requirements allowing the operator to determine challenges to containment integrity.

LOCATION IN PSAR: SECTION 7.5.10

C.3.C <u>Containment Effluent Radioactivity - Noble Gases from Identified Release Points (i.e. discharge to atmosphere from the containment cleanup and annulus filtration system)</u> CATEGORY 2

PURPOSE: Monitoring of the containment effluent will verify that the containment cleanup and annulus filter systems are performing their requred functions.

RANGE: 10^{-6} μCi/cc to 10^{-2} μCi/cc

RATIONALE FOR RANGE: The lower range approaches the lowest sensitivities commercially available. Upper range is 4 decades above lower.

INSTRUMENT LOOP ACCURACY: Accuracy will be within a factor of 2 over the entire range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Instrumentation is similar to that used on LWR, accuracy is consistent with Reg. Guide 1.97.

LOCATION IN PSAR: SECTION 11.3

C.3.D <u>Radiation Exposure Rate (inside buildings or areas, e.g. auxiliary buildings, annulus, SGB which are in direct contact with primary containment where penetrations and hatches are located)</u> CATEGORY 2

PURPOSE: Monitoring of penetrations and hatches will detect a breach of containment at the penetration or hatch.

RANGE: 10^{-1} R/hr to 10^{4} R/hr

RATIONALE FOR RANGE:

1. Since source term for CRBR is similar to LWR, range is similar to LWR for similar instruments and is consistent with Reg. Guide 1.97.
2. Standard commercially available range.

INSTRUMENT LOOP ACCURACY: Accuracy will be within a factor of 2 over the entire range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Instrumentation is similar to that used on LWR, accuracy is consistent with Reg. Guide 1.97.

LOCATION IN PSAR: SECTION 12.1

C.3.E Effluent Radioactivity - Noble Gases (from buildings as indicated in C.3.D above) CATEGORY 2

PURPOSE: Indication of breach of containment at the penetration by detecting noble gases in building in direct contact with containment.

RANGE: $10^{-6}\mu$Ci/cc to $10^{-3}\mu$Ci/cc

RATIONALE FOR RANGE: Since source term for CRBR is similar to LWR, range is similar to LWR for similar instruments and consistent with Reg. Guide 1.97.

INSTRUMENT LOOP ACCURACY: Accuracy will be within a factor of 2 over the entire range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Instrumentation is similar to that used on LWR, accuracy is consistent with Reg. Guide 1.97.

LOCATION IN PSAR: SECTION 11.3.3.3

TYPE D: Verification of Safety System Operation

Those variables that provide information to indicate the operation of individual safety systems and other systems important to safety. These variables are to help the operator make appropriate decisions in using the individual systems important to safety in mitigating the consequences of an accident.

D.1 TITLE: Decay Heat Removal

D.1.A SGHRS

D.1.A.1 PWST Level CATEGORY 1

PURPOSE: The PWST level instrumentation provides the operator with a reading of water inventory in the PWST. Alarms are provided to alert the operator to low level conditions and allow him to take corrective actions. Minimum level will be required for plant operation to provide adequate emergency supply. The PWST is the primary source of auxiliary feedwater to the SGAHRS. The set point for minimum PWST inventory corresponds to the PWST water inventory required to complete the 30 day decay heat removal mission. If the water inventory were allowed to fall below the minimum allowable level during normal plant operation, sufficient water inventory for the full 30 day decay heat removal mission may not be available.

RANGE: 0-162.5"

RATIONALE FOR RANGE: This covers all possible water levels in the tank corresponding to the internal diameter of the PWST and envelopes the low level setpoint of significance to plant safety.

INSTRUMENT LOOP ACCURACY: ±1.6 inches (±1%)

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This accuracy is consistent with commerically available level instrumentation, and exceeds that required for the operator to determine if the plant has adequate auxiliary feed water inventory.

LOCATION IN PSAR: To be provided later.

D.1.A.2.A AFW Flow (Turbine Driven Pump) CATEGORY 2

PURPOSE: This parameter provides indication that the auxiliary feedwater flow is being controlled to permit the SGAHRS to complete its heat removal mission.

RANGE: 0-300,000 lbm/hr

RATIONALE FOR RANGE: The instrument range was chosen to cover the full range of flow conditions with a 25,000 lbm/hour margin.

INSTRUMENT LOOP ACCURACY: 2.8×10^3 lbm/hour (±1%)

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This instrument loop accuracy is more than adequate for monitoring system performance.

LOCATION IN PSAR: To be provided later.

D.1.A.2.B AFW Flow (Motor Driven Pumps) CATEGORY 2

PURPOSE: This parameter provides indication that the auxiliary feedwater flow is being controlled to permit the SGAHRS to complete its heat removal mission.

RANGE: 0-300,000 lbm/hr

RATIONALE FOR RANGE: This instrument range was chose to cover the full range of flow conditions with a 25,000 lbm/hour margin.

INSTRUMENT LOOP ACCURACY: 2.8×10^3 lbm/hour (±1%)

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This instrument loop accuracy is more than adequate for monitoring system performance.

LOCATION IN PSAR: To be provided later.

D.1.A.3 Steam Drum Level CATEGORY 2

PURPOSE: This water level position indication will allow the operator to verify the proper controlled operation of the auxiliary feedwater supply subsystem.

RANGE: -21 to +16"

RATIONALE FOR RANGE: This range covers all trip levels and control setpoints with at least 3 inches margin.

INSTRUMENT LOOP ACCURACY: 0±.5 inches (±1.35%)

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This accuracy is sufficient for the steam drum level control for PPS functions and is more than adequate for monitoring purposes.

LOCATION IN PSAR: SECTION 7.5.2.1.3, Table 7.5-1

D.1.A.4 Steam Drum Pressure CATEGORY 2

PURPOSE: The steam drum pressure is monitored to indicate proper operation of the Protected Air Cooled Condenser (PACC) and the vent valves, during decay heat removal operation. Control of saturated drum pressure determines the heat sink temperature of the IHTS.

RANGE: 0-2500 psig

RATIONALE FOR RANGE: This range was chosen to cover the maximum design pressure plus a 10% margin.

INSTRUMENT LOOP ACCURACY: ±20 psig (±0.8%)

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This instrument loop accuracy is consistent with the capability of commercially available equipment and was established to provide sufficient accuracy for PACC and venting control. It is more than adequate for monitoring purposes.

LOCATION IN PSAR: SECTION 7.5.11, Table 7.5-1

D.1.A.5 Pump Discharge Pressure CATEGORY 3

PURPOSE: The AFW pump discharge pressure, along with the pump inlet pressure, provides the operator with an indication of pump performance.
RANGE: 0-2200 psig

RATIONALE FOR RANGE: This range covers the full range of expected pump outlet pressures plus a 160 psi margin.

INSTRUMENT LOOP ACCURACY: ±22 psig (±1%)

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The instrument accuracy is required for system performance and is more than adequate for the monitoring function.

LOCATION IN PSAR: To be provided later.

D.1.A.6 Vent Valves, Steam Drum Superheater CATEGORY 3

PURPOSE: The actual position of the vent valves will indicate proper operation of these valves to control steam drum pressure soon after shutdown. Later when the heat load has decreased, PACCS will control steam drum pressure and the valves are required to close. The indication then indicates that the valves are closed.

RANGE: Open/closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: Not applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: To be provided later.

D.1.A.7 Safety valves, (Steam Drum, Superheater, Evaporator) CATEGORY 3

PURPOSE: This valve position indication will allow the operator to verify the relay valves are closed (in normal operation and following the initial stage of SGAHRS operation) to prevent loss of water inventory.

RANGE: Open/Closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: Not applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: To be provided later.

D.1.A.8 Superheater Steam Outlet Isolation Valve CATEGORY 3

PURPOSE: This direct valve position indication will allow the operator to verify this valve is open or closed as required for each particular mode of plant operation.

RANGE: Open/Closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: Not applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: SECTION 7.5, Figure 7.5-6

D.1.A.9 Feedwater Isolation Valves CATEGORY 3

PURPOSE: This valve position indication will allow the operator to verify that these valves are closed or open as required by the plant operating mode.

RANGE: Open/Closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: Not applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: SECTION 7.5, Figure 7.5-6

D.1.A.10 PACC Outlet Water Flow CATEGORY 3

PURPOSE: The PACC outlet flowmeters are used in conjunction with temperature and pressure measurements to provide indication of PACC performance.

RANGE: 0-100,000 lb/hour

RATIONALE FOR RANGE: This range was established to cover all possible flows with a margin of 10,500 lbm/hour above the expected flow levels.

INSTRUMENT LOOP ACCURACY: ±1500 lbm/hour (±1.5%)

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This accuracy is adequate for PACC control and is more than adequate for monitoring PACC performance.

LOCATION IN PSAR: To be provided later.

D.1.A.11 <u>PACC Non-Condensible Vent Valve Position</u> CATEGORY 3

<u>PURPOSE</u>: The direct position indication of the vent valves will allow the operator to verify that valves are open or closed as required by the specific mode of plant operation.

<u>RANGE</u>: Open/Closed

<u>RATIONALE FOR RANGE</u>: Not applicable

<u>INSTRUMENT LOOP ACCURACY</u>: Not applicable

<u>RATIONALE FOR INSTRUMENT LOOP ACCURACY</u>: Not applicable

<u>LOCATION IN PSAR</u>: To be provided later.

D.1.A.12 <u>Evap. (West) Inlet Iso. Valve</u> CATEGORY 3

<u>PURPOSE</u>: This valve position indication provides information to allow the operator to verify the valve is open or closed as required by the specific plant operating mode.

<u>RANGE</u>: Open/Closed

<u>RATIONALE FOR RANGE</u>: Not applicable

<u>INSTRUMENT LOOP ACCURACY</u>: Not applicable

<u>RATIONALE FOR INSTRUMENT LOOP ACCURACY</u>: Not applicable

<u>LOCATION IN PSAR</u>: To be provided later.

D.1.A.13 <u>Evap. (East) Inlet Iso. Valve</u> CATEGORY 3

<u>PURPOSE</u>: This valve position indication provides information to allow the operator to verify that the valve is open or closed as required for the specific operating mode of the plant.

<u>RANGE</u>: Open/Closed

<u>RATIONALE FOR RANGE</u>: Not applicable

<u>INSTRUMENT LOOP ACCURACY</u>: Not applicable

<u>RATIONALE FOR INSTRUMENT LOOP ACCURACY</u>: Not applicable

<u>LOCATION IN PSAR</u>: To be provided later.

D.1.A.14 Recirculation Pump Isolation Valve CATEGORY 3

PURPOSE: This valve position indicator will allow the operator to verify this valve is either open or closed as required by the specific system operating mode.

RANGE: Open/Closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: Not applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: SECTION 7.5.2.1.3

D.1.A.15 Recirc. Pump Discharge Pressure CATEGORY 3

PURPOSE: This pump pressure indication will allow the operator to verify the performance of the recirculation pump to ensure the ability of the steam generator system to remove heat.

RANGE: 0-2700 psig

RATIONAL FOR RANGE: This range covers the full range of operating pressures as well as a 10% margin above design pressure.

INSTRUMENT LOOP ACCURACY: ±27 psig (±1%)

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy is within capabilities of commercially available instrumentation and exceeds that required to allow the operator to determine recirculation pump performance.

LOCATION IN PSAR: To be provided later.

D.1.A.16 Steam Drum Drain Valve Position CATEGORY 3

PURPOSE: This valve position indication will allow the operator to verify these valves are open or closed as required by the specific plant operating condition.

RANGE: Open/Closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: Not applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: SECTION 7.5.2.1.3 and Fig. 7.5.6

D.1.A.17 Recirc. Pump Bypass Valves Position CATEGC :Y 3

PURPOSE: This valve position indication will allow the operator to verify these valves are either closed or open as required by the specific system operating mode.

RANGE: Open/Closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: Not applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: SECTION 7.5, Figure 7.5-6

D.1.A.18 Superheater Bypass Valves CATEGORY 3

PURPOSE: This valve position indication will allow the operator to verify this valve is closed or open as required for the specific system operation mode.

RANGE: Open/Closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: Not applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: To be provided later.

D.1.A.19 Superheater Inlet Isolation Valve CATEGORY 3

PURPOSE: This valve position indication will allow the operator to verify this valve is open or closed as required for the specific system operating mode.

RANGE: Open/Closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: Not applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: SECTION 7.5.6.1.2, Figure 7.5-6

D.1.B HTS Loops

D.1.B.1 Pony Motor Speed PHTS — CATEGORY 3

PURPOSE: This parameter verifies that a portion of the heat removal train is operating. The PHTS Pony Motor is used to maintain forced convection in the PHTS during the shutdown heat removal mission.

RANGE: 0-120 rpm

RATIONALE FOR RANGE: The pony motor operates in one of six discrete speeds on a "selection" basis, the highest of which is 115 rpm.

INSTRUMENT LOOP ACCURACY: ±4 rpm (±3% of the 120 rpm span)

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The selection of this accuracy is based on the state-of-the-art capability for the equipment and is adequate for monitoring pump operation.

LOCATION IN PSAR: SECTION 7.5.2.1.2, Table 7.5-1

D.1.B.2 Pony Motor Speed IHTS — CATEGORY 3

PURPOSE: This parameter verifies that a portion of the heat removal train is operating. The IHTS Pony Motor is used to maintain forced convection in the IHTS during the shutdown heat removal mission.

RANGE: 0-120 rpm

RATIONALE FOR RANGE: The pony motor operates in one of six discrete speeds on a "selection" basis, the highest of which is 115 rpm.

INSTRUMENT LOOP ACCURACY: ±4 rpm (±3% of the 120 rpm span)

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The selection of this accuracy is based on the state-of-the-art capability for the equipment and is adequate for monitoring pump operation.

LOCATION IN PSAR: SECTION 7.5.2.1.2, Table 7.5-1

D.1.B.3 IHTS IHX Na Outlet Temperature — CATEGORY 3

PURPOSE: The IHX outlet temperature provides the operator with direct indication of reactor heat removal and verifies core cooling. During reactor operation and following reactor shutdown this parameter, combined with the PHTS hot leg temperature, provides the T across the IHX, this ΔT is an indication of PHTS heat rejection.

RANGE: 300° - 1100°F

RATIONALE FOR RANGE: This range was selected to provide capability to monitor all anticipated normal and off-normal conditions with margin.

INSTRUMENT LOOP ACCURACY: ± 3.1%

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This is based on the highest accuracy commercially available with reliable instrumentation and is adequate for accident monitoring.

LOCATION IN PSAR: SECTION 7.5.2.1.1, 7.5.3.1.2, Table 7.5-1

D.1.B.4 Evaporator Na Outlet Temperature CATEGORY 3

PURPOSE: This temperature indication verifies to the operator heat rejection through the steam generator system.

RANGE: 300° - 800°F

RATIONALE FOR RANGE: This range was chosen to monitor the full range of anticipated temperatures.

INSTRUMENT LOOP ACCURACY: ±10°F (2% of span)

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This accuracy was chosen to meet the needs of the Plant Protection System and is adequate for accident monitoring.

LOCATION IN PSAR: SECTION 7.5.2.1.1, Table 7.5-1

D.1.B.5 PHTS Flow CATEGORY 3

PURPOSE: The PHTS flow provides a direct verification of the capability to cool the reactor.

RANGE: -1500 TO +6000 GPM

RATIONALE FOR RANGE: This range was chosen to cover the flow rate while operating on pony motors or natural circulation. The reverse flow measurement covers the use of 2 pony motors operating and the 3rd pump idle.

INSTRUMENT LOOP ACCURACY: ≤6.1%

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This is based on the state-of-the-art accuracy available for this type of instrumentation, and is adequate for this accident monitoring function.

LOCATION IN PSAR: SECTION 7.2.1.2, 7.5.2.1.1

D.1.B.6 IHTS Flow CATEGORY 3

PURPOSE: This information provides verification of IHTS operation and accordingly capability to cool the reactor.

RANGE: 0 to +6000 gpm

RATIONALE FOR RANGE: This range was chosen to cover the flow rates while operating on pony motors or on natural circulation.

INSTRUMENT LOOP ACCURACY: ± 7% of span

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This accuracy is based on the state-of-the-art accuracy available for this type of instrument and is adequate for monitoring IHTS flow.

LOCATION IN PSAR: SECTION 7.5.2.1.1 and Table 7.5.1

D.2 TITLE: Direct Heat Removal Service (DHRS)/EVST Cooling

D.2.A OHX Sodium Outlet Temperature CATEGORY 3

PURPOSE: This parameter verifies that the direct heat removal service (DHRS) is functioning properly, i.e. that the sodium returning to the reactor has been cooled.

RANGE: 32-1200°F

RATIONALE FOR RANGE: This range is based on the maximum temperature expected plus a minimum of 10% margin.

INSTRUMENT LOOP ACCURACY: ±1% of full range

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This accuracy is based on that of commerical grade instrumentation and is satisfactory for accident monitoring purposes.

LOCATION IN PSAR: SECTION 7.6.3.1

D.2.B Overflow Vessel Level CATEGORY 3

PURPOSE: This parameter verifies sufficiency sodium inventory which is necessary for the continuing availability of DHRS.

RANGE: 0.5-17ft

RATIONALE FOR RANGE: The range of this instrument is based on the depth of the overflow vessel.

INSTRUMENT LOOP ACCURACY: ±5% full range

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This is the best accuracy attainable with state-of-the-art instrumentation and is adequate for accident monitoring.

LOCATION IN PSAR: SECTION 7.6.3.1

D.2.C Reactor Overflow Temperature CATEGORY 3

PURPOSE: This parameter verifies that the direct heat removal service (DHRS) is functioning properly, i.e. that heat energy is being removed from the reactor.

RANGE: 32-1500°F

RATIONALE FOR RANGE: The range of this instrument is based on the maximum temperature expected plus a minimum of 10% margin.

INSTRUMENT LOOP ACCURACY: ±1% of full range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This accuracy is based on that of commerical grade instrumentation and is satisfactory for accident monitoring purposes.

LOCATION IN PSAR: SECTION 7.6.3.1

D.2.D Primary Makeup Flow CATEGORY 3

PURPOSE: Verify that the direct heat removal service (DHRS) is functioning properly, i.e. that the sodium makeup pumps are providing the required flow.

RANGE: 0-500 gpm

RATIONALE FOR RANGE: This range is based on the maximum flow expected plus a minimum of 10% margin.

INSTRUMENT LOOP ACCURACY: ±3% of full range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Ths accuracy is based on that of commerical grade instrumentation and is satisfactory for accident monitoring purposes.

LOCATION IN PSAR: SECTION 7.6.3.1

D.2.E OHX NaK Outlet Temperature CATEGORY 3

PURPOSE: This parameter verifies that the direct heat removal service (DHRS) is functioning properly, i.e. that NaK returning from the ABHX has been cooled.

RANGE: 32-1200°F

RATIONALE FOR RANGE: This range is based on the maximum temperatures expected plus a minimum of 10% margin.

INSTRUMENT LOOP ACCURACY: ±1% of full range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This accuracy is based on that of commerical grade instrumentation and is satisfactory for accident monitoring purposes.

LOCATION IN PSAR: SECTION 7.6.3.1

D.2.F OHX NaK inlet Temperature CATEGORY 3

PURPOSE: This parameter verifies that the direct heat removal service (DHRS) is functioning properly, i.e. that NaK returning from the OHX is transferring heat from the primary sodium makeup loop.

RANGE: 32-1200°F

RATIONALE FOR RANGE: This range is based on the maximum temperature expected plus a minimum of 10% margin.

INSTRUMENT LOOP ACCURACY: ±1% of full range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This accuracy is based on that of commerical grade instrumentation and is satisfactory for accident monitoring purposes.

LOCATION IN PSAR: SECTION 7.6.3.1

D.2.G OHX NaK Flow CATEGORY 3

PURPOSE: This instrumentation verifies that the direct heat removal service (DHRS) is functioning properly, i.e. that the EVST NaK pumps are providing the required flow.

RANGE: 0-500 gpm

RATIONALE FOR RANGE: This range is based on the maximum flow expected plus a minimum of 10% margin.

INSTRUMENT LOOP ACCURACY: ±3% of full range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This accuracy is based on that of commerical grade instrumentation and is satisfactory for accident monitoring purposes.

LOCATION IN PSAR: SECTION 7.6.3.1

D.2.H EVST Outlet Temperature CATEGORY 2

PURPOSE: This parameter verifies that the EVST direct heat removal service is functioning properly, i.e. that EVST design temperatures are not exceeded and to record the same.

RANGE: 32-1200°F

RATIONALE FOR RANGE: This range is based on the maximum temperature expected plus a minimum of 10% margin.

INSTRUMENT LOOP ACCURACY: ±1% of full range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This accuracy is based on that of commerical grade instrumentation and is satisfactory for accident monitoring purposes.

LOCATION IN PSAR: SECTION 7.6.3.1

D.2.I EVST Level CATEGORY 3

PURPOSE: This parameter verifies that the sodium is at a safe level (fuel is covered and sodium nozzles are covered enabling forced or natural convection in the EVST cooling system to remove decay heat).

RANGE: 25-37 ft

RATIONALE FOR RANGE: The rationale is based on the need to measure from the lowest sodium level in the EVST (corresponding to EVST leak into guard vessel) to the highest safe level plus a minimum of 10% margin.

INSTRUMENT LOOP ACCURACY: ±5% of full range

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This accuracy is based on state-of-the-art instrumentation and is satisfactory for accident monitoring purposes.

LOCATION IN PSAR: SECTION 7.6.3.1

D.2.J EVST Na Flow CATEGORY 2

PURPOSE: This parameter verifies that the EVST direct heat removal service is functioning properly, i.e. that the EVST Na pumps are providing the required flow to the Na/NaK cooler.

RANGE: 0-500 GPM

RATIONALE FOR RANGE: This range is based on the maximum flow expected plus a minimum of 10% margin.

INSTRUMENT LOOP ACCURACY: ±3% of full range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: This accuracy is based on that of commercial grade instrumentation and is satisfactory for accident monitoring purposes.

LOCATION IN PSAR: SECTION 7.6.3.1

D.2.K Reactor Vessel Level CATEGORY 3

PURPOSE: This instrument verifies sodium inventory in the reactor vessel which is necessary for continuing availabilit· of DHRS.

RANGE: These wide range reactor vessel instruments measure from 6" above operating level to 6" below the top of the outlet nozzle.

RATIONALE FOR RANGE: The level range includes the maximum sodium level which is expected for any event and the lowest level at which primary loop flow can be maintained.

INSTRUMENT LOOP ACCURACY: The accuracy of the instrument channel is ±5% of range or ±9.5 inches. The indicator accuracy is ±1% of range or ±1.9 inches.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Accuracy requirements have been established consistent with the capabilities of this type of measuring system. Loop flow is the back up for the level.

LOCATION IN PSAR: SECTION 7.5.3.1.1 (to be revised to address the above).

D.2.L Sodium Side Valve Indication

D.2.L.1 Cold Trap Isolation (81-PP-HV-109) CATEGORY 3

PURPOSE: This indication provides information with respect to this valve being open or closed. Its purpose is to verify that the direct heat removal service (DHRS) system is functioning properly, i.e. that this valve is aligned as required to enable the proper coolant flow.

RANGE: Open/Closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: Not applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: SECTION 7.6.3.1

D.2.L.2 OHX Bypass (82-PP-HV-102) CATEGORY 3

PURPOSE: This information provides indication with respect to the valve being open or closed. Its purpose is to verify that the direct heat removal service (DHRS) system is functioning properly, i.e. that this valve is aligned as required to enable the proper coolant flow.

RANGE: Open/Closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: Not applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: SECTION 7.6.3.1

D.2.L.3 OHX Inlet Valve (81-PP-HV-103) CATEGORY 3

PURPOSE: This information provides indication with respect to the valve being open or closed. Its purpose is to verify that the direct heat removal service (DHRS) system is functioning properly, i.e. that this valve is aligned as required to enable the proper coolant flow.

RANGE: Open/Closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: Not applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: SECTION 7.6.3.1

D.2.M NaK Side Valve Indication

D.2.M.1 EVST/DHRS Crossover Valve (82-EPHV-415) CATEGORY 3

PURPOSE: This provides indication of the valve being open or closed. Its purpose is to verify that the direct heat removal service (DHRS) system is able to function properly, i.e. that this valve is aligned as required to enable the proper coolant flow.

RANGE: Open/Closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: Not applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: SECTION 7.6.3.1

D.2.M.2 EVST/DHRS Crossover Valve (81-EPHV-416) CATEGORY 3

PURPOSE: This provides indication of the valve being open or closed. Its purpose is to verify that the direct heat removal service (DHRS) system is able to function properly, i.e. that this valve is aligned as required to enable the proper coolant flow.

RANGE: Open/Closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: Not applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: SECTION 7.6.3.1

D.2.M.3 EVST/DHRS Crossover Valve (81-EPHV-357) CATEGORY 3

PURPOSE: This provides indication of the valve being open or closed. Its purpose is to verify that the direct heat removal service (DHRS) system is able to function properly, i.e. that this valve is aligned as required to enable the proper coolant flow.

RANGE: Open/Closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: Not applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: SECTION 7.6.3.1

D.2.M.4 EVST/DHRS Crossover Valve (81-EPHV-358) CATEGORY 3

PURPOSE: This provides indication of the valve being open or closed. Its purpose is to verify that the direct heat removal service (DHRS) system is able to function properly, i.e. that this valve is aligned as required to enable the proper coolant flow.

RANGE: Open/Closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: Not applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: SECTION 7.6.3.1

D.2.M.5 EVST/DHRS Crossover Valve (81-EPHV-359) CATEGORY 3

PURPOSE: This provides indication of the valve being open or closed. Its purpose is to verify that the direct heat removal service (DHRS) system is able to function properly, i.e. that this valve is aligned as required to enable the proper coolant flow.

RANGE: Open/Closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: Not applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: SECTION 7.6.3.1

D.2.M.6 EVST/DHRS Crossover Valve (81-EPHV-420) CATEGORY 3

PURPOSE: This provides indication of the valve being open or closed. Its purpose is to verify that the direct heat removal service (DHRS) system is able to function properly, i.e. that this valve is aligned as required to enable the proper coolant flow.

RANGE: Open/Closed

RATIONALE FOR RANGE: Not applicable

INSTRUMENT LOOP ACCURACY: N ' applicable

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Not applicable

LOCATION IN PSAR: SECTION 7.6.3.1

D.3 TITLE: Cooling Water System

D.3.A Emergency Chilled Water Temperature CATEGORY 2

PURPOSE: Indication of the Emerg. Chilled Water Chiller inlet & outlet temps. is necessary for evaluation of ECW chillers performance, efficiency & ability to fulfill plant heat removal requirements; Low efficiency of ECW Chillers will impair the operation of Emerg. Recirc. Gas Cooling system, Fuel Handling System, Emerg. HVAC System & certain Radiation Monitoring equipment.

RANGE: 30°F to 80°F

RATIONALE FOR RANGE: The instrument range of 30°-80°F is provided on the basis of normal (42°F) and high (65°F) operating conditions and 25% downscale and upscale margin.

INSTRUMENT LOOP ACCURACY: Accuracy of the loop is within ±6% of the 50°F span.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of the loop is based on the accuracy of its individual market available components. The loop consists of thermocouple (a_1=±3.5% for 50°F span) temperature transmitter (a_2=±0.5%) and panel electronic temperature indicator (a_3=±2%).

LOCATION IN PSAR: SECTION 9.7.2 - Emergency Chilled Water System (being rewritten)

D.3.B Emergency Chilled Water Pressure CATEGORY 2

PURPOSE: Indication of the Emerg. Chilled Water Chiller discharge pressure is necessary for evaluation of ECW circ. pumps' performance, system piping tightness & pressure operating conditions. The low discharge pressure will indicate ECW pump or piping failure, & will impair the ability of Emerg. Chilled Water System for plant heat removal.

RANGE: 0-220 psig

RATIONALE FOR RANGE: The instrument range of 0-220 psig is provided on the basis of ECW chiller discharge pressure normal (110 psig) and high (180 psig) operating conditions, and 20% upscale margin.

INSTRUMENT LOOP ACCURACY: The accuracy of the loop is within ±2.5% of 220 psig span.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of the loop is based on the accuracy of its market available components. The loop consists of electronic pressure transmitter (a_1=±0.5%) and panel electronic pressure indicator (a_2=2%).

LOCATION IN PSAR: SECTION 9.7.2 - Emergency Chilled Water System

D.3.C Emergency Chilled Water Flow CATEGORY 2

PURPOSE: Indication of Emerg. Chilled Water flow thru chillers is necessary for the evaluation of ECW Circ. Pumps' performance and system flow operating conditions. The low flow of Emerg. Chilled Water will trip Emerg. Chiller & disable the ECW System which is required for plant heat removal operation.

RANGE: 0-2000 gpm

RATIONALE FOR RANGE: The instrument range of 0-2000 gpm is provided on the basis of normal (1250 gpm) and high (1600) flow operating conditions and approximately 20% upscale margin.

INSTRUMENT LOOP ACCURACY: Accuracy of the loop is within ±3.5% of the 2000 gpm span.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of the loop is based on the accuracy of its individual market available components. The loop consists of orifice with flange taps (a_1=±0.5%) electronic flow transmitter (a_2=0.5%) and panel electronic flow indicator (a_3=±2%).

LOCATION IN PSAR: SECTION 9.7.2 - Emergency Chilled Water System (being rewritten).

D.3.D Emergency Chilled Water Recir. Pump Status CATEGORY 3

PURPOSE: Emergency Chilled Water System pump status is used for assessing operation of Emergency Recirculation Gas Cooling Systems, Fuel Handling Systems, Emergency HVAC Systems, and certain Radiation Monitoring equipment.

RANGE: Run/Not Run

RATIONALE FOR RANGE: N/A

INSTRUMENT LOOP ACCURACY: N/A

RATIONALE FOR INSTRUMENT LOOP ACCURACY: N/A

LOCATION IN PSAR: To be provided later.

D.3.E Emergency Chiller Status CATEGORY 3

PURPOSE: Emergency Chilled Water System chiller status indicates operation of Emergency Recirculation Gas Cooling Systems, Fuel Handling Systems, Emergency HVAC Systems, and certain Radiation Monitoring equipment.

RANGE: Run/Not Run

RATIONALE FOR RANGE: N/A

INSTRUMENT LOOP ACCURACY: N/A

RATIONALE FOR INSTRUMENT LOOP ACCURACY: N/A

LOCATION IN PSAR: To be provided later.

D.3.F Emergency Chilled Water Exp. Tank Level CATEGORY 3

PURPOSE: Indication of Emergency Chilled Water Expansion Tank level allows proper evaluation of systems operating and leakage conditions. ECW Expansion Tank Low-Low Level signal trips ECW Recirculation Pump and disables Emergency Chilled Water System impairing plant heat removal operation.

RANGE: 0-100 inches.

RATIONALE FOR RANGE: The instrument range 0-100" is provided on the basis of ECW Expansion Tank height.

INSTRUMENT LOOP ACCURACY: The accuracy of the loop is within ±2.5% of the span.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of the loop is based on the accuracy of its individual market available components. The loop consists of the electronic level transmitter ($a_1 = \pm 0.5\%$) and panel electronic level indicator ($a_2 = \pm 2\%$).

LOCATION IN PSAR: SECTION 9.7.2 - Emergency Chilled Water System (being rewritten)

D.3.G Expansion Tank Isolation Valve Position CATEGORY 3

PURPOSE: Emergency Chilled Water System expansion status indicates operation of Emergency Recirculation Gas Cooling Systems, Fuel Handling Systems, Emergency HVAC Systems, and certain Radiation Monitoring equipment.

RANGE: Open/Not Open

RATIONALE FOR RANGE: N/A

INSTRUMENT LOOP ACCURACY: N/A

RATIONALE FOR INSTRUMENT LOOP ACCURACY: N/A

LOCATION IN PSAR: To be provided later.

D.3.H Emergency Plant Service Water Supply Temperature CATEGORY 2

PURPOSE: Indication of Emergency Plant Service Water supply header temperature is used for evaluation of Emergency Water Cooling System heat removal capabilities.

RANGE: 30-130°F

RATIONALE FOR RANGE: The instrument range of 30-130°F is provided on the basis of normal (90°F), low (45°F) high (110°F), operating conditions and 20% upscale and downscale margin.

INSTRUMENT LOOP ACCURACY: The accuracy of the loop is within ±4.3% of 100°F span.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of the loop is based on the accuracy of its individual market available components. The loop consists of thermocouple ($a_1=\pm1.8\%$ of 100%F span), electronic temperature transmitter ($a_2=\pm0.5\%$) and panel electronic indicator (±2%).

LOCATION IN PSAR: SECTION 9.9.2 - Emergency Plant Service Water System

D.3.I Emergency Plant Service Water Flow CATEGORY 2

PURPOSE: Indication of Emergency Plant Service Water flow through the chillers is used for evaluation of Emergency Chilled Water Systems operation capabilities.

RANGE: 0-2500 gpm

RATIONALE FOR RANGE: The instrument range of 0-2500 gpm is provided on the basis of normal (2000 gpm) and high (2100 gpm) operating conditions, and 20% upscale margin.

INSTRUMENT LOOP ACCURACY: The accuracy of the loop is within ±3.5% of 2500 gpm span.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of the loop is based on the accuracy of its individual market available components. The loop consists of orifice with flange tops ($a_1=\pm0.5\%$), electronic flow transmitter ($a_2=0.5\%$) and panel electronic flow indicator ($a_3=\pm2\%$).

LOCATION IN PSAR: SECTION 9.9.2 - Emergency Plant Service Water System

D.3.J Emergency Plant Service Water Basin Level CATEGORY 2

PURPOSE: Indication of Emergency Cooling Tower Water Storage Basin level is used for evaluation of EPSW reserve storage capacity and Cooling Water System operation capabilities.

RANGE: 0-100%

RATIONALE FOR RANGE: The instrument range El. 771'-816' is based on the storage basin bottom (El. 771') and top (816') elevation.

INSTRUMENT LOOP ACCURACY: The accuracy of the loop is within ±3% of 45 foot span.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of loop is based on the accuracy of its individual market available components. The loop consists of the electronic level transmitter ($a_1=\pm1\%$) and panel electronic level indicator ($a_2=\pm2\%$).

LOCATION IN PSAR: SECTION 9.9.2 - Emergency Plant Service Water System

D.3.K Emergency Plant Service Water Pit Level CATEGORY 2

PURPOSE: Indication of Emergency Plant Service Water pump pit level allows for evaluation of EPSW pump operation conditions and Cooling Water System operation capabilities.

RANGE: 0-100%

RATIONALE FOR RANGE: The instrument range El. 810' - 821' ft. is based on pump pit bottom (el. 810') and top (821') elevation.

INSTRUMENT LOOP ACCURACY: The accuracy of the loop is within ±3% of 11 foot span.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of the loop is based on the accuracy of its individual market available components. The loop consists of the electronic level transmitter ($a_1=\pm1\%$) and panel electronic level indicator ($a_2=\pm2\%$).

LOCATION IN PSAR: SECTION 9.9.2 - Emergency Plant Service Water System

D.3.L Emergency Plant Service Water Pump Status CATEGORY 3

PURPOSE: Emergency Plant Service Water flow status indicates proper operation of Emergency Chilled Water System, and cooling of the Diesel Generator Systems.

RANGE: N/A

RATIONALE FOR RANGE: N/A

INSTRUMENT LOOP ACCURACY: N/A

RATIONALE FOR INSTRUMENT LOOP ACCURACY: N/A

LOCATION IN PSAR: To be provided later.

D.3.M Emergency Cooling Water Status CATEGORY 3

PURPOSE: Indication of Emergency Cooling Fan Status is used for evaluation of Emergency Water Cooling System heat removal capabilities.

RANGE: Run/Not Run

RATIONALE FOR RANGE: N/A

INSTRUMENT LOOP ACCURACY: N/A

RATIONALE FOR INSTRUMENT LOOP ACCURACY: N/A

LOCATION IN PSAR: To be provided later.

D.4 TITLE: Power Supplies

D.4.A.1 Electrical Voltage (1E Inst.) CATEGORY 2

PURPOSE: Indication system status by indicating the voltage levels at 4.16KV switchgear and the diesel generators and undervoltage conditions at 480V switchgear, 125/250V DC switchgear and 120/208V uninterruptible power supplies. This information is necessary to indicate whether system voltage is adequate for the operation of plant electrical loads.

RANGE: As discussed below

RATIONALE FOR RANGE: Instrument range is selected to provide readings from zero to nominal voltage rating (e.g., 4.16KV, range is 0-5000 volts) using commercially available scales.

INSTRUMENT LOOP ACCURACY: Accuracy within 1.8% for 4.16KV, diesel generators, 0.3% for 480V switchgear, 0.0% for DC and UPS

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of the loop is based on the accuracy of its individual components. Instruments for medium voltage switchgear consist of a potential transformer (0.3%), a transducer (0.5%) and a voltmeter (1.0%) for a combined accuracy of within ±1.8%. Low voltage switchgear (480V) utilize a potential transformer (0.3%), an undervoltage relay (field adjusted to correct setpoint) and an annunciator to indicate undervoltage conditions. DC and UPS systems use an undervoltage relay and an annunciator.

LOCATION IN PSAR: SECTIONS 8.3.1.1.2, 8.3.1.1.5 and 8.3.2.1.1.1. and Figures 8.3-2, 8.3-3 and 8.3-5.

D.4.A.2 Electrical Voltage (Non 1E) CATEGORY 3

PURPOSE: Indicate a system status by indicating the voltage levels at 13.8KV switchgear and 4.16KV switchgear and undervoltage conditions at 480V switchgear, 125/250V DC switchgear and 120/208V uninterruptible power supplies. This information is necessary to indicate whether system voltage is adequate for the operation of plant electrical loads.

RANGE: As discussed below.

RATIONALE FOR RANGE: Instrument range is selected to provide readings from zero to the nominal voltage rating (e.g., 4.16KV, range is 0-5000 volts) using commercially available scales.

INSTRUMENT LOOP ACCURACY: Accuracy within 1.8% for 13.8KV
0.3% for 480V switchgear
0.0% for DC and UPS

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of the loop is based on the accuracy of its individual components. Instruments for

medium voltage switchgear (13.8KV, 4.16KV) consist of a potential transformer (0.3%), a transducer (0.5%) and a voltmeter (1.0%) for a combined accuracy of within ±1.8%. Low voltage switchgear (480V) utilize a potential transformer (0.3%), and undervoltage relay (field adjusted to correct setpoint) and an annunciator to indicate undervoltage conditions. DC and UPS systems use an undervoltage relay and an annunciator.

LOCATION IN PSAR: SECTION 8.3.2.1.2 and Figure 8.3-2 and 8.3-4.

D.4.B.1 Electrical Current (1E Inst.) CATEGORY 2

PURPOSE: Indicate system status by indicating the ampere load of medium voltage switchgear, medium voltage loads, 480V unit substations and DC batteries and battery chargers.

RANGE: As discussed below

RATIONALE FOR RANGE: Instrument range is selected to provide adequate ampere readings from zero to normal fuel load current using commercially available scales. Ammeter scales for batteries are selected to indicate load and charging current (e.g., 800 - 0 - 800)

INSTRUMENT LOOP ACCURACY:

Accuracy within 1.8 - 2.1% for medium voltage switchgear
1.8 - 2.7% for 480V unit substations
1.0% for DC batteries & battery chargers

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of the loop is based on the accuracy of its individual components. Instruments for medium and low voltage switchgear consist of a current transformer (CT) (0.3 to 1.2%), a transducer (0.5%) and an ammeter (1.0%) for a combined accuracy of 1.8% to 2.7% depending on CT ratio. The accuracy of DC instruments is based on the ammeter itself.

LOCATION IN PSAR: Figures 8.3-2, 8.3-3, 8.3-5

D.4.B.2 Electrical Current (Non 1E Inst.) CATEGORY 3

PURPOSE: Indicate system status by indicating the ampere load of medium voltage switchgear, medium voltage loads, 480V unit substations and DC batteries and battery chargers.

RANGE: As discussed below.

RATIONALE FOR RANGE: Instrument range is selected to provide adequate ampere readings from zero to normal full load current using commercially available scales. Ammeter scales for batteries are selected to indicate load and charging current (e.g., 800 - 0 - 800)

INSTRUMENT LOOP ACCURACY:

Accuracy within 1.8 - 2.1% for medium voltage switchgear
1.8 - 2.7% for 480V unit substations
1.0% for DC batteries & battery chargers

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of the loop is based on the accuracy of its individual components. Instruments for medium and low voltage switchgear consist of a current transformer (CT) (0.3) to 1.2%), a transducer (0.5%) and an ammeter (1.0%) for a combined accuracy of 1.8% to 2.7% depending on CT ratio. The accuracy of DC instruments is based on the ammeter itself.

LOCATION IN PSAR: Figures 8.3-2 and 8.3-4

D.4.C Nitrogen CATEGORY 3

PURPOSE: This instrument indicates to the operator that there is an adequate supply of nitrogen gas available for use within the RCB and RSB.

RANGE: 0-200 psig

RATIONALE FOR RANGE: The normal pressure seen by this instrument is 175 ± 5 psig. The range of the instrument (0 to 200 psig) was selected to cover this normal pressure and provide a 10% range margin for contingency.

INSTRUMENT LOOP ACCURACY: ±2% of full scale (±4 psi).

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy is based on the need to ensure that a minimum nitrogen pressure of 160 psig is available in the RCB and RSB. Since a low pressure alarm is actuated at 168 psig, the required accuracy provides insurance that the operator is warned before pressure drops below this value.

LOCATION IN PSAR: SECTION 9.5.5.1

D.4.D Instrument Air CATEGORY 3

PURPOSE: Indication of the Instrument Air Header pressure is used for the evaluation of continued supply of Instrument Air.

RANGE: 0-250 psig

RATIONALE FOR RANGE: The instrument range of 0-250 psig is provided on the basis of normal (165 psig) and maximum (210 psig) operating conditions and 20% upscale margin.

INSTRUMENT LOOP ACCURACY: Accuracy of the loop is within ±2.5% of the 250 psig span.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of the loop is based on the accuracy of its individual market available components. The loop consists of pressure transmitter ($a_1 = \pm 0.5\%$) and panel electronic pressure indicator ($a_2 = \pm 2\%$).

LOCATION IN PSAR: SECTION 9.10.1 - Service Air and Instrument Air Systems.

D.5 TITLE: Ventilation Systems

D.5.A System 28 Ventilation, Subsystems, EA, EB, MA, MB CATEGORY 3

PURPOSE: To indicate system status for safety related subsystems EA, EB, MA & MB which includes status of subsystem fans and isolation valves & supply & return gas temperature alarms. (To monitor the environmental status of decay heat removal components).

RANGE: See Below

RATIONALE FOR RANGE: Instrument range is not applicable for status of fans and isolation valves. Range for the temperature is 20°F to 240°F which envelops the functional operating range of Systems EA, EB, MA and MB and the setpoint of 150°F.

INSTRUMENT LOOP ACCURACY: For status of fans & isolation valves, instrument loop accuracy is not applicable. For temperature alarm loops, instrument loop accuracy is ± .7% of span.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Instrument loop accuracy is based on addition of accuracies of each instrument in the loop. Resistance temperature detector: ±0.2%; Temperature switch: ±.5%, Total: ±0.7% of span.

LOCATION IN PSAR: 7.6 (being rewritten)
7.6.6 - Recirculating Gas Cooling Instrumentation and Control System

D.5.B Cell Atmosphere Temperatures 28PA, 28PB, 28PC, 28RC CATEGORY 3

PURPOSE: To indicate system status by providing temperature indications in control room for PHTS & Reactor Cavity Cell atmospheres.

RANGE: 32°F - 600°F

RATIONALE FOR RANGE: Instrument range of thermocouples, 32°F - 600°F, based on linear range of type "E" thermocouples.

INSTRUMENT LOOP ACCURACY: Temperature indication loops ± 3.0% of span.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Instrument loop accuracy is based on addition of accuracy of each instrument in the loop. Resistance temperature detector: ±0.2%; temperature transmitter: ±0.75%; temperature indicator; ±2.0%, Total: ±3.0%

LOCATION IN PSAR: SECTION 7.6 (being rewritten), 7.6.6 - Recirculating Gas Cooling Instrumentation and Control System

D.5.C Nuclear Island HVAC Status CATEGORY 3

PURPOSE: To monitor system status of Nuclear Island HVAC components which includes A/C units, filter units, fans, dampers, air handling units, and discharge air temperature indication and alarm to verify proper system alignment.

RANGE: Not Applicable for fan, damper status. For temperature the range is 32°F to 600°F

RATIONALE FOR RANGE: For instrument range of thermoucouples, 32°F - 600°F is derived based on linear range of Type E thermoucouples.

INSTRUMENT LOOP ACCURACY: For status of fans and dampers instrument loop accuracy is not applicable. For temperatures alarm loop accuracy is within ±1.0% and for temperature indication loop accuracy is within ±3.0%.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of the instrument Loop is based on the accuracy of its individual components. Thermoucouples have accuracy within ±0.5% alarm switches ±0.5%, temperature transmitter ±0.5% and the indicators ±2.0%. So the overall accuracy of the alarm and indicator loop comes within ±1.0% and ±3.0%, respectively.

LOCATION IN PSAR: SECTION 7.6 - Nuclear Island HVAC Instrumentation and Control System is being rewritten

D.6 TITLE: Confinements

D.6.A Confinement Pressure CATEGORY 2

PURPOSE: To monitor the RSB confinement differential pressure to insure that RSB confinement is monitored by verifying sub-atmospheric pressure.

RANGE: TBD

RATIONALE FOR RANGE: The range of these differential pressure transmitters are selected based on the maximum pressure which can be created by the RCB supply fans (positive) and RSB filter fans (negative).

INSTRUMENT LOOP ACCURACY: Within 0.5%.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Since output of the pressure transmitter is directly going to the computer and the computer has a very high accuracy, the instrument loop accuracy is the same as the instrument accuracy.

LOCATION IN PSAR: SECTION 7.6 - Nuclear Island HVAC Instrumentation and Control System is being rewritten.

D.6.B Annulus Pressure CATEGORY 2

PURPOSE: Monitoring of Annulus Pressure will verify that the Annulus space is being maintained at negative pressure with respect to atmosphere.

RANGE: TBD

RATIONALE FOR RANGE: TBD

INSTRUMENT LOOP ACCURACY: TBD

RATIONALE FOR INSTRUMENT LOOP ACCURACY: TBD

LOCATION IN PSAR: To be supplied later

D.6 TITLE: RSB Confinement

D.6.C. Radiation Monitoring CATEGORY 2

PURPOSE: Monitoring of the RSB HVAC effluent will assist in determining if RSB Cleanup System is functioning properly.

RANGE: 10^{-6} to 10^{-2} μCi/cc

RATIONALE FOR RANGE: Lower range is selected on basis of RSB confinement initiation setpoint and commercially available range. Upper range selected as standard 4 decade range of monitors.

INSTRUMENT LOOP ACCURACY: Accuracy will be within a factor of 2 over the entire range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Instrumentation is similar to that used on LWR, accuracy is consistent with Reg. Guide 1.97.

LOCATION IN PSAR: SECTION 11.4

D.7 TITLE: CAPS Boundary Integrity

D.7.A CAPS Pressure, Surge Vessel CATEGORY 3

PURPOSE: This instrument provides indication to the operator that the radioactive inventory of this vessel is contained and that the pressure has not reached a value that will threaten the containment function of the surge vessel.

RANGE: 0-200 Psig

RATIONALE FOR RANGE: The instrument range has been selected to provide information during normal operation (40 ± 10 psig); under pressure-limiting condition (compressor shutoff at 135 psig); and up to the setting of the pressure relief valve (175 psig). The margin above the relief setting ensures that, despite the uncertainty of the instrument loop accuracy and the pressure relief setting, the operator can confirm that relief has occurred prior to any threat to the pressure boundary function.

INSTRUMENT LOOP ACCURACY: ±4 psig (±2% of full scale).

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of ±4 psi was selected so that, when added to th uncertainty of the relief valve setting, the operator has an assured margin before the confinement boundary is threatened which is adequate for monitoring.

LOCATION IN PSAR: SECTION 9.5.5.4

D.7.B CAPS Pressure, Cold Box CATEGORY 3

PURPOSE: This instrument provides information to the operator that the radioactivity in the CAPS cold box is contained and that the pressure boundary (CAPS cold box wall) is not threatened.

RANGE: 0-50 psig

RATIONALE FOR RANGE: The instrument range is selected to provide information for normal operation of the cold box (0-35 psig) and to alarm the operator if this pressure exceeds the upper limit. This will alert the operator before there is any threat to the vessel boundary.

INSTRUMENT LOOP ACCURACY: ±1 psi (±2% of full scale)

RATIONALE FOR INSTRUMENT LOOP ACCURACY: For accident monitoring an accuracy of ±4 psi is adequate to assure that operator action can be taken prior to a threat to the pressure boundary.

LOCATION IN PSAR: SECTION 9.5.5.1

D.8 TITLE: RAPS Boundary Integrity

D.8.A RAPS Pressure, Surge Vessel CATEGORY 3

PURPOSE: This instrument provides indication to the operator that the radioactive inventory in the RAPS surge vessel is contained and that the pressure boundary (vessel wall) is not threatened.

RANGE: 0-200 psig

RATIONALE FOR RANGE: The instrument range is selected to include the normal operating conditions within the vessel (95 to 105 psig) and the setting of the vessel pressure relief valve (175 psig). The margin ensures that, with a ±4 psig uncertainty band of the relief valve, the operator can confirm that pressure relief has occurred prior to any threat to the boundary.

INSTRUMENT LOOP ACCURACY: ±4 psi (±2% of full scale)

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of ±4 psi was selected so that, when added to the uncertainty in the relief valve actuation level (±4 psig), the operator has an assured margin before the pressure boundary is threatened.

LOCATION IN PSAR: SECTION 9.5.5.4

D.8.B RAPS Pressure Noble Gas Storage Vessel CATEGORY 3

PURPOSE: This instrument provides information to the operator that the radioactive inventory of the Noble Gas Storage Vessel is contained and that the pressure boundary (vessel wall) is not threatened.

RANGE: -10 to +200 psig

RATIONALE FOR RANGE: The instrument range (-10 to 200 psig) is selected to cover not only normal operating conditions within the vessel (-7 to 75 psig) but also the pressure relief valve setting (175 psig). The margin ensures that with the ±4 psig uncertainty band of the relief valve the operator can ascertain that relief has occurred before the boundary is threatened.

INSTRUMENT LOOP ACCURACY: ±4 psi (±2% of full scale)

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of ±4 psi was selected so that, when added to the uncertainty in the relief valve actuation level (±4 psig), the operator has an assured margin before the pressure boundary is threatened.

LOCATION IN PSAR: SECTION 9.5.5.1

D.8.C RAPS Pressure, Cold Box Discharge CATEGORY 3

PURPOSE: This instrument provides information to the operator that the radioactive inventory of the vessel is contained and that the pressure boundary (vessel wall) is not threatened. This pressure, which is sensed on the discharge line of the cold box (cryostill), is also the pressure within the vessel.

RANGE: 0-200 psig

RATIONALE FOR RANGE: The range is selected to cover not only the normal value of the parameter but also the level at which the relief valve will actuate (175 psig) to protect the vessel. The 25 psi margin ensures that with the uncertainty band (±4 psig) the operator can ascertain that relief has occurred before the boundary is threatened.

INSTRUMENT LOOP ACCURACY: ±4 psi (±2% of full scale)

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy of ±4 psi was selected so that when added to the uncertainty in the relief valve actuation level (±4 psi), the operator has an assured margin before the pressure boundary is threatened.

LOCATION IN PSAR: SECTION 9.5.5.1

TYPE E: Monitoring of Radiation Releases

Those variables to be monitored as required for use in determining the magnitude of release of radioactive materials, and continually assessing such releases.

E.1 TITLE: Containment Radiation

E.1.A Containment Area Radiation High Range CATEGORY 1

PURPOSE: Monitors are located in annulus space and monitor radiation levels emitted from containment. Monitors will provide long term surveillance (8000 hrs.) of activity in containment.

RANGE: 1 R/hr to 10^7 R/hr

RATIONALE FOR RANGE: Since source term for CRBR is similar to LWR, range is similar to LWR for similar instruments and consistent with Reg. Guide 1.97.

INSTRUMENT LOOP ACCURACY: Accuracy will be within a factor of 2 over the entire range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Instrumentation is similar to that used on LWR, accuracy is consistent with Reg. Guide 1.97.

LOCATION IN PSAR: SECTION 12.1

E.2 TITLE: Area Radiation

E.2.A Radiation Exposure Rate (Inside building where access is required to service equipment important to safety) CATEGORY 2

PURPOSE: Detection of significant releases and long term surveillance in areas where access may be required to service safety equipment

RANGE: 10^{-1} R/hr to 10^4 R/hr
NOTE: It is assumed that if the radiation level is $<10^{-1}$ R/hr, lower radiation level indication is not necessary. Standard Health Physics requirements will be in effect

RATIONALE FOR RANGE:

1. Since source terms for CRBR and LWR are similar, range is similar to LWR for similar instruments and consistent with Reg. Guide 1.97.
2. Standard commercially available range.

INSTRUMENT LOOP ACCURACY: Accuracy will be within a factor of 2 over the entire range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Instrumentation is similar to that used on LWR, accuracy is consistent with Reg. Guide 1.97.

LOCATION IN PSAR: SECTION 12.1

E.3 TITLE: Airborne Radioactive Materials Released From Plant

E.3.A Noble Gas and Vent Flow Rate

E.3.A.1 Containment or Purge Effluent CATEGORY 2

PURPOSE: Detection of significant releases and long term surveillance of all identified plant release points.

RANGE: 10^{-6} μCi/cc to 10^{5} μCi/cc 0 to 110% vent design flow (not needed if effluent discharges are through common plant vent).

RATIONALE FOR RANGE: Since source term for CRBR is similar to LWR, range is similar to LWR for similar instruments and is consistent with Reg. Guide 1.97.

INSTRUMENT LOOP ACCURACY: Accuracy will be within a factor of 2 over the entire range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Instrumentation is similar to that used on LWR, accuracy is consistent with Reg. Guide 1.97.

LOCATION IN PSAR: SECTION 12.1

E.4 TITLE: Annulus Filtration System (Noble Gas) CATEGORY 2

PURPOSE: Detection of significant releases and long term surveillance of all identified plant release points.

RANGE: 10^{-6} μCi/cc to 10^{5} μCi/cc 0 to 110% vent design flow (not needed if effluent discharges are through common plant vent).

RATIONALE FOR RANGE: Since source term for CRBR is similar to LWR, range is similar to LWR for similar instruments and is consistent with Reg. Guide 1.97.

INSTRUMENT LOOP ACCURACY: Accuracy will be within a factor of 2 over this entire range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Instrumentation is similar to that used on LWR, accuracy is consistent with Reg. Guide 1.97.

LOCATION IN PSAR: SECTION 12.1

E.5 TITLE: Steam Generator Building, Reactor Service Building (Noble Gas) CATEGORY 2

PURPOSE: Detection of significant releases and long term surveillance of all identified plant release points.

RANGE: 10^{-6} μCi/cc to 10^{3} μCi/cc 0 to 110% vent design flow (not needed if effluent discharges are through common vent)

RATIONALE FOR RANGE: Since source term for CRBR is similar to LWR, range is similar to LWR for similar instruments and is consistent with Reg. Guide 1.97.

INSTRUMENT LOOP ACCURACY: Accuracy will be within a factor of 2 over the entire page.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Instrumentation is similar to that used on LWR, accuracy is consistant with Reg. Guide 1.97.

LOCATION IN PSAR: SECTION 12.1

E.6 TITLE: Particulates and Halogens

E.6.A All Identified Plant Release Points (except steam generator safety relief valves or atmospheric steam dump valves and condenser air removal system exhaust) CATEGORY 3

PURPOSE: Detection of significant releases and long term surveillance of all identified plant release points.

RANGE: 10^{-3} μCi/cc to 10^{2} μCi/cc 0 - 110% vent design flow

RATIONALE FOR RANGE: Since source term for CRBR is similar to LWR, range is similar to LWR for similar instruments and is consistent with Reg. Guide 1.97.

INSTRUMENT LOOP ACCURACY: Accuracy will be within a factor of 2 over the entire range.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Instrumentation is similar to that used on LWR, accuracy is consistent with Reg. Guide 1.97.

LOCATION IN PSAR: SECTION 12.1

E.7 TITLE: Environs Radiation and Radioactivity

E.7.A Radiation Exposure Meters (Continuous Indication at fixed locations) CATEGORY 3

PURPOSE: To verify significant releases and local magnitudes.

RANGE: See below

RATIONALE FOR RANGE: Range, location, and qualification criteria to be developed to satisfy NUREG-0654, Section II.H.5b and 6b requirements for emergency radiological monitors.

INSTRUMENT LOOP ACCURACY: TBD

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Instrumentation is similar to that used on LWR, accuracy is consistant with Reg. Guide 1.97.

LOCATION IN PSAR: SECTION 12.1

E.7.B Airborne Radiohalogens and Particulates (portable sampling with onsite analysis capability). CATEGORY 3

PURPOSE: This instrumentation enables the operator to assess magnitudes of any releases.

RANGE: $10^{-9}\mu Ci/cc$ to $10^{-3}\mu Ci/cc$

RATIONALE FOR RANGE: The range conforms to the guidance provided in Reg. Guide 1.97.

INSTRUMENT LOOP ACCURACY: TBD

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Conventional standards for accuracy for this type equipment will be applied.

LOCATION IN PSAR: To be provided.

E.7.C Plant and Environs Radiation (Portable Instrumentation) CATEGORY 3

PURPOSE: This instrumentation enables the operator to access the magnitudes of releases.

RANGE: 10^{-3} R/hr to 10^{4} R/hr, photons 10^{-3} rads/hr to 10^{4} rads/hr, beta radiations and low-energy photons

RATIONALE FOR RANGE: The range conforms to the guidance of Reg. Guide 1.97. Radiation instruments capable of monitoring over the necessary range will be available.

INSTRUMENT LOOP ACCURACY:

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracies will be typical of this type of counting instruments with energy discrimination capability for the appropriate radiation type and will employ industry accepted techniques.

LOCATION IN PSAR: SECTION 11.4 and 12.1

E.7.D Plant and Environs Radioactivity (portable Instrumentation) CATEGORY 3

PURPOSE: This instrumentation enables the operator to assess the magnitude of any release.

RANGE: Multichannel gamma-ray spectrometer

RATIONALE FOR RANGE: The range will be within conventional standards for this type equipment.

INSTRUMENT LOOP ACCURACY: Variable dependent on the make of the detector. To be determined upon final selection of equipment.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The typical accuracies for this type of equipment will be accepted.

LOCATION IN PSAR: To be provided.

E.8 TITLE: Meterology

E.8.A Wind Direction CATEGORY 3

PURPOSE: Will allow operator to assess direction of any plant releases carried by the wind.

RANGE: 0 to 360°F ($\pm 5^{\circ}$ accuracy with a deflection of 15°). Starting speed 0.45 mps (1.0 mph). Damping ratio between 0.4 and 0.6, distance constant ≤ 2 meters

RATIONALE FOR RANGE: Conforms to the guidance provided in the Reg. Guide 1.97.

INSTRUMENT LOOP ACCURACY: Conventional standards for the accuracy of this type of equipment will be applied.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: Conventional standards for the accuracy of this type of equipment will be applied.

LOCATION IN PSAR: To be provided.

E.9 TITLE: Grap Sample from Containment CATEGORY 3

PURPOSE: This information provides operator with data to make an assessment of any releases in containment and perform radioisotopic analysis.

RANGE: NA

RATIONALE FOR RANGE: The counting equipment will be selected at a later date, however, the necessary detector type and energy discrimination capability will be provided to support this radioisotopic analysis.

INSTRUMENT LOOP ACCURACY: Achievable accuracies will be consistent with this type of equipment in accordance with accepted industry standards.

RATIONALE FOR INSTRUMENT LOOP ACCURACY: The accuracy is based on standard industry practice.

LOCATION IN PSAR: To be provided.

7.5 INSTRUMENTATION AND MONITORING SYSTEM

The instrumentation and monitoring systems included in this Section are the Flux Monitoring System, the Heat Transport Instrumentation System, the Reactor and Vessel Instrumentation System, the Fuel Failure Monitoring System, the Leak Detection Instrumentation System, and the Sodium-Water Reactor Pressure Relief System. Table 7.5-1 lists the measured parameters and instrumentation provided by these systems. The instrumentation which is safety related as defined in Section 3.2.1 is identified with an asterisk in column 2 of Table 7.5-1. Instrumentation and monitoring for TLTM parameters not included in the design basis are also discussed. These include containment hydrogen monitoring and containment vessel temperature and pressure monitoring.

7.5.1 Flux Monitoring System

The objective of the Flux Monitoring System (FMS) is to provide indications and electrical signals proportional to reactor power for reactor plant control and protection. The FMS meets its objective by means of neutron measuring instrumentation comprised of sensors and signal conditioning equipment which provide indications and signals for conditions of reactor shutdown, startup and full power operation.

Neutron sensors located around the periphery of the reactor guard vessel sense thermalized reactor leakage flux which is proportional to the reactor flux and thus to reactor power. Signals from the sensors are conditioned and then used to do the following:

- o Determine the flux status of the reactor from shutdown through startup and all power levels.
- o Provide signals to the Plant Protection System (PPS) to initiate reactor protective trips.
- o Provide signals to the Plant Control System (PCS) for reactor and plant control.
- o Provide neutron flux information for display, annunciation and recording.

A block diagram of the FM System is provided in Figure 7.5-1.

7.5.1.1 Design Description

The Neutron Flux Monitoring System provides three ranges of instrumentation: Source Range, Wide Range and Power Range. Each range of instrumentation is provided in three identical channels comprised of a detector, preamplifier (source and wide ranges), junction box (power range) and signal conditioning equipment. The Flux Monitoring System measures neutron flux proportional to reactor power over a span or more than ten decades from shutdown to above full power and provides indications and electrical outputs for plant protection, plant control, accident monitoring, data handling and display, recording, and annunciation.

7.5.1.1.2 Wide Range

Each of the three channels of Wide Range Instrumentation will use a U^{235} fission chamber to sense neutron flux from low power to above full power by providing, within each channel, overlapping ranges of counting, mean square voltage (MSV) and direct current instrumentation. The counting and MSV instrumentation provides precent power indications on logarithmic scaled meters and rate of change of level on a linear scale from -1 to 0 to +3 decades per minute. These two overlapping ranges of instrumentation are designated as Category 1, Type B, Accident Monitoring equipment as defined in PSAR Section 7.5.11. The d-c instrumentation indicates percent power on a linear scale.

The signal conditioning equipment produces electrical signals which are indicative of the power levels and rate of change of power levels. These signals are used for plant protection, data handling and annunciation. The MSV and linear circuits outputs will be linear to at least 140 percent power and will have a significant positive response to as high a power level as required by the worst case power overshoot for which protection must be provided.

Built-in test circuits and controls will be provided to permit testing and aligning the equipment during plant operation and during plant shutdown.

7.5.1.1.3 Power Range

Each of the three channels of power Range Instrumentation will use B^{10} compensated ionization chambers to sense the neutron flux in a span of from less than one percent power to more than full power. The d-c current output

Output of the detector will be processed in the signal conditioning equipment to provide linear indication of percent power and linear output signals for plant protection, plant control, data logging and annunciators. This instrumentation operates over the same flux span as the direct current circuitry of the wide range instrumentation to add redundancy and diversity to the wide range power measurements.

The output of this instrument will be linear to at least 140 percent power and will have no foldover to as high a power level as required by the worst case power overshoot for which protection must be provided.

Built-in test circuits and controls will be provided to permit testing and aligning the equipment during plant operation and plant shutdown.

7.5.1.2 Design Analysis

The Flux Monitoring System will be a functional subsystem of the Plant Protection System and will meet the safety related channel performance and reliability requirements of the CRBRP General Design Criteria, RDT Standard C16-IT, Dec. 1969, IEEE Standard 279-1971, applicable Regulatory Guides, criteria of Section 7.5.11 and other appropriate criteria and standards by complying with the applicable design requirements delineated in Section 7.1.2.

The FMS meets CRBRP General Design Criterion 21, which is applicable to instrumentation for normal and accident conditions, as follows:

- o The shutdown flux level will be monitored at all times while fuel is in the core so as to provide safe operational control of the reactor during low power, normal shutdown, refueling and shutdown maintenance operations.

- o The reactor flux will be continuously monitored during operation from shutdown to full power operation (i.e., overlap will exist between cascaded channels so that all power levels can be monitored without a gap in range).

- o Reactor power operations will be continuously monitored with linear response to power up to at least 140% full power. Significant positive response will be provided to as high a power level as required by the worst case power overshoot for which protection must be provided. This positive response will be provided for as long as is required to seal in the scram trip.

- o The FMS instrument response time delays will meet the response requirements of the Reactor Shutdown and Plant Control Systems.

- o Indication of reactor power level and rate of change of power level will be provided to the operator. One set of meters and a selector switch will be provided for each range of instrumentation permitting the operator to select one channel at a time to be displayed on the

related meters. Seven power level meters, five selector switches and three rate of change of power meters will be provided for the operator.

- o The source range level will be indicated in logarithmic counts per second and rate of change of level in decades per minute. Linear count rate will be provided at shutdown at the refueling console and at the FMS system panels in the control room. Audible count rate indication will be provided in the control room and in containment at the refueling console.

- o The wide ranges will be indicated as follows:

  Counting channels - Logarithmic percent power level and decades per minute rate of change.

  MSV channels - Logarithmic percent power level and decades per minute rate of change.

  DC channels - Linear percent power level.

- o The power range will be indicated in linear percent power level.

Preliminary Failure Mode and Effect Analysis results applicable to the FMS have been determined in an analysis of possible failure modes and their effects on the Reactor Shutdown System performance and are presented in Tables C.S. 1-4 and C.S. 1-5.

7.5.2 Heat Transport Instrumentation System

7.5.2.1 Description

The Heat Transport Instrumentation System provides sensors, associated signal conditioning equipment and controls other than Plant Control, for the Primary Heat Transport, the Intermediate Heat Transport and the Steam Generator. The signals from the sensors are conditioned and then supplied to the Reactor Shutdown System logic, the Plant Control System, the Plant Data Handling and Display System, and the Plant Annunciator System as appropriate. The location of the Heat Transport Instrumentation is provided in Figures 5.1-2 and 5.1-4 (P&ID's).

7.5.2.1.1 Primary and Intermediate Sodium Loops

Reactor Inlet Pressure

The measurement is made by pressure elements installed in the cold leg of the primary loop piping just before it enters the reactor vessel. NaK filled capillaries from the pressure elements are connected to pressure transducers which develop electrical signals proportional to the pressure. These pressure transducers provide a secondary boundary if the bellows in the pressure elements should fail.

7.5.3 Reactor and Vessel Instrumentation

7.5.3.1 Description

The Reactor and Vessel Instrumentation System includes all in-vessel temperature, sodium level and vibration sensors for instrumenting the reactor parameters required for the Reactor Shutdown System, PCS, surveillance and design verification. It also includes signal conditioning equipment needed to make the sensor signal usable in the systems receiving the signal.

Table 7.5-2 shows the in-vessel instruments provided, their location, their quantity and purpose.

7.5.3.1.1 Sodium Level

A total of six sodium level sensors are provided. All of these sensors are mounted in wells to provide the physical barrier maintaining the integrity of the primary loop closed system. The sensors are induction type probes continuously sensitive over their entire length. Four of the units, located approximately equally spaced on the top of the reactor, are short with a sensing range of from 6 inches above the operating level to 24 inches below. Three of these provide the level signals to the three Reactor shutdown system logic and are thus isolated from each other and from non-PPS equipment. The fourth is an installed spare unit providing a means of maintaining the three operating channels without a shutdown in the event of failure of one of them. The remaining two level sensors are located close to one of the short units but provides a measuring range from 6 inches above the operating level to six inches below the top of the outlet nozzle. It has approximately sixteen feet of sensing length. The two signals is are supplied to two indicators located on the main control panel and are monitored at all times, including refueling. These two wide range sodium level channels are Category 1, Accident Monitoring Instruments.

7.5.3.1.2 Temperature

All in-vessel temperatures are sensed by 1/8 inch, chromel alumel, ungrounded, stainless steel sheathed thermocouples. Thirty wells are provided for thermocouples located in the sodium at the exit from the core. These thermocouples provide signals to the PCS and the PDH&DS. Additional wells are provided at the core exit (308), core periphery (2), and on parts of the upper internal structure (6) for thermocouples providing signals to the PDH&DS for surveillance and design verification. The 338 thermocouples provided at the core exit are Category 3, Accident Monitoring Instruments.

7.5.3.1.3 Non-replaceable Instruments

Within the reactor vessel, four biaxial accelerometers are mounted on the upper internal structure so that they cannot be replaced. These sensors are not required to function beyond the first six months of operation although they are required to physically withstand the sodium environment for the life of the reactor. The signals provided by these sensors provide design

7.5.10 Containment Atmosphere Temperature

The objective of the Containment Atmosphere Temperature Monitoring System is to provide indication in the Control Room of the atmosphere temperature inside the containment building.

7.5.10.1 Design Description

The temperature instrumentation consists of two fully redundant and independent channels. Each channel consists of two thermocouples mounted on the RCB dome, with each thermocouple providing a signal to conditioning instrumentation in the SGB. The instrumentation sends a signal to the Control Room where individual readout is provided. This instrument is also required to perform functions for events which lie beyond the design basis for the plant. This instrument is further discussed in this capacity in Section 2.1 and 2.2 of Reference 10b of PSAR Section 1.6.

7.5.11 Accident Monitoring Instrumentation

The Accident Monitoring Instrumentation is an integrated set of instruments made available to assess plant and environs conditions during and following accidents.

7.5.11.1 Description

Accident Monitoring parameters are monitored to perform the following functions:

- o Provide primary information to permit manual actuation of safety systems. — Variable Type A

  Type A variables monitor the primary information required to permit the control room operator to take specific manually controlled actions for which no automatic control is provided and that are required for safety systems to accomplish their safety functions for Design Basis Accident events. Primary information is that which is essential for the direct accomplishment of the specified safety functions; it does not include those variables that are associated with contingency actions that may also be identified in written procedures.

- o Indicate that safety functions are being accomplished (i.e., reactor shutdown, core cooling, containment integrity). — Variable Type B

  Type B variables provide information necessary to indicate whether plant safety functions are being accomplished.

- Indicate potential for or breach of barriers to fission products release (i.e., fuel, cladding, primary boundary, containment). — Variable Type C

  Type C variables provide information to indicate the potential for, and/or the actual breach of barriers to fission product releases. The barriers are (1) fuel cladding, (2) primary coolant pressure boundary, and (3) containment.

- Indicate operation of safety systems or other systems important to safety. — Variable Type D

  Type D variables provide information to indicate the operation of individual safety systems and other system important to safety. These variables are to help the operator make appropriate decisions in using the individual system important to safety in mitigating the consequences of an accident.

- Indicate magnitude of release of radioactive materials and continuously access such release. — Variable Type E

  Type E variables provide information required for use in determining the magnitude of release of radioactive materials, and continually assessing such releases.

7.5.11.2 Instrumentation Design and Qualification

A graded approach to instrument requirements has been incorporated which emphasizes the importance to safety of a particular measured variable. Different categories for instrumentation have been identified as follows:

Category 1: Class 1E instrumentation which requires seismic and environmental qualification, single failure criteria, and Class 1E power source.

Category 2: Instrumentation which is environmentally qualified and powered from a reliable power source.

Category 3: Instrumentation of a high quality commercial grade.

7.5.11.2.1 Category 1

- Each Category 1 parameter is monitored by at least two instruments. These instruments are referred to as:

- Principal Instruments, and
- Redundant Backup Instruments

All Category 1 Principal Instruments are classified as 1E. Category 1 Redundant Backup Instruments are classified as 1E up to the isolation device from the sensor.

A third verification instrument is provided if a failure of the principal or redundant instrument will result in information ambiguity (that is the redundant displays disagree) that could lead operators to defeat or fail to accomplish a required safety function. This third instrument is called a verification instrument.

- The Principal Instrument Indication will be located in the viewing area of the operator in the Control Room. The Redundant Backup Instrument Indicator will be in the proximity of the Principal Instrument

  Indicator to permit the operator to make comparisons. If a Verification Instrument is required, its indication will be accessible but not necessarily in the Control Room. (The plant computer may provide the Verification Instrument information).

- A minimum of one instrumentation channel for each Category 1 variable will be recorded unless it can be shown that recording that particular parameter will not provide benefit in analyzing the overall accident. The plant computer (non-1E) is the preferred method of recording. Special attention will be given to the logging frequency of each of these Category 1 parameters so that an adequate presentation of the parameter response during an event will be available.

  A recorded pre-event history for these parameters is required for a minimum of one hour, and continuous recording of these instruments is required following an accident until such time as continuous recording of such information is no longer deemed necessary.

- The single failure criteria for Category 1 instruments is applied to the combination of the Principal Instrument and the Redundant Backup Instrument. The Verification Instrument is not taken into consideration when considering single failure criteria. No single failure within the Principal Instrument chain, and the Redundant Backup Instrument chain, their auxiliary supporting

features, or their power sources, concurrent with the failures that are a condition of, or a result of a specific accident, will prevent the operator from being presented the required information.

- The Principal Instruments from sensor to indicator, and the Redundant Backup Instruments from sensor through the indication device will be qualified in accordance with PSAR Section 1.6 Reference 13, "Requirements for Environmental Qualification of Class 1E Equipment." They are qualified to provide the information needed by the operator to assess plant and environs conditions during and following design basis events.

- Instrumentation will continue to read within the required accuracy following, but not necessarily during, a Safe Shutdown Earthquake (SSE).

- The Principal Instrument (from sensor to indicator) and Redundant Backup Instrument (from sensor through the isolation devices) will be energized from Class 1E power and be supplied with battery backing where momentary interruption of the indication is not tolerable.

7.5.11.2.1 Category 2

- Each Category 2 instrument signal, will be, as a minimum, processed for display on demand.

- The Category 2 instrument indicators will be located to effectively support normal and emergency plant operations.

- The Category 2 instruments from sensor to indicator will as a minimum be qualified in accordance with Reference 13, PSAR Section 1.6, "Requirements for Environmental Qualification of Class 1E Equipment" except for seismic. They will be qualified to provide the information needed by the operator to assess plant and environs conditions during and following design basis events.

- The instrumentation will be energized from a highly reliable power source (not necessarily a Class 1E power supply). Where interruption of the power supply is acceptable station AC power may be used. Where momentary interruption is not tolerable, the non-1E UPS is used.

7.5.11.2.3 Category 3

- Each Category 3 instrument signal, will be, as a minimum, processed for display on demand.
- The location of the Category 3 instrument indication will be chosen to support normal and off-normal operations.
- The Category 3 instrumentation will be a high quality commercial grade.

7.5.11.2.4 General Requirements to Category 1, 2, and 3

- Servicing, testing, and calibration programs will be specified to maintain the capability of the monitoring instrumentation. For those instruments where the required interval between testing shall be less than the normal time interval between generating station shutdowns, a capability for testing during power operation shall be provided.
- Whenever means for removing channels from service are included in the plant design, the plant design will facilitate administrative control of the access to such removal means.
- The plant design will facilitate administrative control of the access to all setpoint adjustments, module calibration adjustments, and test points.
- The monitoring instrumentation design will minimize the development of conditions that would cause meters, annunciators, recorders, alarms, etc., to give anomalous indications potentially confusing to the operator.
- The instrumentation will be designed to facilitate the recognition, location, replacement, repair, or adjustment of malfunctioning components or modules.
- To the extent practicable, monitoring instrumentation inputs will be from sensors that directly measure the desired variables. An indirect measurement will be made only when it can be shown by analysis to provide unambiguous information.

7.5.11.3 Instrument Identification

All Category 2 instruments that are Types A, B, or C, and all Category 1 Principal and Redundant Backup instruments, will be specifically identified on their respective control panels so the operator can easily discern that they are for use under accident conditions. The above instruments will be yellow color coded (Federal Standard 595a, Chip Number 33793).

TABLE 7.5-1

INSTRUMENTATION SYSTEM FUNCTIONS AND SUMMARY

System	Measured Parameters	Instrument	Measurement Location	Purpose
Flux Monitoring	Source Range	BF_3	Thimbles on periphery of guard vessel	Determines or Provides: 1. Flux status at shutdown, startup and power levels 2. Signals to PPS logic (except source range) 3. Signals for reactor and plant control (D.C. linear power ranges) 4. Signals for display, accident monitoring, annunciation and recording
	Wide Range*	Fission Chambers	Thimbles on periphery of guard vessel	
	Power Range*	B-10, Compensated Ion Chamber	Thimbles on periphery of guard vessel	
Heat Transport Primary/ Intermediate Loops	Reactor Inlet Pressure*	Pressure Element	Cold leg primary loop	PPS and display PHTS performances
	Primary and Intermediate Flow*	PM Flowmeter	Cold leg of primary and intermediate loops (hot leg in intermediate loop 2)	PPS, Plant Control and Display, PHTS performance
	IHX Primary Outlet Temperature*	Thermocouple	Cold leg piping nearest to IHX primary outlet	Plant Control System (PCS), PPS, and Display
	Primary and Intermediate Hot and Cold Leg Temperature	Resistance Temperature (RTD)	Primary and Intermediate hot and cold leg	Surveillance, display and use to calorimetrically calibrate PM flowmeters
	Primary and Intermediate Pump Discharge Pressure	Pressure Elements	Drainline from discharge piping of the loop's sodium pump	Surveillance, display and monitor differential pressure between primary & intermediate loops PHTS performance
	Intermediate IHX Outlet Pressure	Pressure Elements	Intermediate between IHX & Superheater	Surveillance, display & monitor differential pressure between intermediate loops

TABLE 7.5-1 (Continued)

System	Measured Parameters	Instrument	Measured Location	Purpose
Reactor and Vessel Instrumentation	Core Sodium Exit Temperature	Thermocouples	Selected fuel and blanket assemblies.	Display, control and accident monitoring - core outlet temperature
	Core Peripheral Temperature	Thermocouples	Core periphery - 2 locations	Display - Design verification
	Upper Internals Temperature	Thermocouples	Parts of upper internal structure 6 locations	Display - design verification, predict stress on various components
	Sodium Level above Core*	Level Probe	Reactor vessel plenum	PPS Display and Accident Monitoring
	Upper Internals Movement	Vibration Element	4 Biaxial on parts of appropriate structure	Display - measure vibrations induced by sodium flow
Fuel Failure Monitoring	Cover Gas Gamma Activity	Gamma Spectrometer	Sampling in RSB	Detect each instance of fuel clad failure and characterize failure
	Delayed Neutron Monitoring	BF_3 Counter	Shielded moderator assembly adjacent to each of the PHTS hot leg pipes	Detect fuel in PHTS
	Tag Gas Isotopic Composition	Mass Spectrometer	Gas tag sampling traps in RSB	Locate failed fuel
Leak Detection	Liquid Metal to Gas Leaks	Contact detectors cable detectors aerosol monitors	In various locations in sodium circuits	Identify location of liquid metal to gas leaks for continuous surveillance of liquid metal systems boundaries

TABLE 7.5-2

REACTOR AND VESSEL INSTRUMENTATION

Instrument	Measured Parameter	Location	Purpose
Thermocouple	Core Exit Sodium Temperature	One at each of 30 selected fuel and blanket assemblies	Control, surveillance and accident monitoring Core outlet temp.
		308 additional locations at selected fuel and blanket assemblies	Surveillance, Diagnostic and accident monitoring - Distribution of temperature across the core
Thermocouple	Core Peripheral Temperature	Two spaced locations on the core periphery	Design Verification - Distribution temp. around the core
	Upper Internals Temperature	Six on parts of the upper internal structure	Design Verification - Distribution of temp. to predict stress on various components
Sodium Level Detector	Sodium Level above the core	Four short units distributed equally around periphery	Protection and Control - Measures the operating level of the sodium in the reactor
		Two long units near one of the four short ones	Surveillance and accident monitoring - Measure the sodium level from operating level down to below the top of the outlet nozzle
Vibration Detector	Upper Internals Vibration	Four biaxial on parts of appropriate structure	Design Verification - Measure vibrations induced by sodium flow

Question CS760.35

The natural circulation transient is analyzed for 500 seconds; after this time the transient is said to be "well-behaved". However, in order to conserve protected water, the air-cooled condensers must remove the entire decay heat load. Experiments with steam-generators in the steam condenser mode have shown difficulty in predicting behavior. The results show pressure fluctuations and apparent bistable modes of operation. What evidence can you give to show that the PACCs will operate as expected and what would be the consequences of pressure fluctuations and/or lower than expected heat rejection capability?

Response

Design analysis and testing is being done to provide assurance that the PACC design will perform within design requirements. Considerations to be included in the analysis of the PACC thermal design and hydraulic stability are discussed in updated PSAR Sections:

5.6.1.3.2.2 "Thermal Analysis of PACC"

5.6.1.3.2.3 "Thermal Hydraulic Stability"

PACC functional tests will be conducted periodically and heat rejection rates will be calculated from test data. These tests will identify lower than expected heat rejection capability if it occurred. The plant is relatively insensitive to PACC heat rejection capability. If lower than PACC design heat rejection occurred, the SGAHRS steam vent duration would be extended slightly. If higher than PACC, design heat rejection occurred, the SGAHRS steam vent duration would be slightly reduced.

The PACC thermal design conservatively accounts for heat transfer uncertainties and allows for 10% tube plugging as noted in Section 5.6.1.3.2.2.

Each PACC air side will have forced circulation capability to remove 15 MWt of heat. The cooler inlet air (max. 100°F) will be drawn in at the cell base and rise through the 600°F condenser and exit out the cell roof through a stack.

5.6.1.3.2.2 Thermal Analysis of PACC

A thermal hydraulic analysis of the PACC has been performed. The steam side calculations represent a coiled, finned condenser tube from steam inlet to condensate outlet. The appropriate water/steam side heat transfer coefficient for each segment is determined for the flow regime for each segment based on water/steam properties and film temperature drop.

For a ratio of steam-to-water density ≥ 0.125, the Boyko-Kruzhilin correlation (Ref. 5.6-2) is used. For a ratio of steam-to-water density < 0.125, the heat transfer coefficient is selected based on Baker's flow regime transition data. (Ref. 5.6-3) When the flow regime in a tube segment is stratified, the modified Soliman, Schuster and Berenson correlation (Ref. 5.6-4) is used. When the flow regime is dispersed or slug, the Chato correlation (Ref. 5.6-5) is used.

The pressure drop and void fraction correlations used in determining the flow rate in the heat exchanger tubes are:

Reynold's Number	Void Fraction	Frictional Pressure Drop
Re < 2000	Lockhart-Martinelli (ref 5.6-6)	Lockhart-Martinelli (ref 5.6-6)
Re > 2000	Boroczy (ref 5.6-7)	Boroczy (ref 5.6-8)

The analysis considers a fouling resistance of 0.0005 (Hr-Ft^2-°F)/Btu on the steam side after 30 years of service. This value is consistent with thermal standards of the Tubular Exchanger Manufacturers Association (TEMA).

For the air-side, the convective heat transfer coefficient is computed using the method outlined in the ESCOA Fintube Engineering Manual (Ref. 5.6-1) as a function of the gas-side mass flow and the tube, fin and coil geometry. Several air-side heat transfer coefficients were examined. The correlation in the ESCOA manual most resembles the conditions in the PACC design.

The ESCOA air-side heat transfer coefficient is based on the total overall heat transfer area between the steam and air. However, for PACC an individual air-side heat transfer coefficient is used for each increment of the model. Local air-side thermal and physical properties are used based on the local air and steam temperatures. Furthermore, row dependent air side heat transfer coefficients are calculated separately for each of the four turns by employing an averaging method since each turn of the coil has a different air flow area. All these are taken into account to derive the appropriate local air-side heat transfer coefficient for each increment.

An air-side fouling resistance of 0.001 (Hr-ft^2-°F)/Btu is applied in the PACC thermal analysis. This value is consistent with recommendations of the ESCOA Fin Tube Engineering Manual (Ref. 5.6-1).

Using the above described correlations and assuming 10% plugged tubes, the nominal PACC capacity has been determined to be 29.07 x 10^6 Btu/hr/tube bundle or 8.53 MW (17.06 MW/PACC).

The approach to conservatively determine PACC thermal performance included a sensitivity study where reasonable uncertainties were assumed in turn for each critical parameter. The parameters and uncertainty ranges evaluated and their effect on heat transfer are given in Table 5.6-14.

The most critical source of uncertainty, the air side heat transfer coefficient, was conservatively assumed to have a 25% uncertainty. This was based on ESCOA data (Ref. 5.6-1) which indicates a maximum uncertainty of 20%. This uncertainty in air side heat transfer coefficient could result in a 12.7% reduction in PACC capacity. Combining all the uncertainties given in Table 5.6-14 using the method described by Kline and McClintock (Ref. 5.6-9) results in a minimum PACC heat rejection rate of 15 MW.

5.6.1.3.2.3 Thermal Hydraulic Stability

Thermal hydraulic stability in the PACC condensate return line and in the PACC heat exchanger bundle will be investigated analytically and experimentally (during component test) to assure there will be no significant impact on the PACC performance. The large condensate return lines will be designed to assure stability of the two phase gravity flow.

Flow instability is sometimes associated with parallel condensing tube bundles. Features to ensure steam/water flow stability have been successfully applied to eliminate flow instabilities in gravity drains of moisture separator reheater tube bundles in steam turbine cycles of LWR plants. This will be addressed in the analysis.

In the PACC unit, shell-side air or tube-side steam maldistribution would cause similar effects. Analytical and experimental development programs are currently underway to develop circumferential and axial flow distribution features (e.g., bundle air-side inlet and outlet perforated plate distribution screens) to provide sufficiently uniform air flow distribution to assure that the outlet conditions of all tubes remain uniformly subcooled. A three-dimensional flow analysis will be used to define the design of the required air flow distributing features. The design of these air flow distribution features will be refined and verified by tests using a one-fifth scale isothermal air flow model. Final confirmation of acceptable air flow distribution and resulting uniformity of condensate subcooling will be obtained during the PACC lead unit test. This will preclude unstable flow or cyclical cooling modes which have been observed under variable heat load conditions in similar heat exchangers. Inlet orifices with four size variations to overcome the effect of manifold pressure variation are provided to preclude tube side flow maldistribution.

Individual tube oscillations may occur, even in the absence of system oscillations, since this is a function of the nature of individual tube flow. For PACC, oscillatory flow, corresponding to slug or plug flow, will be predicted over part of the condensation path. These flow regimes are expected

to impart some individual tube oscillations. The design bases of the PACC tube to outlet header connection include a conservatively postulated cyclical subcooling for which ASME code fatigue requirements will be met.

It is expected that the PACC air flow design and tube orificing capability will obviate system instability across the heat exchanger bundle. Experience with reheater tube bundles suggests the individual tube oscillations will be acceptable. Specifically, this will be less severe than conservatively assumed cycling to be used in PACC fatigue design analysis.

A full-scale PACC test conducted prior to FSAR submittal with low pressure (165-250 psia) steam provides a means for simulating PACC operation at CRBRP refueling conditions. This condition is included as part of the PACC duty cycle which occurs during plant startup from and plant shutdown to refueling temperature of 400°F. This full scale PACC test, to be performed on the lead unit, will address thermal performance and stability.

5.6.1.3.3 Pump Characteristics

The feed pump head and torque as a function of feed pump flow rate will be determined as the design progresses.

5.6.1.3.4 Valve Characteristics

The flow coefficients of all valves and the closing times of all isolation valves will be determined as the design progresses.

5.6.1.3.5 Pipe Leaks

Pipe leaks can be categorized under identified leakage and unidentified leakage. Identified leakage is leakage into closed systems, such as from pump seals or valve packing leaks where the leakage is captured and directed to a sump or collection tank. These leaks occur in system components where it is not practical to make the components 100% leaktight. The existence of identified leakage is known in advance and is provided for in the system design.

References to Section 5.6

5.6-1 ESCOA Fintube Engineering Manual, 1979.

5.6-2 Boyko, L. D. and Kruzhilin, G. N., "Heat transfer and hydraulic resistance during condensation of steam in a horizontal tube and in a bundle of tubes", Int. J. Heat Mass Transfer, 10, pp. 361-373 (1967).

5.6-3 Baker, O., "Simultaneous flow of oil and gas", Oil and Gas Journal 53, p. 185 (1954).

5.6-4 Soliman, M., Schuster, J. R. and Berenson, P. J., "A general heat transfer correlation for annular flow condensation", J. Heat Transfer 90, p. 267 (1968).

5.6-5 Chato, J. C., "Laminar condensation inside horizontal and inclined tubes", ASHRAE Journal, Vol. 4, No. 2, p. 52, February 1962.

5.6-6 Lockhart, R. W. and Martinelli, R. C., "Proposed correlation of data for isothermal two-phase, two-component flow in pipes", Chem. Eng. Progress 45, p. 39 (1949).

5.6-7 Baroczy, C. J., "Correlation of liquid fraction in two-phase flow with application to liquid metals", NAA-SR-8171 (April 1963), Atomics International, Canoga Park, California.

5.6-8 Baroczy, C. J., "A systematic correlation for two-phase pressure drop", Chem. Eng. Prog. Symp. Ser. 62, No. 64, p. 232 (1966).

5.6-9 Kline, S.J., and McClinlock, F.A., "Describing Uncertainties in Single-Sample Experiments", Mechanical Engineering, January 1953.

TABLE 5.6-14

PACC HEAT TRANSFER UNCERTAINTIES

Parameter	Uncertainty	Heat Transfer Reduction, %
Air-side heat transfer coefficient	± 25%	12.68
Water-side heat transfer coefficient	± 20%	.95
Air-side fouling factor	+ .0015 / - .0005 $hr-ft^2-F/Btu$	.33
Water-side fouling factor	± .0005 $hr-ft^2-F/Btu$	1.45
Contact thermal resistance between the tubes and fins	± .001 $hr-ft^2-F/Btu$	2.26
Staggered/in-line flow ratio	+ 0.66 / - 0.34	2.72
Circumferential flow variation	± 30%	.67
Axial flow maldistribution	± 10%	1.05
Air-side system pressure drops		
- transition	± 10%	.18
- inlet louvres	+ 200% / - 50%	.90
- diffuser	+ 62% / - 50%	.36
- casing	± 10%	.04
- screen (perforated plate)	± 20%	.27
- coil assembly	± 30%	.72
- coil center	± 15%	.76
- expansion	± 15%	.09
- outlet louvres	+ 200% / - 50%	1.26

Question CS760.49

Included in the continuing analysis submitted by the applicant in response to concerns voiced in Question Q001.581, reference is made to an Evaluation Basis Leak (EBL). This EBL is defined as that sodium leak rate equal to the design sodium flow rate in the piping and is maintained until the maximum available system inventory is discharged through the break for the primary HTS piping analysis. The applicant has translated this to specify a constant spill rate of 33,500 gallons per minute for 36 seconds. The basis for this assumption is not specifically defined. For example, when a break occurs, the pumps will immediately respond by over-speeding due to the sudden depressurization. Thus, it is unclear as to the constant spill rate assumption. Furthermore, the arbitrary sudden termination at 36 seconds is not substantiated.

Provide in detail the basis for this EBL. Substantiate for the assumed leak size that it provides a conservative leak rate.

Response

As stated in the response to Question Q001.581, the Evaluation Basis Leak (EBL) flow rate was selected to approximate the maximum flow from the PHTS piping into the Reactor Cavity, the PHTS cells, and the Overflow and Primary Sodium Storage Tank Cell. The 36 second spill duration is obtained by dividing the maximum spill volume (20,000 gal.) by the flow rate (33,500 gal/m).

The break size assumed in the EBL is considerably beyond the design base. The piping Design Basis Leak (DBL) is defined and discussed in Section 3.6.1.1 of the PSAR. This DBL provides a conservative leak rate for system evaluation. The analyses and test results are presented in WARD-D-0185, "Clinch River Breeder Reactor Plant Integrity of Primary and Intermediate Heat Transport System Piping in Containment", September 1977, and show that no leak rate greater than 8 gpm can be deterministically derived.

In the hypothetical event that a leak as large as an EBL did occur, the Plant Protection System (PPS) would trip the sodium pumps within seconds on either flow mismatch or speed mismatch. Pump over-speed, would be prevented by the pump drive system controls. Erroneous information to the pump flow controllers could not result in pump over-speed conditions beyond five percent because of the synchronous nature of the pump drive system. Furthermore, there is no driving pressure in the PHTS to cause pump overspeed.

Since no reasonable conditions or physical mechanisms have been identified which would result in a leak rate of the magnitude identified in the EBL it seems inappropriate to further analyze this event.

Question CS760.50

The applicant admits that the EBL spill rate is not as high as might be postulated for a double-ended rupture of the primary HTS piping. Thus, the potential for larger spills exists.

The applicant is requested to provide analyses addressing the consequences of sodium spills from the primary hot leg which a) include pipe break sizes up to a double-ended break; b) conservatively include the extent of cell liner failure, if any, initially assumed and c) if there is liner failure, utilize the sodium/water reaction data resulting from the Sandia experiments.

Response

As indicated in Question Response CS760.49 further analysis of the EBL in the PHTS piping is inappropriate. For similar reasons, analysis of a double-ended rupture is also inappropriate. However, sensitivity analyses for important input parameters to the SPRAY code for sodium leaks from the hot leg of the Primary Heat Transport System (PHTS) piping into the PHTS cells have been performed and are discussed in Question Response Q001.700. This sensitivity analysis encompasses the conditions associated with a double-ended rupture of the PHTS.

Analysis of a leak rate of 150 percent full flow (50,250 gpm) indicated that cell pressurization greater than that from a hypothetical EBL would not occur (Figure Q001.700-3).

In all cases studied in the sensitivity analysis, the PHTS cell design pressure of 30 psig was not approached. Failure of the engineered safety feature cell liner would not occur as a result of a double-ended rupture of the PHTS piping.

Question CS760.113

What are the SGAHRS system setpoints? At what drum level is the auxiliary feed full and full off? How is the PACC controlled?

Response

The SGAHRS setpoints are shown in the attached PSAR Table 7.4-2. Following a SGAHRS primary initiation (high main steam to main feedwater flow ratio) the motor driven pumps will begin to feed the steam drum when the drum level drops to 4 inches below Normal Water Level (NWL) and control the water level in each drum at 4 inches below NWL. With a secondary SGAHRS initiation (low steam drum level) the motor driven pumps will begin to feed each steam drum when the drum level drops to 8 inches below NWL and control the level in each drum at 4 inches below NWL. The turbine-driven pump will start delivering water to each drum when the drum level drops to 18 inches below NWL and maintain steam drum at that level. The AFW flows to each individual steam drum are controlled automatically by control valve controllers.

PACC control is described in revised PSAR section 7.4.1.1.2.

Material Specifications

A list of material specifications for the SGAHRS vessels, piping, pumps, and valves is given in Table 5.6-3. Corresponding weld materials specifications are listed in Table 5.6-4.

5.6.1.1.5 Leak Detection Requirements

Leak detection requirements for the SGAHRS are as follows:

a. Excessive leakage of high pressure and temperature water from the steam generator system into the SGAHRS will be detectable

b. Excessive leakage of low pressure water will be detectable

The methods used for leak detection are described in Section 5.6.1.2.5.

5.6.1.1.6 Instrumentation Requirements

Functional requirements of the SGAHRS instrumentation are to monitor the following parameters and to warn the plant operator of any abnormal or dangerous conditions in the following parameters:

1. Protected water storage tank level, pressure, and temperature
2. Auxiliary feedwater pump inlet pressure and temperature
3. Auxiliary feedwater pump discharge temperature and pressure
4. Auxiliary feedwater flow and temperature
5. Position of all isolation and control valves
6. Drive turbine steam supply and discharge pressure
7. Operating status of protected air cooled condenser
8. Operating status of all motors
9. Startup of air-cooled condenser
10. Startup of auxiliary feedwater pumps.

The plant protection system instrumentation and control equipment associated with the active components which must operate to insure that SGAHRS performs its safety function are described in Section 7.4. The SGAHRS control set points are included in Table 7.4-2 "SGAHRS Nominal Set Points."

7.4 INSTRUMENTATION AND CONTROL SYSTEMS REQUIRED FOR SAFE SHUTDOWN

The Instrumentation and Control Systems necessary for safe shutdown are those associated with monitoring of core criticality, decay heat removal (SGAHRS portion), outlet steam isolation, and control room habitability.

Monitoring of core criticality is effected by the Flux Monitoring System (Section 7.5.1). The control room habitability is covered in Chapter 6. Thus, this section treats the control and instrumentation needs for decay heat removal by the Steam Generator Auxiliary Heat Removal System (SGAHRS) and outlet steam isolation by the Outlet Steam Isolation System (OSIS); control and instrumentation for Direct Heat Removal Service (DHRS) is discussed in Section 7.6.

7.4.1 Steam Generator Auxiliary Heat Removal Instrumentation and Control System

7.4.1.1 Design Description

7.4.1.1.1 Function

The SGAHRS (fluid system and mechanical components as described in Section 5.6.1, and electrical components as described below) provides the heat removal path and heat sink for the nuclear steam supply system following upset, emergency, or faulted events which render the normal heat sink unavailable.

The SGAHRS Instrumentation and Control System in conjunction with the PPS detects the need for, initiates, and controls the alternate heat removal path when the normal heat sink is unavailable. The SGAHRS nominal control setpoints shown in Table 7.4-2 are discussed in the following subsections.

7.4.1.1.2 Equipment Design

The mechanical system for which the SGAHRS I&C is provided is briefly described below.

When actuated, the SGAHRS draws water from a Protected Water Storage Tank and pumps it to each steam drum. Two supply lines are provided for each steam drum. One line is supplied by two half-sized, motor-driven feedwater pumps while the other is supplied by a full-sized, turbine-driven pump. Each supply line provides a flow control valve and an isolation valve at the inlet to each steam drum. The isolation valves are provided to isolate the auxiliary feedwater system from the steam generator system during power operation and to provide leak isolation during SGAHRS operation.

In addition, a Protected Air Cooled Condenser (PACC) supplied with each steam drum is placed into operation. This system rejects heat to the atmosphere via convection. Saturated steam is supplied to the condenser from the steam drum

and saturated water is returned. This steam and water loop is driven by natural circulation. Each PACC unit consists of two tube bundles, two sets of louvers and two fans. Regulation of heat rejection is accomplished by controlling the air flow across the condensing tubes through adjustment of inlet louver and fan blade pitch positions. The air side flow is driven by either forced or natural convection.

The arrangement of SGAHRS equipment is shown in Figure 5.1-5 (SGAHRS P&ID). Instrumentation and controls are provided for the components described below:

- o <u>Auxiliary Feedwater Pump Control</u> - Upon receipt of the SGAHRS initiation signal, (see Section 7.4.1.1.3), the two motor driven pumps are started, resulting in both pumps coming on line and operating at constant speed. In addition, the isolation valves in the steam supply lines from the steam drums to the turbine driven pump are opened. At the turbine inlet a pressure regulating valve reduces the steam supply pressure to the 1000 psig required by the turbine drive. The turbine drive mechanism is equipped with a governor to provide speed regulation. Each auxiliary feedwater pump can also be actuated manually at the operator's discretion.

  Each pump control includes a "Normal Long Term Cooldown (LTC)" mode selector. In "normal" mode, the pumps start on SGAHRS initiation. In the "LTC" mode, the operator may shutdown any or all AFW pumps provided the steam drum water level is above the trip point setting. When in the "LTC" mode, the pumps come on line automatically when the steam drum water level drops to a low level trip point.

- o <u>Auxiliary Feedwater Flow Control</u> - The Auxiliary Feedwater Isolation Valves are opened upon receipt of the SGAHRS initiation signal. During SGAHRS operation, these valves close automatically upon indication of a sodium/water reaction, a high steam drum level, a steam drum pressure less than 200 psig, or AFW flow greater than 150% of full flow for 5 sec. This automatic closure occurs only in the affected loop. If the valves are closed by a high drum level signal they will reopen automatically when the drum level falls to the low drum level trip point. The flow to the steam drum is controlled with a control valve that is positioned by a single controller. Manual control of the Auxiliary Feedwater Flow Control valves is provided at the main control panel and at the local SGAHRS panel.

- <u>Protected Air Cooled Condenser Control</u> - The Protected Air Cooled Condenser louvers are opened and the fans started upon receipt of either a SCRAM or the SGAHRS initiation signal. The PACCs control the steam drum pressure to a variable setpoint with a nominal setting of 1400 psig by regulating heat rejection. Regulation of heat rejection is accomplished by controlling the air flow across the condensing tubes thru adjustment of inlet louver & fan blade pitch positions. During the airside forced convection mode of PACC operations, the air flow is varied by changing fan blade pitch with inlet louvers maintained at full open position. In the natural circulation mode of PACC operation, the air flow is varied by changing the position of the inlet louvers. The fan blades and inlet louvers are positioned by automatic controllers. Manual control of the inlet louver position and fan blade pitch is provided. Manual controls are also provided for the blower motors. The outlet louver is interlocked with the inlet louver. It opens automatically when the inlet louver actuator is energized. If a high concentration of sodium aerosol in each PACC cell is detected, redundant trip logic generates trip signals
to shutdown the affected PACC system for approximately 1 1/2 hours.

- <u>Pressure Controlled Bypass Valve</u> - To prevent overheating of the Auxiliary Feedwater Pumps at reduced flow, each pump is provided with a bypass line from the discharge back to the Protected Water Storage Tank. The valve in the bypass line is normally open upon initiation during pump startup. After startup, the valve closes and then opens when pump discharge pressure rises to 1970 psig and closes when the pressure drops below 1820 psig.

- <u>Auxiliary Feedwater Isolation Valves and Pump Inlet Isolation Valves</u> - The isolation valves in each of the supply lines to the steam drums (AFW isolation valves) are provided to insure an uninterrupted supply of auxiliary feedwater to unaffected loops following failures in a loop which would otherwise limit the effectiveness of the auxiliary feedwater system. The isolation valves at the pump inlets are provided to prevent loss of water from the Protected Water Storage Tank (PWST) in the event of a failure between these valves and the AFW isolation valves and to allow switching suction from the PWST to the condensate storage tank.

- <u>Superheater and Steam Drum Vent Control Valves</u> - These valves are opened upon SGAHRS initiation and depressurize the steam drums to the valves respective setpoint levels. The superheater vent control valve setpoint is 1475 psig and the steam drum vent control valve setpoint is 1550 psig. The valves function to provide steam release during the venting period until the PACC units can remove the heat load in a closed loop manner.

o PACC Noncondensible Vent Valve Control

These valves are provided to vent noncondensibles from the PACC tube bundles during normal plant and PACC operation, and for PACC heatup following maintenance. Control of PACC noncondensible vent valves is by differential temperature control. The temperature differential between a concentration of non-condensible gases in a collection pipe and saturated steam temperature, measured in the PACC outlet header, opens the vent valve. Venting is stopped when saturated steam enters the collection pipe and the temperature differential drops below the set point. The valves are also capable of actuation by remote manual operation.

TABLE 7.4-2

SGAHRS NOMINAL SET POINTS

	Set Point
SGAHRS Primary Initiation Signal: High Main Steam to Main Feedwater Flow Ratio	1.3
SGAHRS Secondary Initiation Signal: Low Steam Drum Level (Inches from Normal Water Level)	-8
Turbine-Driven AFW Pump operating Speed (RPM)	4000
AFW Pump Recirculation Valve (52AFV-108) (Note 1)	
Pump Pressure - Open Valve (psig)	1970
Pump Pressure - Close Valve (psig)	1820
AFW Control Valve (52AFV-104 (Note 1):	
Steam Drum Level Control:	
Motor-Driven Pumps (in. from normal water level (note 6)	-4
Turbine-Driven Pumps (in. from normal water level (note 6)	-18
Flow Limiter (lbm/hr)	264,500
Drive Turbine Pressure Control Valve (52AFV-121)(psig)(Note 1) Controls steam pressure to Drive Turbine at:	1000

TABLE 7.4-2
SGAHRS NOMINAL SET POINTS (cont'd)

	Set Point
AFW Isolation Valve (52AFV-103 (Note 1):	
Valve Closes on:	
High AFW Flow for 5 sec. (lbm/hr)	378,000
Low Steam Drum Pressure (psig)	200
High Drum Level (in. from normal water level (Note 2 and 6)	+8, +12
Sodium/Water Reaction	Indication
AFW Pump Test Loop Isolation Valves:	SGAHRS
Valves Close on the SGAHRS Initiation signal	Initiation
Steam Drum Vent Valves (52AFV-117) (psig) (Note 1) control Steam Drum Pressure at:	1550
Superheater Vent Valves (52AFV-116) (psig) (Note 1) control Steam Drum Pressure at:	1475
Steam Drum Level at which AFW pumps automatically restart in long term cooldown mode (inches from normal water level):	
Motor-Driven Pump (52AFP002A)	-8
Motor-Driven Pump (52AFP0028) (Note 3 and 6)	-8
Turbine-Driven Pump (52AFP001) (Note 4 and 6)	-18
Protected Air Cooled Condenser (PACC) (psig) controls steam drum pressure at: During refueling and other long term cooldown operations: PACC nominal setpoint is 250 (psig)	1400
PACC Vent Valves (52ACV-129 (Note 1) Control by:	Note 5

TABLE 7.4-2
NOMINAL SET POINTS (Cont'd)

NOTES:

1. The capability for the operator to assume manual control of the indicated functions from either the control room or the local panel is provided.

2. Valves will reopen should steam drum level fall to the low level trip (-8 in. from normal water level). Valves in the motor-driven AFW pump loops close at +8 in. from normal water level while the valves in the turbine-driven AFW pump loops close at +12 in. from normal water level.

3. In the long term cooldown mode, the second motor driven pump automatically restarts after a 1-minute delay if steam drum level remains at -7 in. or lower.

4. Steam drum pressure must be above 1000 psig to initiate turbine operation.

5. PACC vent control valves are controlled by the temperature differential between the noncondensible gas collection pipe and the steam saturation temperature measured in the PACC outlet header.

6. Normal steam drum water level is 1 inch above drum centerline.

Question CS760.116

The presentation describing the protected air cooled condensers (PACC) needs clarification. Details are needed with respect to tube size and number, tube inner and outer diameter, air volume constraints, estimated natural draft air speed, fan speeds, and so forth. Natural circulation is easily demonstratable if the heat transfer is known. It is essential that the heat removal capability be established for the PACCs under the varying operating conditions.

Response

A description of the PACC heat exchanger tubes is provided in revised PSAR Section 5.6.1.2.3.1, "Protected Air Cooled Condensers (PACC)."

The forced draft air flow for each tube bundle is provided by an axial flow fan which operates at 1200 rpm. At thermal hydraulic design conditions, the air flow is 77600 SCFM with a corresponding fan design power requirement of 53 bhp.

The PACC design will provide air flow control from 10 to 100 percent of rated flow. The PACC design will have natural draft capability. Under natural draft operation an estimated heat removal capability of 32 percent per PACC is available and lead unit tests will be performed at reduced water/steam side pressure to confirm the natural draft heat rejection capability.

5.6.1.2.3.1 Protected Air Cooled Condensers (PACC)

Component Description

The PACC is a tube-type steam condenser constructed of carbon steel. Heat is rejected to the atmosphere by condensing the saturated steam from the steam drums by forced circulation of air over the tube bundles.

Each unit is sized to reject 15 MWt under conditions of forced convection on the air side and natural circulation flow on the steam/water side. Each PACC has two half-size tube bundles, two variable blade pitch fans and two sets of variable position louvers to control airflow and, therefore, heat rejection. The electrical power supplies and instrument and control circuits for the PACCs are Class 1E. Refer to PSAR Section 7.4 for information on the power sources and I&C.

The arrangement of PACC is illustrated in Figures 5.6-8 and 5.6-9. Air is delivered from axial fans (one for each tube bundle) into the insulated plenum surrounding each tube bundle. Air flows circumferentially around the tube bundle, then radially inward through the fin tube bundle into a central core. Air then flows upward through the central core and exhausts through louvers to an exhaust stack.

Each tube bundle consists of 50 finned tubes connected in parallel between vertical pipe headers. Each tube is approximately 100 ft. long and, of the 100 ft. length, 95 ft. is finned. The individual finned tubes are formed in a conical spiral of approximately four concentric turns with a slope toward the center. The tubes are connected in parallel between vertical pipe headers. The inlet header is on the outside and outlet header is in the center of spiraled coils. The finned tubes are made of 2 inch O.D. tubes with 0.156 inch minimum wall as shown on Figure 5.6-10. The O.D. of the fin is 3.28 inches. The fins are serrated into 0.156 inch segments from continuous strip 0.050 inch thick x 0.75 inch wide. The strip is first formed into the shape of an "L". The strip is then wound around the tube O.D. to complete the footed fin attachment to the tube. There are two separate tube bundles in each PACC.

Design Data

Design Conditions:

Pressure	2200 psig
Temperature	650°F

Thermal Hydraulic Performance:

Heat Removal	15 MWt (7.5 MWt per tube bundle)
Steam Pressure	1450 psig
Steam Temperature	592°F
Moisture	0%
Condensate Temperature	592°F
Air Temperature	100°F
Air Pressure	14.3 psia

Design Criteria

The power supplies to the PACC fans, instrumentation and controls are Class IE. The Instrumentation and Control System is a safety related system and as such will meet the requirements of the regulatory guides and standards as listed in Tables 7.1-2 and 7.1-3 of the PSAR. The means of compliance are described in Section 7.1.2.

Three PACC units are provided, one for each heat transport loop, each capable of removing the total decay heat approximately 1 hour after shutdown. Each unit is single active failure proof in that no single active failure will result in the loss of more than 50% of heat removal capability. This is provided by utilizing two tube bundles, two fans, etc., such that at least half capacity is retained following the failure. The PACC unit is a Seismic Category I design, hardened against tornado missiles and designed to withstand the pressure loads from tornados. The PACC tube bundle design is based upon standard techniques for steam-to-air heat exchangers.

Operation and Control

The airflow is regulated by the use of variable position inlet louvers and fans with variable blade pitch. There are separate controls for the air side of each PACC for each of the two fans and for each of the two sets of louvers. The inlet louvers and fan blade pitch are positioned by controllers which compare steam drum pressure to the setpoint and generate position demand signals to the louvers and fan blade pitch drives as required to maintain pressure at the setpoint value. In order for the PACC to effect heat rejection control over the range of operation there are two modes of air side operation:

(1) Forced convection with the louvers open and airflow varied by changing the fan blade pitch.

(2) Natural circulation with airflow varied by changing the position of the inlet louvers.

The range of automatic operation is from 15% to 100% heat rejection. From 100% down to approximately 30% (4.5 MWt) the unit is operating in the first mode, and from 30% to 15% in the second mode. Control is accomplished by sensing and maintaining the steam pressure at the desired set point.

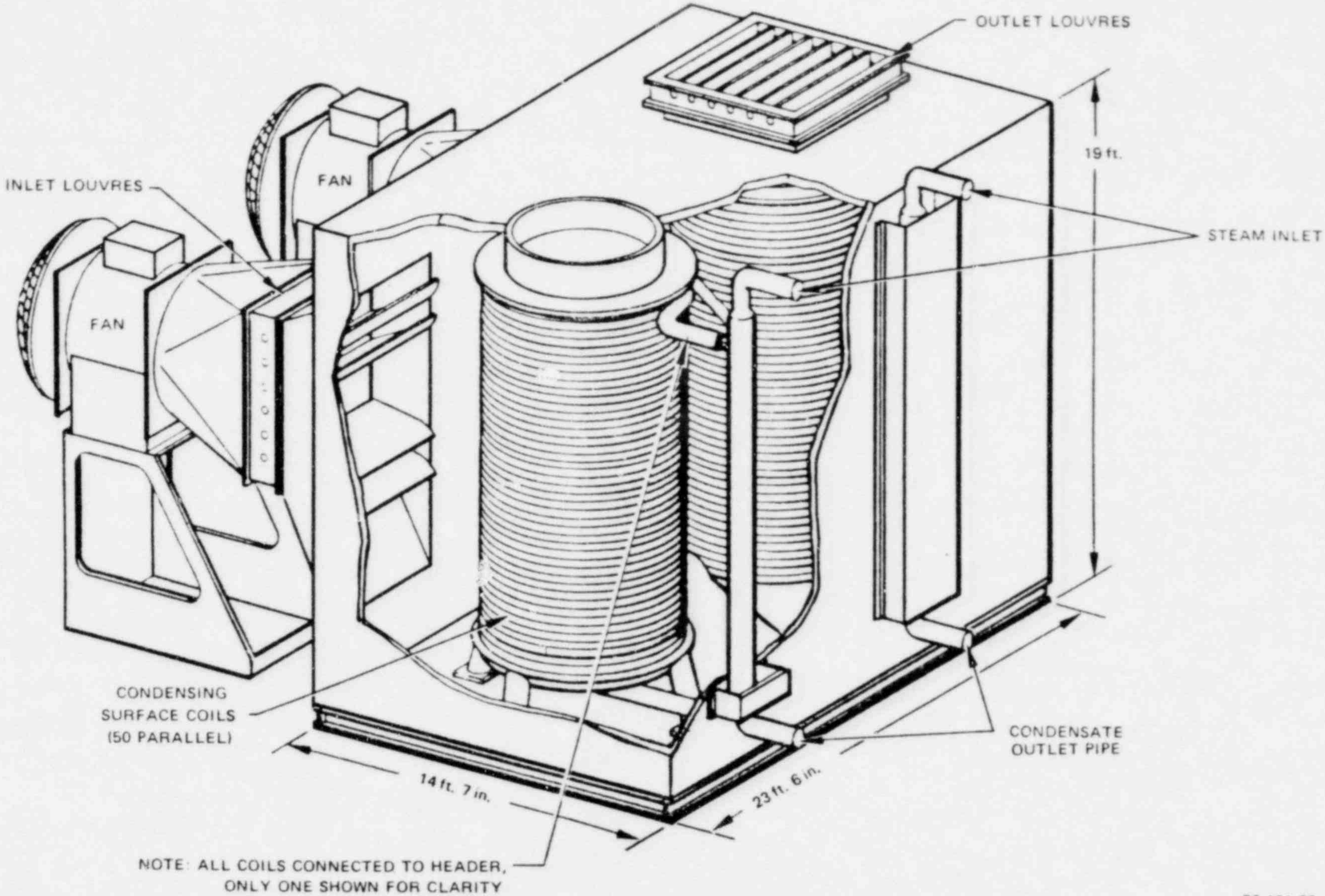


Figure 5.6-8 PROTECTED AIR-COOLED CONDENSER

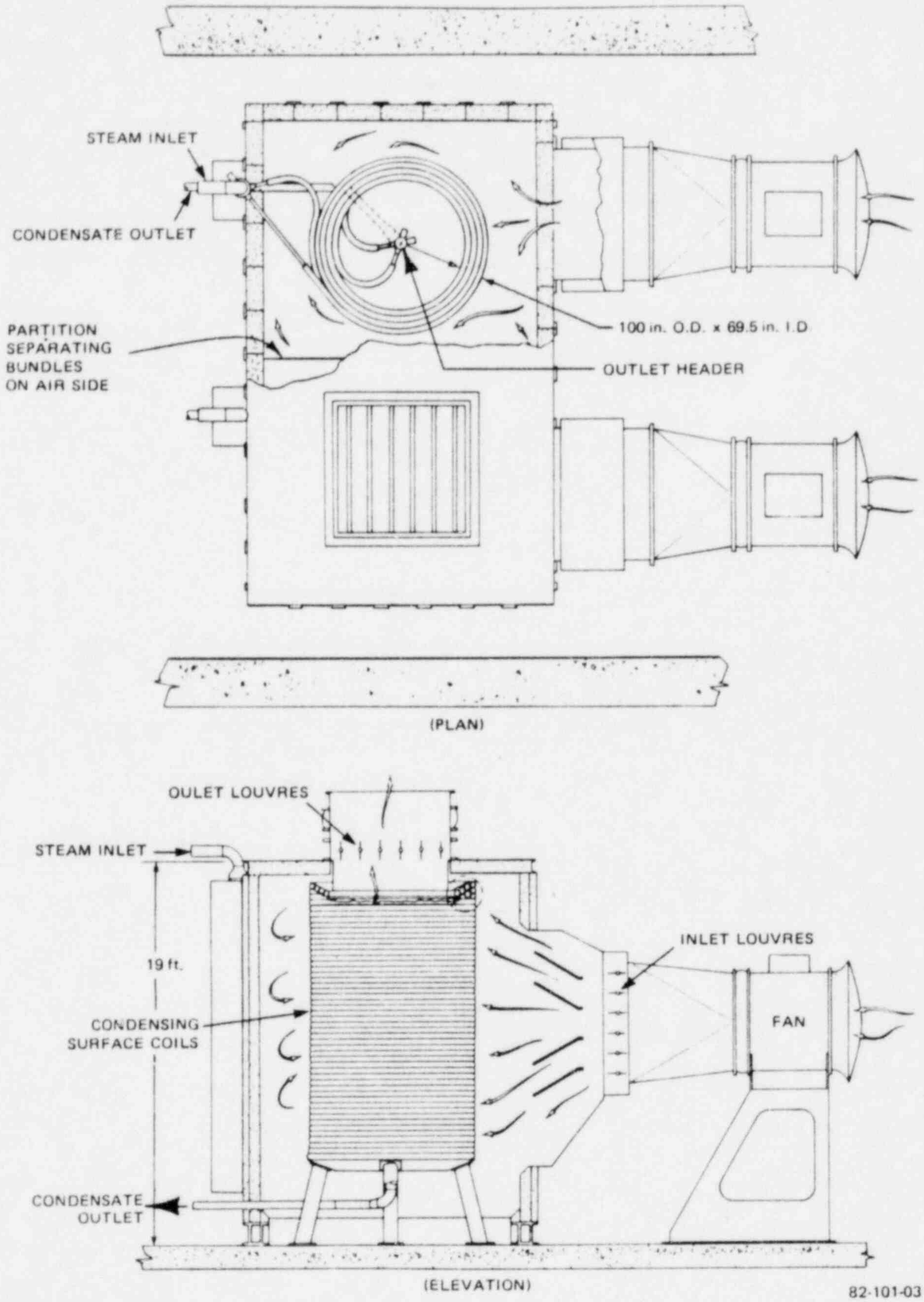


Figure 5.6-9 PROTECTED AIR COOLED CONDENSER

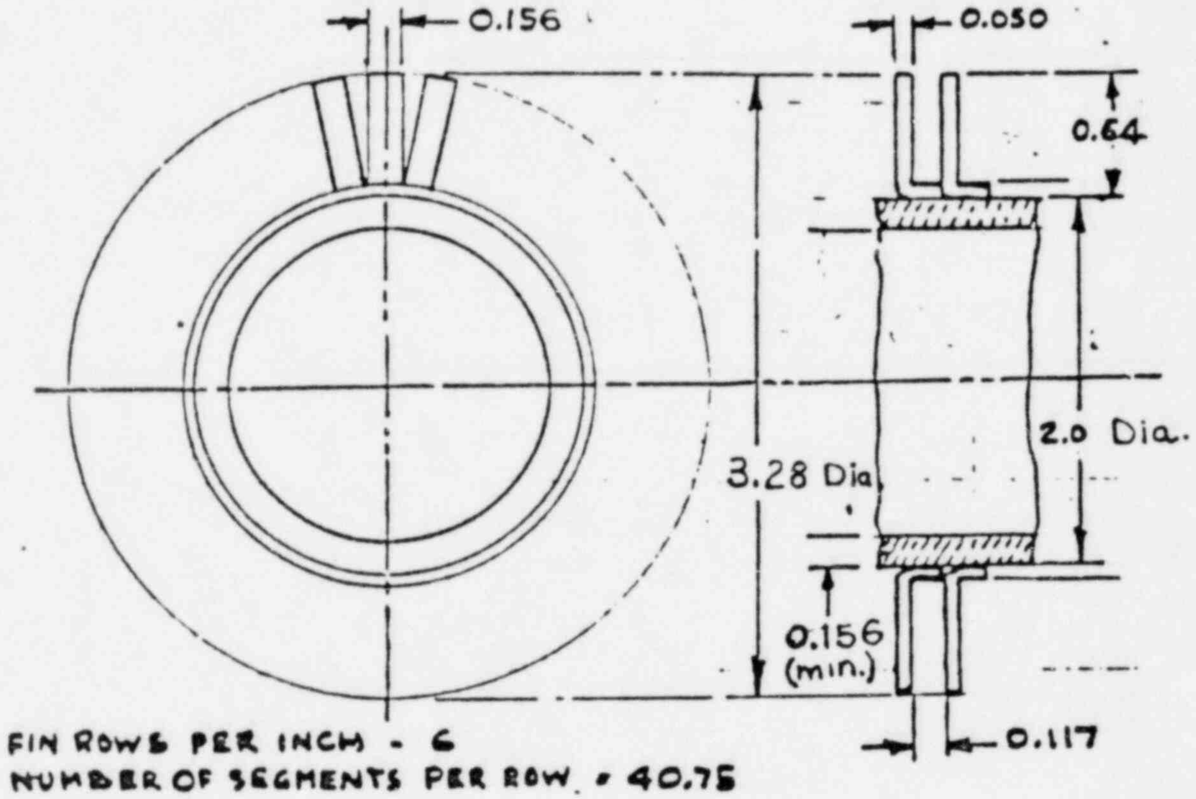


Figure 5.6-10 Nominal PACC Tube and Fin Geometry

Question CS760.131 Transient Effects (5.7.5)

In general, the design transients are not sufficiently described to understand the conditions or the analytical results. The transients are said to be more fully described in Chapter 15 but clarification is needed. In particular, the analysis for the OBE in Chapter 5 quotes a 5 minute manual plant trip whereas the respondence between Chapter 5 and 15 analyses for the loss of steam generator load is not self-contradictory, but needs to be addressed due to the difference in time scales.

a. What are the difference between the results presented in 5.7 and those analyzed in Chapter 15. Provide justification for differences.

b. For the loss of load transient (Section 5.7.3d) provide the steam generator temperature and pressure response and the core temperatures to 2000 seconds.

Response

No inconsistency between Chapters 5.7 and 15 has been identified. It should be noted that the apparent difference in the discussion of the Operating Basis Earthquake (OBE) in these two chapters is due to the differences in application of the OBE to the HTS (Chapter 5.7) and to the Reactor (Chapter 15.2 Reactivity Insertion Design Events). Paragraph 5.7.3.c has been amended to clearly describe the application of the OBE to HTS component analyses.

The steam generator temperature and pressure response and core temperature response is provided in Figures 5.7-6a-k. These data are based on the plant thermal hydraulic design conditions with the hot and cold leg sodium arbitrarily increased 20°F.

It should be noted that inadvertant actuation of the water/steam side of the Sodium/water Reaction Pressure System results in dumping of water/steam sides of both evaporators and the superheater.

Uncontrolled rod withdrawal during startup also results in an up temperature transient at the reactor vessel outlet although the transient occurs at a lower temperature than when the rod withdrawal starts from 100% power. Figure 5.7-5 depicts the transient initiated during startup.

Operating Basis Earthquake (OBE)

c. The operating basis earthquake results in reactive forces acting on the plant components as described in the Seismic Criteria Document. Five OBEs, each with 10 maximum peak response cycles, are assumed to occur over the design life of the plant. Four of these OBE's are assumed to occur during the most adverse Normal Operating Conditions determined on a component and design limit basis. The other one OBE is assumed to occur during the most adverse upset event determined on a component and design limit basis, and at the most adverse time in the upset event. Thus, the plant components are simultaneously exposed to the thermal effects of the thermal transients as well as the stresses of the OBE.

Loss of Steam Generator Load

d. Isolation and dumping of the water/steam sides of both evaporators and the superheater removes the load from that loop. This results in up temperature transients on the steam generator modules, the intermediate cold leg, the IHX intermediate inlet, the IHX primary outlet, and the reactor vessel inlet. The ensuing reactor trip then causes down temperature transients on these components. The intermediate cold leg temperature increases approximately 350°F in 400 seconds; then decreases approximately 220°F in 300 seconds. This transient is then transported to the IHX primary outlet and reactor vessel inlet. Figures 5.7-6 a-k presents the resulting transient at the intermeidate sodium pump, core & steam generators.

e. Inadvertent Opening of Superheater Outlet Power or Safety Relief Valve

This event results in a large increase in load without an accompanying increase in reactor power or sodium flows. It occurs when a super-heater relief valve inadvertently opens to increase steam flow from 40% to 100%. The event results in a reactor trip but overcooling occurs due to the open relief valve. The steam generators, inter-mediate cold leg, IHX intermediate inlet, primary cold leg and reactor vessel inlet drop in temperature about 150°F in 100 seconds. The reactor vessel outlet, primary hot leg, and IHX primary inlet drop in temperature about 200°F in 75 seconds. Figure 5.7-7 depicts the transient at the intermediate pump.

TABLE 5.7-1 (continued)

PRELIMINARY SUMMARY OF HEAT TRANSPORT SYSTEM DESIGN TRANSIENTS

DUTY CYCLE EVENT NUMBER[1]	Event Title	Frequency (Lifetime) Reactor Vessel	IHX	Primary Pump	Inter. Pump	Primary Check Valve	Evap.	Superheater
U-11b	Water side isolation & blowdown of evaporator module	--	--	--	--	--	7	7
U-11b	Adjacent evaporator during water side isolation and blowdown of evaporator	--	--	--	--	--	9	9
U-21a	Adjacent evaporator outlet relief valves open	--	--	--	--	--	3	3
E-9a	Superheater isolation & blowdown-outlet valve open	--	--	--	--	--	Note 4	Note 4
E-14	Inadvertent dump of intermediate sodium	--	--	--	--	--	Note 4	Note 4
OBE[5]	Operating basis earthquake	5	5	5	5	5	5	5
E-16	Three loop natural circulation	Note 4						
U-21b	Inadvertent opening of superheater outlet power or safety relief valve	42	19	24	14	26	13	13
U-23	Inadvertent opening of evaporator inlet dump valve	--	33	--	37	--	--	--
U-8	Primary pump pony motor failure	*15	5	--	--	--	5	5
E-1	Primary pump mechanical failure	Note 4	Note 4	--		Note 4	--	--
E-5	Loss of one primary pump pony motor with failure of check valve in that loop to shut	Note 4	Note 4	Note 4	--	--	Note 4	Note 4
E-6	Design basis steam generator sodium/water reaction	--	Note 4	--	Note 4	--	Note 4	Note 4
E-7	One loop natural circulation (from initial two loop operation)	Note 4	Note 4	--	--	--	Note 4	Note 4
E-15	DHRS Activation 24 Hours After Scram	2	2	--	2	2	2	2
E-16	Three loop natural circulation	Note 4	Note 4	Note 4	--	--	Note 4	Note 4

Notes: 4. Each component, or part of a component, must accommodate 5 occurrences of the most severe emergency transient for that component or part of a component (one every 6 years) and two consecutive occurrences of the most severe event (or of unlike events if consecutive occurrences of unlike events provide a more severe effect than two occurrences of the most severe event).

5. See Paragraph 5.7.3(c)

Figure 5.7-6a Average Channel Sodium Exit Temperature Top of Active Core vs. Time for Loss of Steam Generator Load (Dumping of Water/Steam Sides of Both Evaporators and the Superheater)

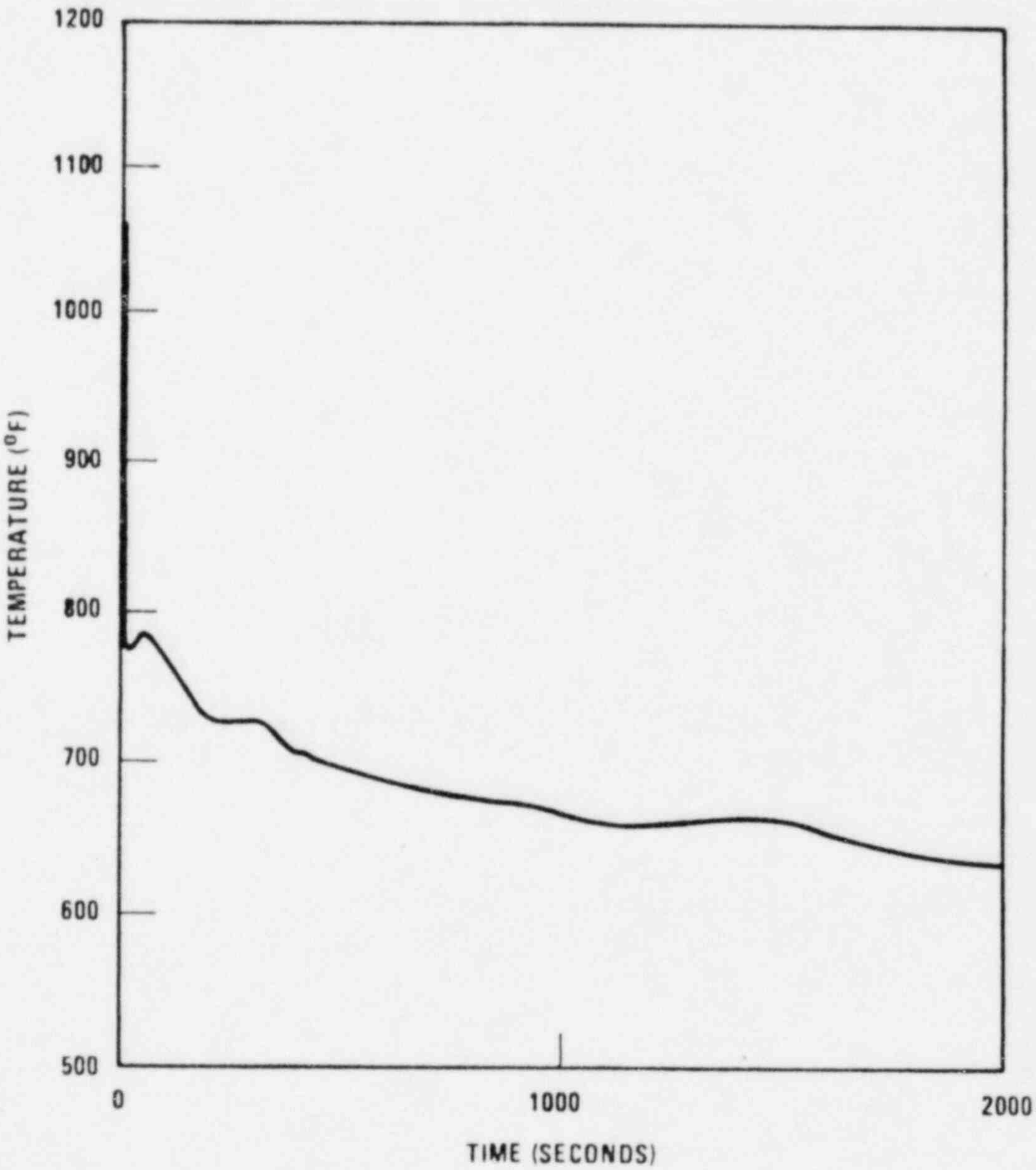


Figure 5.7-6b Maximum Channel Sodium Exit Temperature, Top of Active Core for Loss of Steam Generator Load (Dumping of Water/Steam Sides of Both Evaporators and the Superheater).

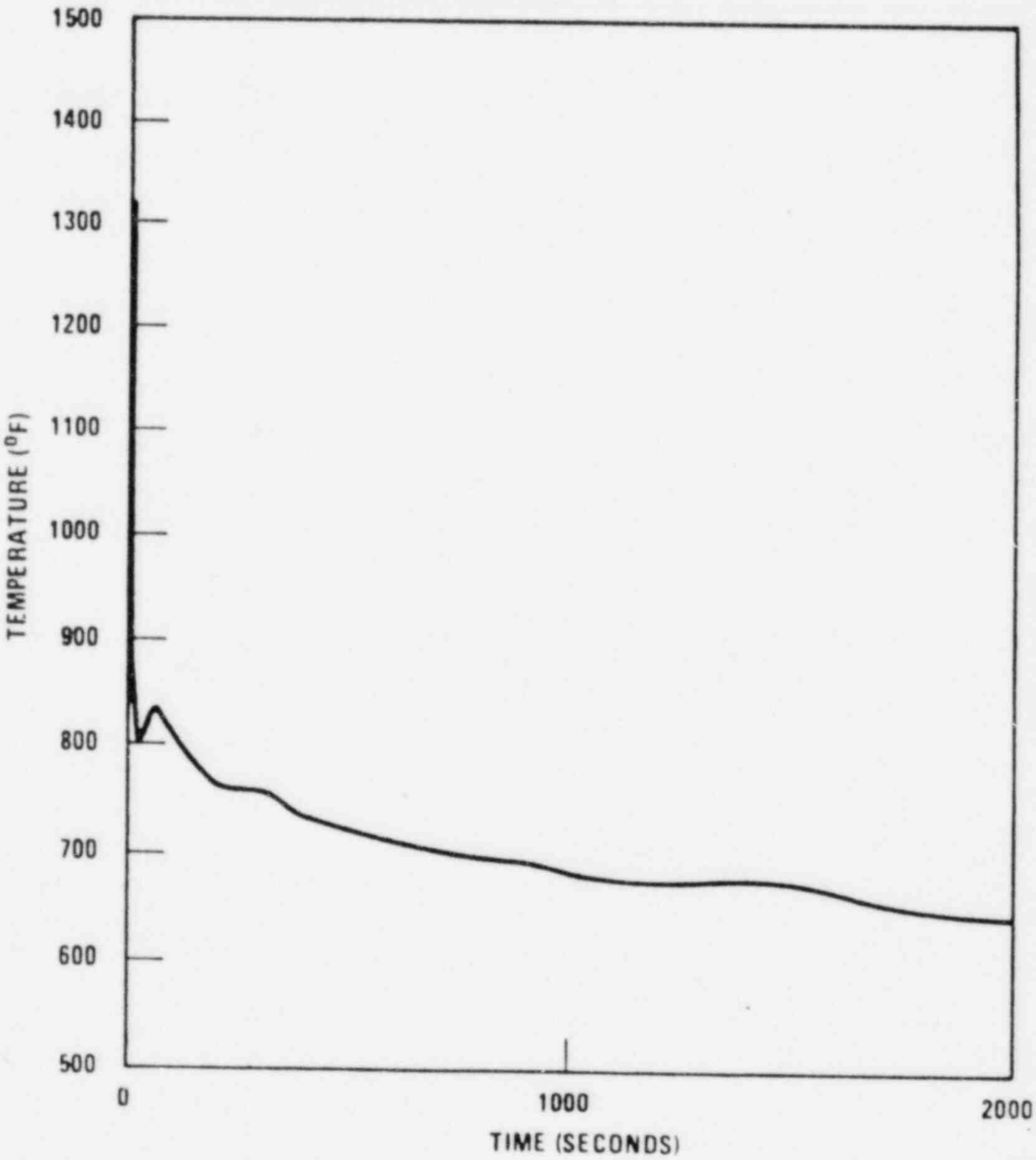


Figure 4.7-6C Blanket Hot Channel Sodium Outlet Temperature for Loss of Steam Generator Load (Dumping of Water/Steam Sides of Both Evaporators and the Superheater).

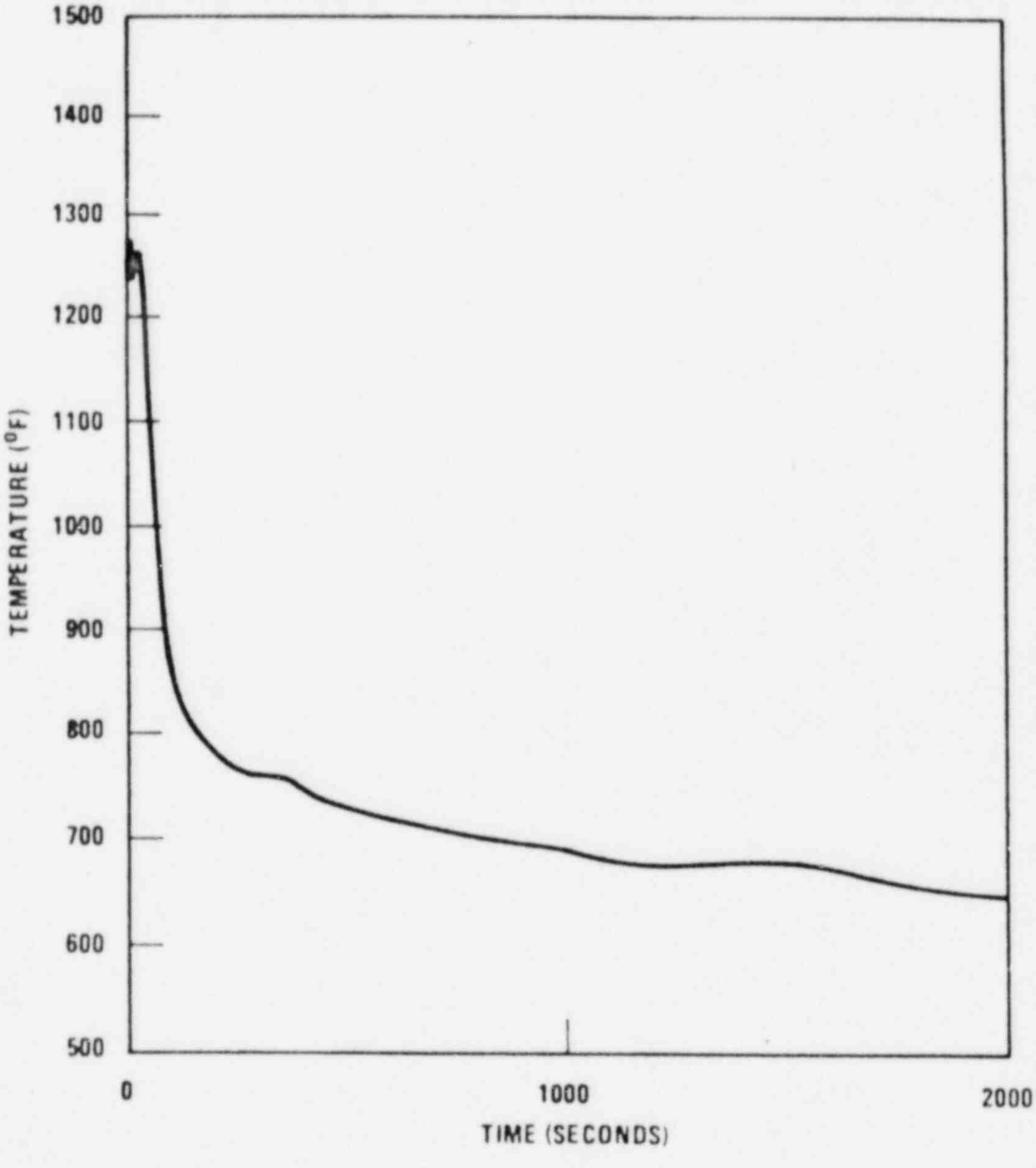


Figure 5.7-6D Reactor Vessel Exit Temperature for Loss of Steam Generator Load (Dumping of Water/Steam Sides of Both Evaporators and the Superheater).

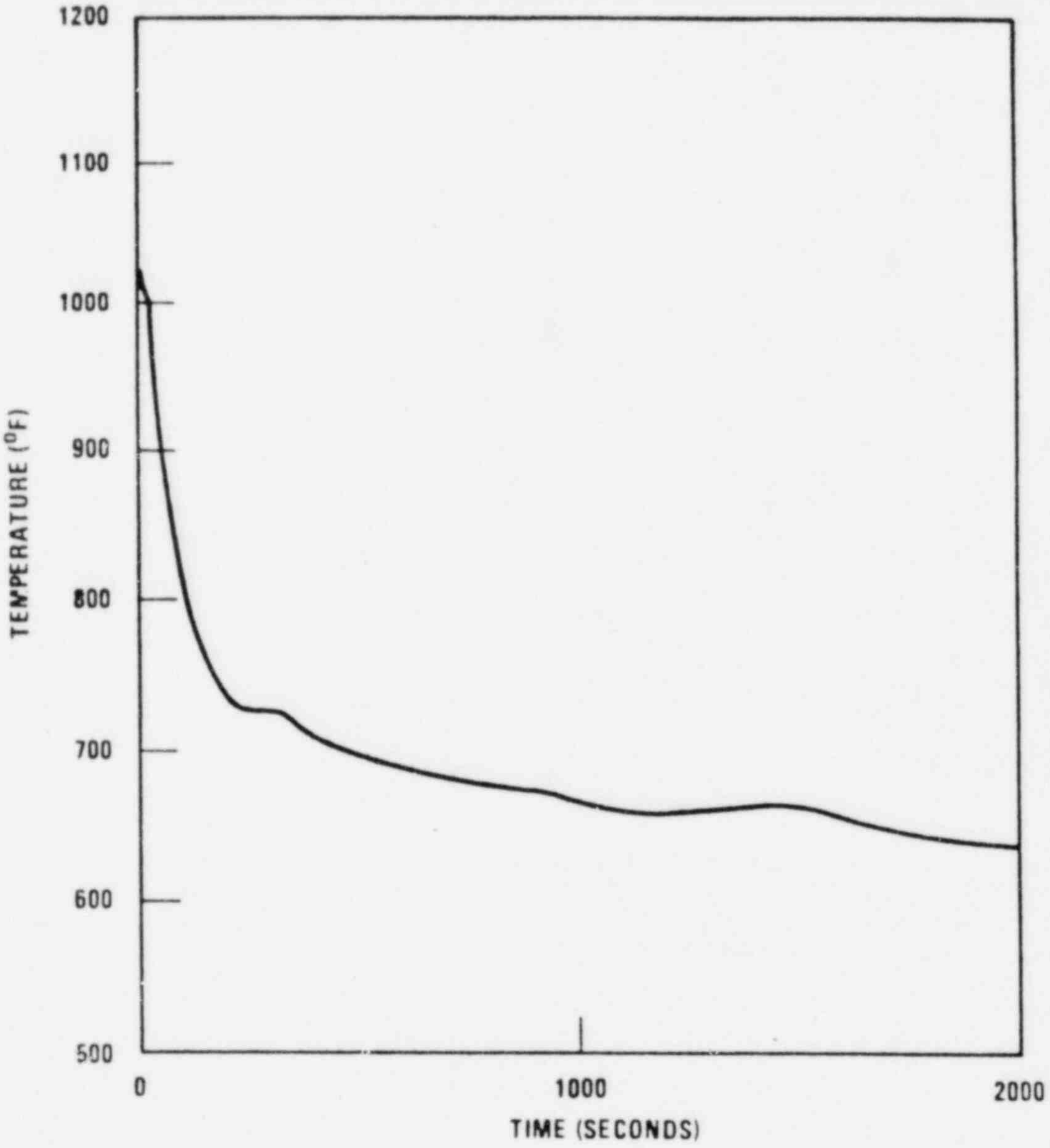


Figure 5.7-6E Affected Loop Superheater Sodium Inlet Temperature for Loss of Steam Generator Load (Dumping of Water/Steam Sides of Both Evaporators and the Superheater).

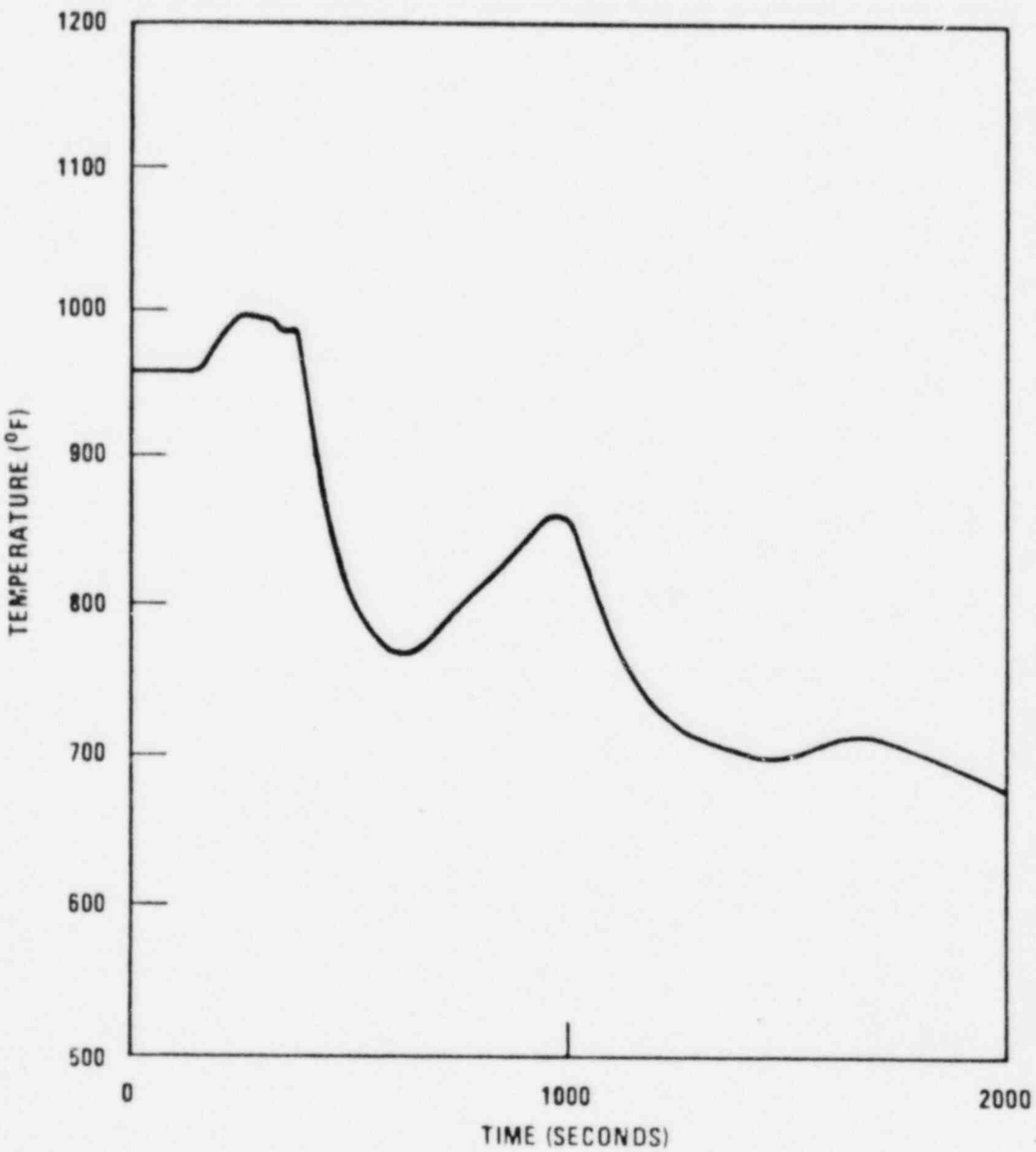


Figure 5.7-6F Affected Loop Evaporator Sodium Inlet Temperature for Loss of Steam Generator Load (Dumping of Water/Steam Sides of Both Evaporators and the Superheater).

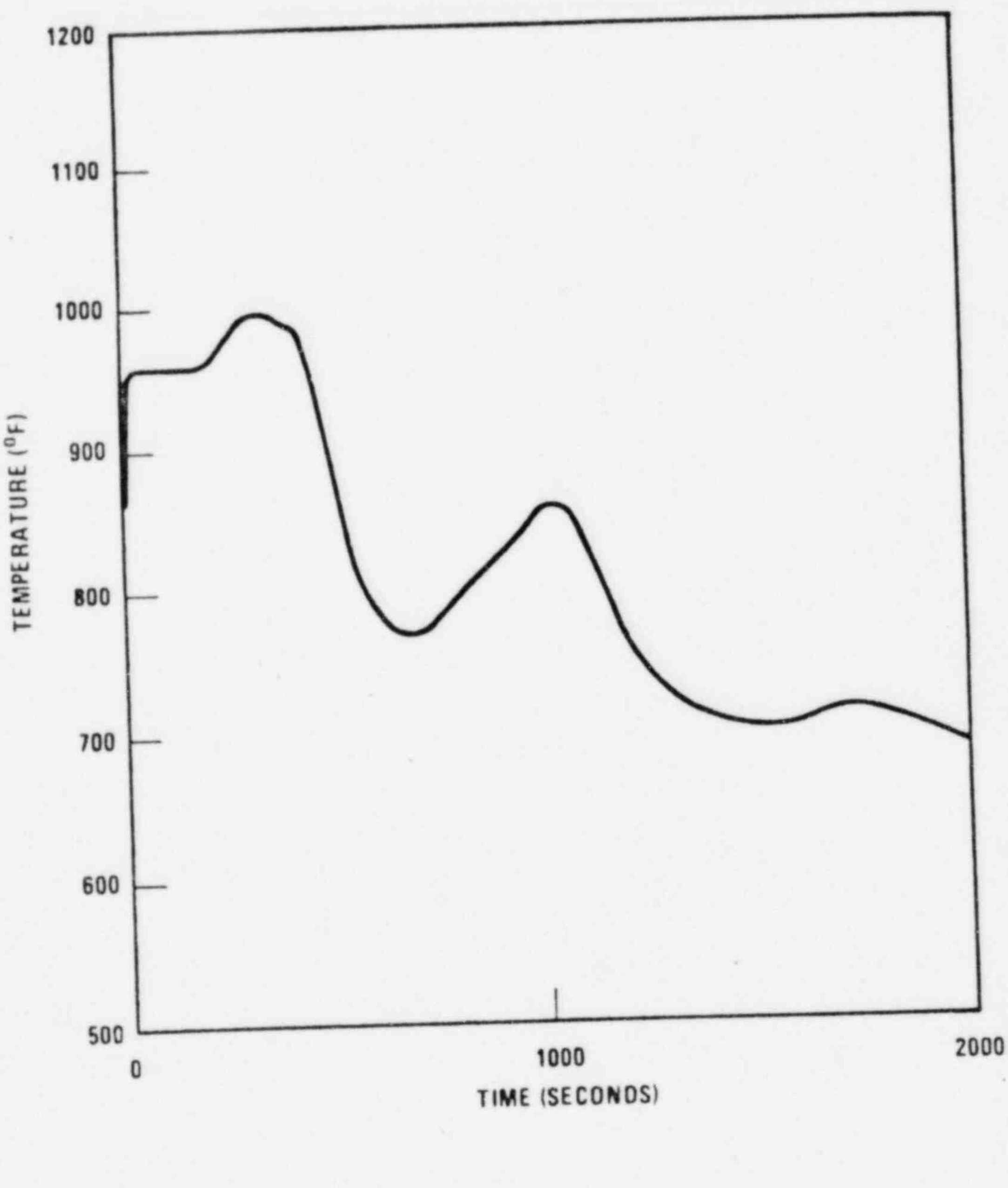


Figure 5.7-6G Affected Loop Evaporator Sodium Exit Temperature for Loss of Steam Generator Load (Dumping of Water/Steam Sides of Both Evaporators and the Superheater).

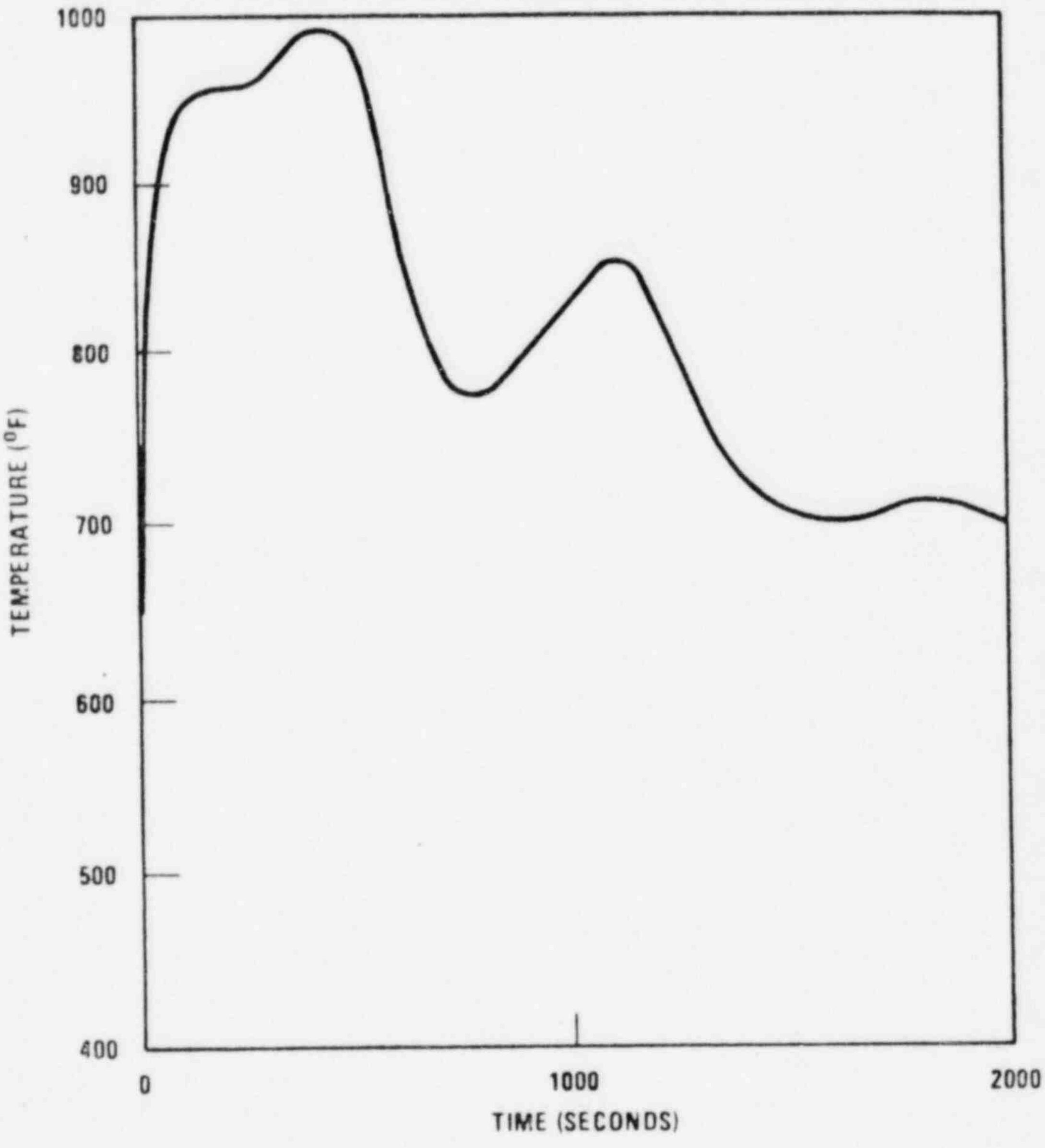


Figure 5.7-6H Intermediate Pump Sodium Temperature Vs. Time for Loss of Steam Generator Load (Dumping of Water/Steam Sides of Both Evaporators and the Superheater).

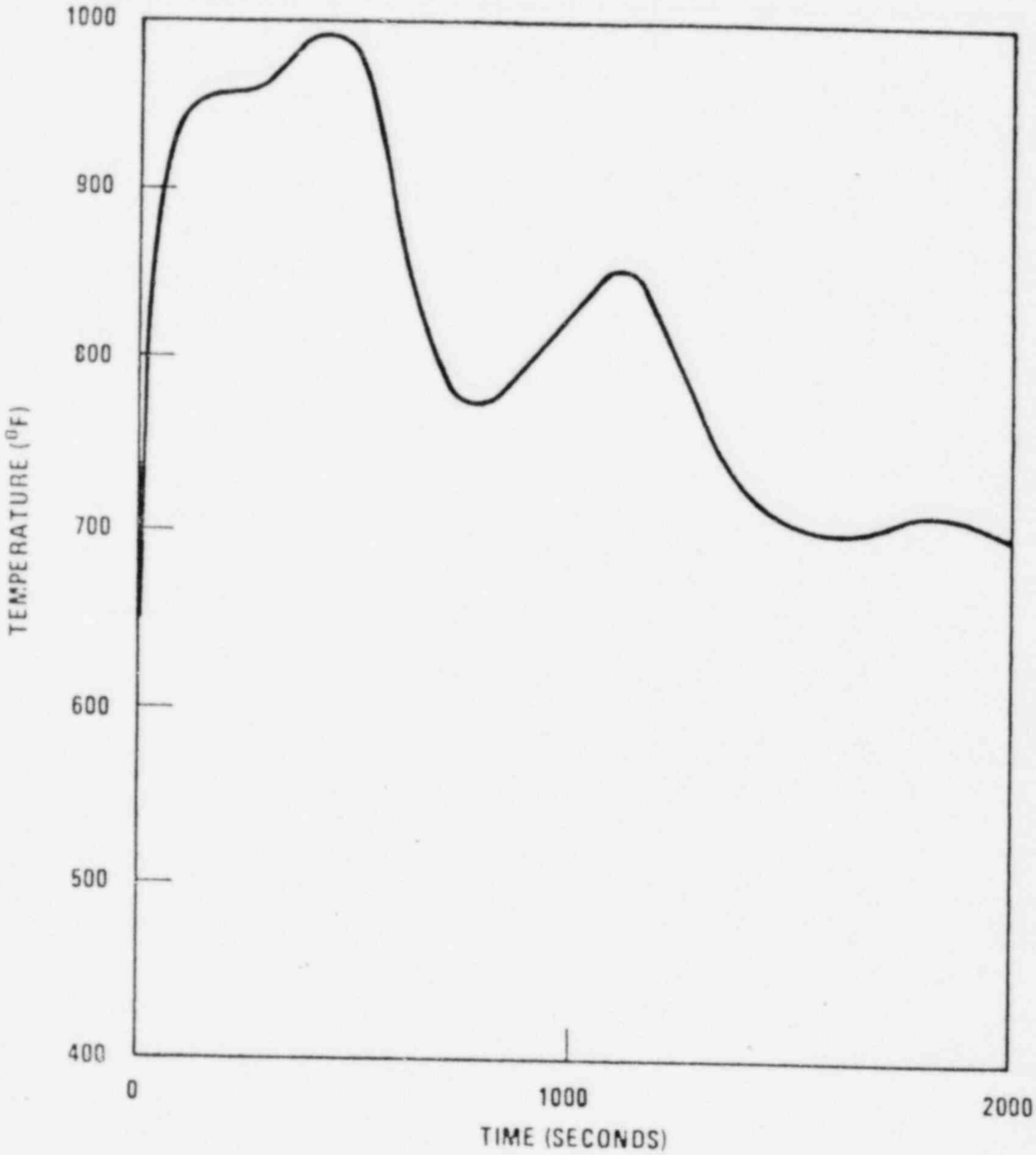


Figure 5.7-61 Affected Loop Drum Steam Temperature for Loss of Steam Generator Load (Dumping of Water/Steam Sides of Both Evaporators and the Superheater).

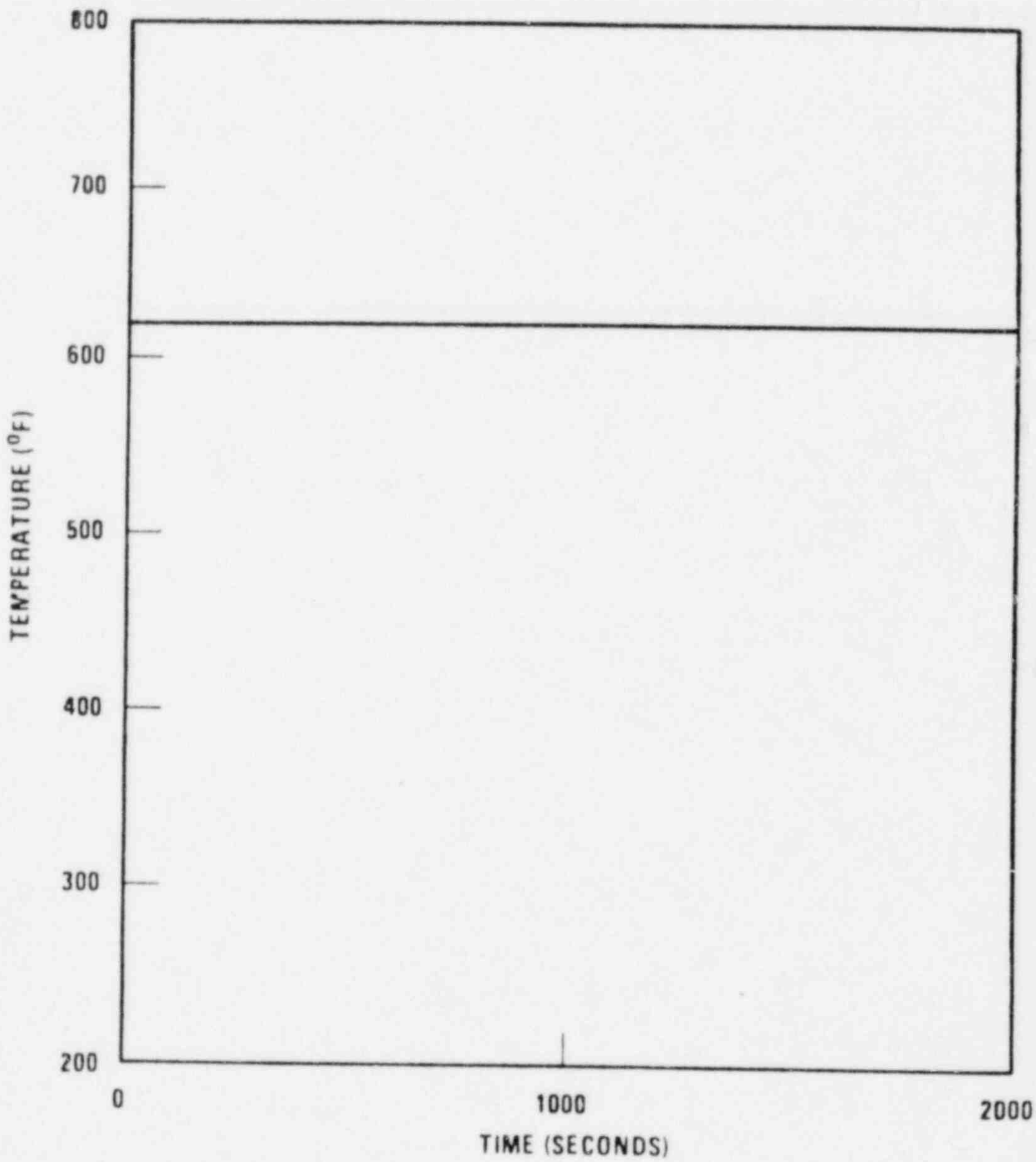


Figure 5.7-6J Affected Loop Evaporator Inlet Water Temperature for Loss of Steam Generator Load (Dumping of Water/Steam Sides of Both Evaporators and the Superheater).

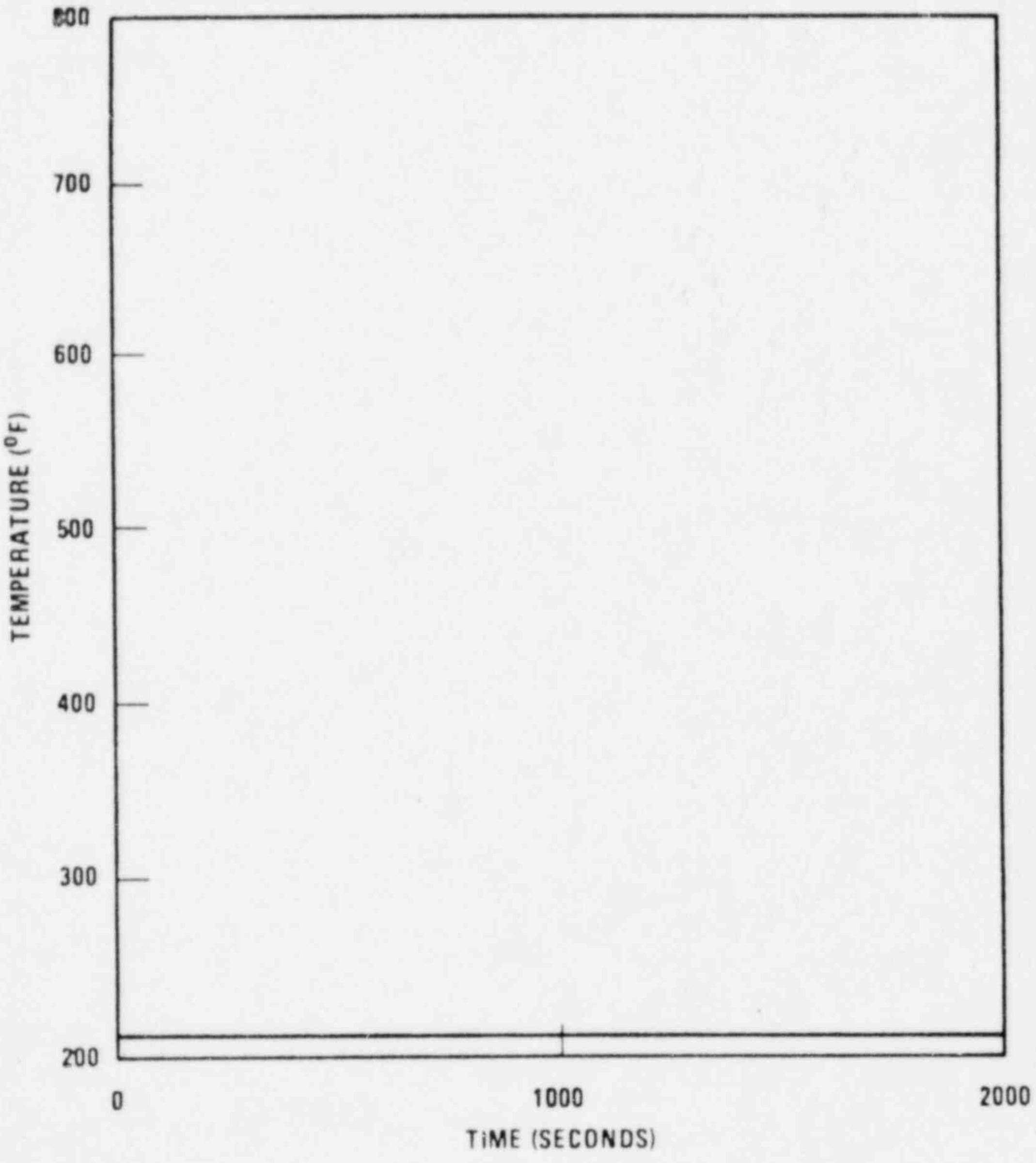
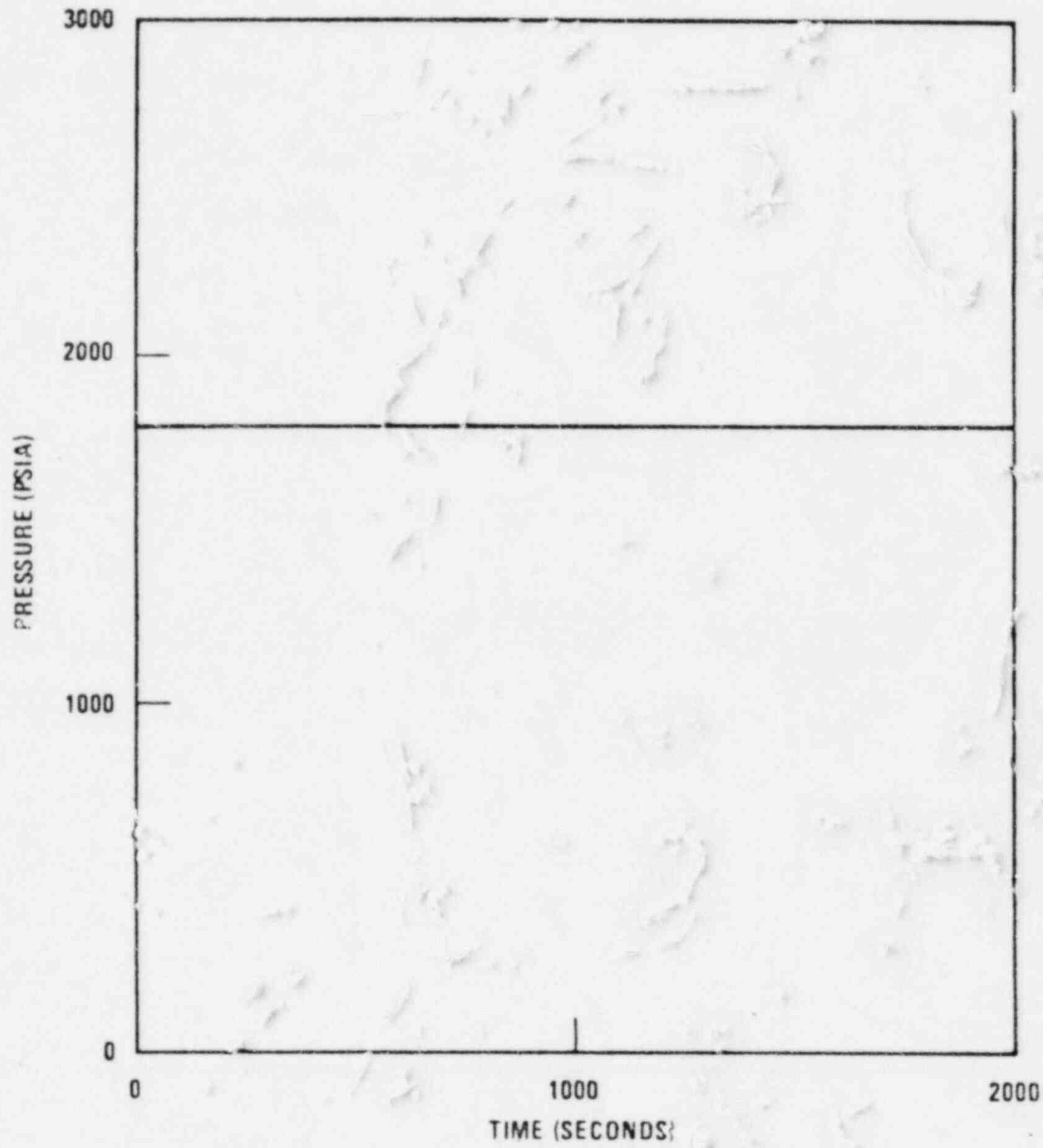


Figure 5.7-6K Affected Loop Drum Pressure for Loss of Steam Generator Load (Dumping of Water/Steam Sides of Both Evaporators and the Superheater).



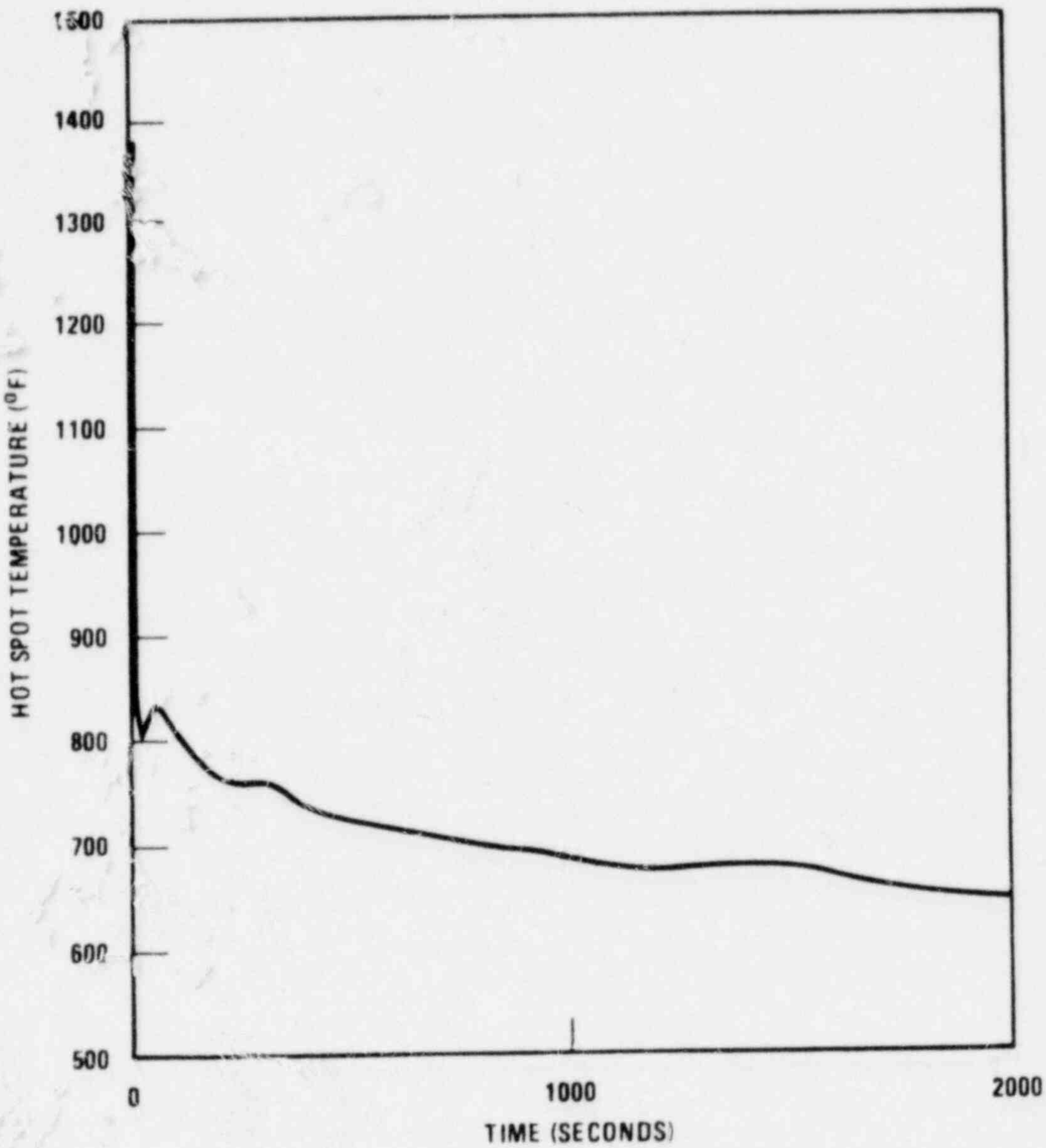


Figure 15.3.1.7-1C Temperature of Hot Spot as a Function of Time After Inadvertant Actuation of the Water/Steam Side of the Sodium Water Reactor Pressure Relief System

7203-18

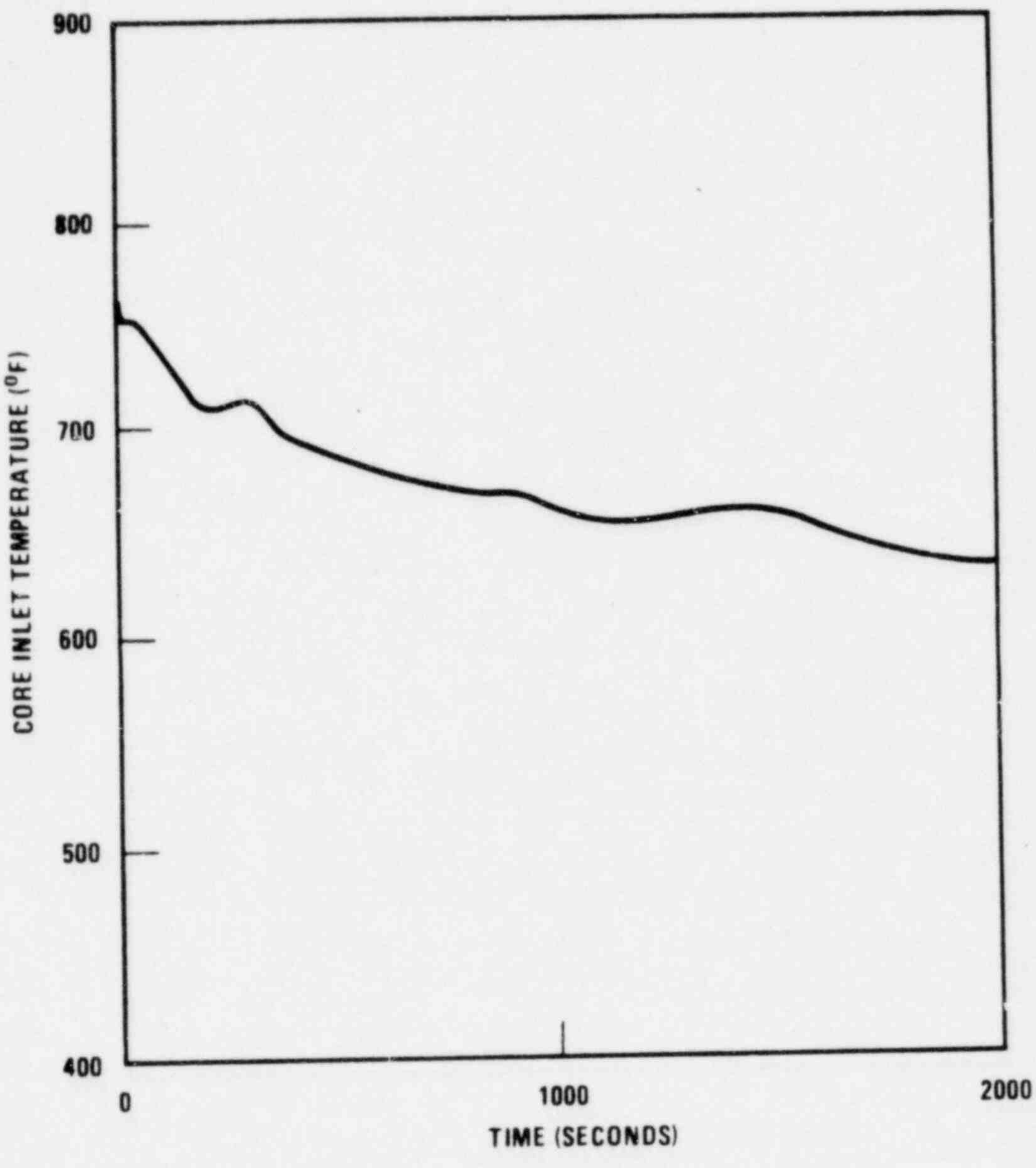


Figure 15.3.1.7-1B. Temperature of Core Inlet as a Function of Time After Inadvertant Actuation of the Water/Steam Side of the Sodium/Water Reactor Pressure Relief System

7203-17

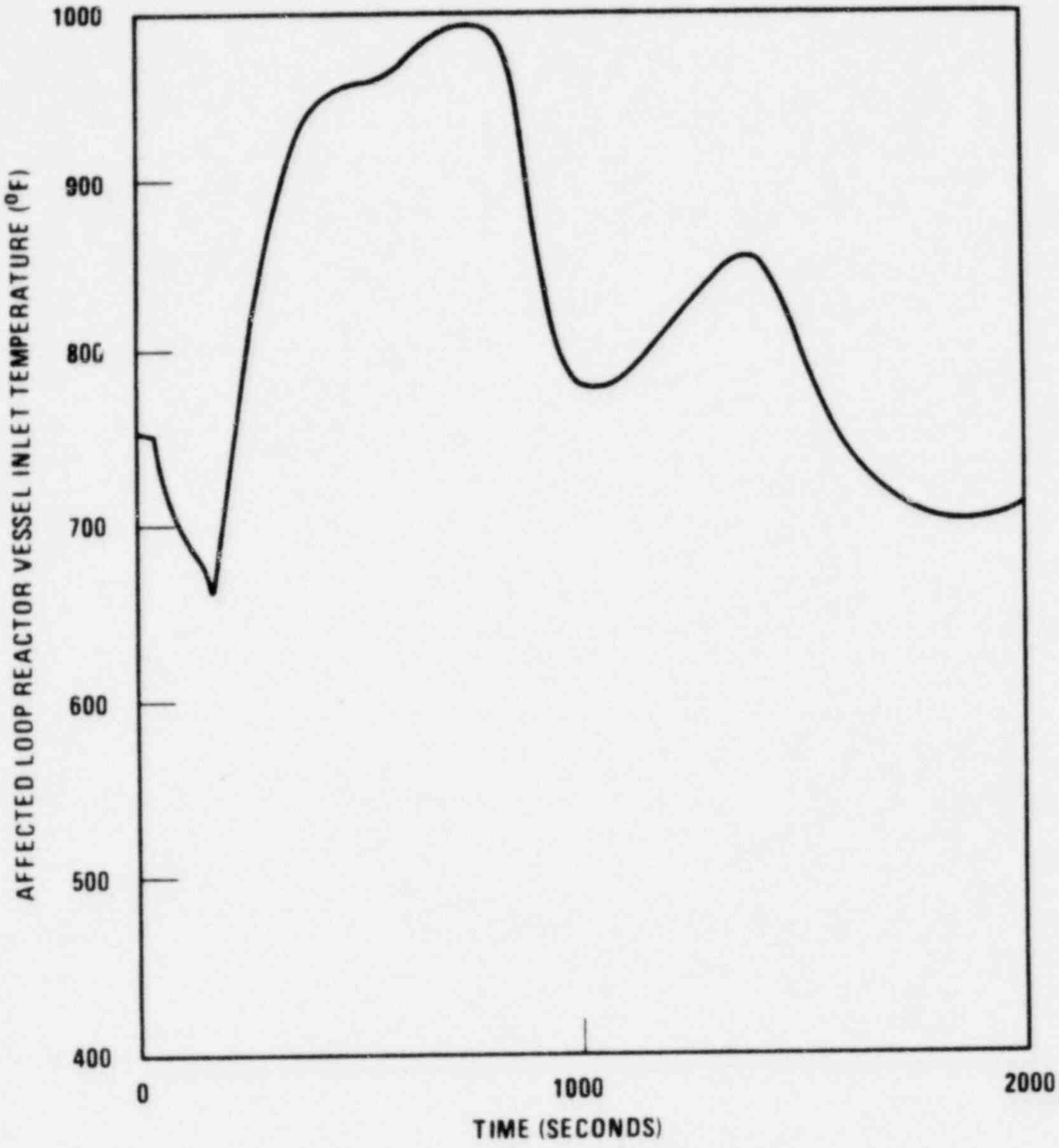


Figure 15.3.1.7-1A. Temperatures of Affected Loop as a Function of Time After Inadvertent Actuation of the Water/Steam Side of the Sodium/Water Reaction Pressure Relief System

7203-16