Department of Energy
Washington, D.C. 20545
Docket No. 50-537
HQ:S:82:136

DEC 06 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:

REVISED RESPONSES TO 430 SERIES NUCLEAR REGULATORY COMMISSION (NRC) QUESTIONS

References: (1) HQ:S:82:036, J. R. Longenecker to P. S. Check, Subject: Responses to Requests for Additional Information - Power Systems, dated June 1, 1982

(2) HQ:S:82:050, J. R. Longenecker to P. S. Check, Subject: Responses to Requests for Additional Information, dated June 18, 1982

(3) HQ:S:82:111, J. R. Longenecker to P. S. Check, Subject: Meeting Summary for the Electrical Power Working Meeting, dated October 19, 1982

(4) HQ:S:82:119, J. R. Longenecker to P. S. Check, Subject: Electrical Power Working Meeting, October 19, 1982 - Additional Information, dated November 2, 1982

Enclosed are revised responses to NRC Questions CS430.1 through 104, originally submitted in the referenced letters (1), (2), and (4). These revised responses incorporate the agreed to modifications discussed between the Clinch River Breeder Reactor Plant (CRBRP) project and the NRC staff in subsequent meetings on the CRBRP Electric Power and Mechanical Systems. Additionally, Preliminary Safety Analysis Report (PSAR) Sections 8.3.1.2.14 (pg. 8.3-31) and 8.3.1.4 (pg. 8.3-36a) have been revised in response to item 12e of Reference (3). This, together with

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Reference (4) completes all identified actions from Reference (3). The enclosed responses will be incorporated into the PSAR in Amendment 74, scheduled for December 1982.

Sincerely,

John R. Longenecker

John R. Longenecker
Acting Director, Office of
Breeder Demonstration Projects
Office of Nuclear Energy

1 Enclosure

cc: Service List
Standard Distribution
Licensing Distribution

ENCLOSURE

Question CS430.1 (8.2)

Provide physical layout drawings and/or additional description in the PSAR of the physical independence to be provided between the offsite power circuits in proximity of the plant to the switchyards and from the switchyard to the Class 1E onsite power system. Also provide description of physical independence between Class 1E and the offsite circuits protective relaying.

Response:

K-31 and Fort Loudoun-2 161KV transmission lines (both connected to the reserve switchyard of the CRBRP) provide the two physically independent offsite power sources to CRBRP; details of their routing and construction in the proximity of the plant have been described in Section 8.2.1.1 and 8.2.1.3 of the PSAR.

The CRBRP will be connected to the TVA 161KV grid using four separate connections between the switchyards and the TVA grid as described in Section 8.1 of the PSAR. All four transmission lines are kept continuously energized. The CRBRP design includes two physically separate and electrically independent switchyards, generating switchyard and reserve switchyard. Each of these two switchyards is connected to the TVA grid by two separate 161KV transmission lines. The two connections to the reserve switchyard, from the Oak Ridge Gaseous Diffusion Plant (ORGDP) switchyard of DOE, designated as the K-31 line, and the other to the Fort Loudoun Hydroelectric Plant, designated as Fort Loudoun-2 line, are considered the two physically independent and immediate access circuits. These circuits are located so as to minimize the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. The physical separation of the four (4) transmission line connections from the TVA 161KV grid to the CRBRP switchyards is shown in Figure 8.2-12. The K-31 transmission line connection crosses over the two connections (Roane and Fort Loudoun 1) to the Generating switchyard. As such, failure of any of the two 161KV line connections to the Generating switchyard will not result in failure of the K-31 or Fort Loudoun-2 lines.

Further, between the CRBRP and the destination substations (K-31 and Fort Loudoun 2):

1. at any one location no transmission line crosses over the two transmission lines to the Reserve Switchyard simultaneously;

2. transmission lines are spaced sufficiently apart such that failure of one line does not affect the other line. (See Figures 8.2-11 and 8.2-12).

The 4.16KV medium voltage (MV) winding of the Reserve Station Service Transformer (RSST) 11AAX005A will be connected to the Medium Voltage switchgear of Class 1E, Division 1 through a non-segregated phase bus duct and to the Medium Voltage Switchgear of Class 1E, Division 3 through a non-segregated phase bus duct and MV cables. The 4.16KV MV winding of the RSST 11AAX005B will be connected to the Medium Voltage Switchgear of Class 1E Division 2 through non-segregated phase bus duct. Similarly, the 4.16KV windings of the Unit Station Service Transformers (USSTs) 11AAX006A and B are also connected to the Class 1E, Division 1, 2 and 3 Medium Voltage Switchgear through non-segregated phase bus ducts.

Non-segregated phase bus ducts from the RSSTs 11AAX005A and B and USSTs 11AAX006A and B to the Medium Voltage Switchgear of Class 1E, Division 1, 2 and 3 will be physically separated such that failure of any one bus duct will minimize the likelihood of failure of the other bus ducts.

Control and protection circuits for the Reserve Switchyard have been arranged to receive 125V DC power from two independent Divisions A and B DC power distribution systems (see Figure 8.2-13).

The DC equipment of the two divisions are physically separate and electrically independent of each other. The control cables of Divisions A and B are routed in separate trays and conduits.

Question CS430.2 (8.2) (3.1.3.1)

Section 3.1.3.1 of the PSAR indicates that each of the reserve transformers is capable of supplying full power required for the auxiliary AC power distribution system to supply one redundant class 1E division load groups. Figure 8.3.1 of the PSAR in contradiction, shows reserve transformers supplying two Class 1E division loads as well as numerous non-Class 1E loads. Correct the contradiction and describe the capability and capacity of the offsite circuits, including the unit station service and reserve transformers, to supply all connected loads (Class 1E and Non-Class 1E) for all modes of plant operation.

Response:

The two reserve station service transformers located in the reserve switchyard have been designed with the capability to provide power to all plant connected loads (Class 1E and Non-Class 1E) under all modes of plant operation including startup, normal operation, and to facilitate and maintain a safe plant shutdown. One of the two reserve station service transformers also supplies 100 percent power to Class 1E loads of Divisions 1 and 3 and the other reserve station service transformer provides 100 percent power to Class 1E loads of Division 2 as indicated in Figure 8.3.1. Section 3.1.3.1 of the PSAR has been revised to further describe the capability and capacity of reserve unit station service transformers.

The CRBRP is connected to the TVA 161kV grid using two separate and physically independent switchyards - the plant generating switchyard and the plant reserve switchyard. The plant generating switchyard is connected to the TVA 161kV power grid by two 161kV transmission lines. The plant reserve switchyard is connected to the TVA 161kV grid by two physically separate and electrically independent 161kV transmission lines. Each of the four transmission lines is capable of providing power to all connected loads (Class 1E and Non-Class 1E) required for plant startup, normal operation and to facilitate and maintain a safe plant shutdown.

The two unit station service transformers have been designed with the capability to provide power to all plant connected loads (Class 1E and Non-Class 1E) under all modes of plant operation including startup, normal operation and to facilitate and maintain a safe plant shutdown. One of the two unit station service transformers also supplies 100 percent power to Class 1E loads of Division 1 and 3 and the other unit station service transformers provides 100 percent power to Class 1E loads of Division 2.

Question CS430.3 (8.1)

Section 8.3.1.1 of the PSAR indicates that three independent load groups are provided with load group 1 redundant to load group 2. No description as to redundancy of load group 3 has been provided in Chapter 8 of the PSAR. Conversely, Section 3.1.3.1 of the PSAR under criterion 26 response indicates that the power supplies servicing the heat transfer system are fully redundant. Clarify Chapter 8 of the PSAR to indicate redundancy of the 3 divisions.

Response:

The Class 1E electrical distribution system consists of three Class 1E divisions (Division 1, 2 and 3). Each of these divisions is separated physically and electrically from the other two divisions as described in Section 8.3.1.4 and 8.3.1.2.1 of the PSAR. Each of these divisions is provided with an onsite (standby) diesel generator and has the capability to shutdown the plant safely. However, from the consideration of connected loads, Class 1E Divisions 1 and 2 provide power to redundant load groups and as such are described as redundant divisions in the PSAR. Class 1E Division 3 provides Class 1E power to Loop 3 of the Heat Transport System (HTS) and to certain-plant Non-Class 1E loads. The Non-Class 1E loads are connected through an isolation subsystem. Since not all the loads powered from Division 3 are identical or similar to those powered by Division 1 or 2, this division has not been identified as redundant to Division 1 or 2 in the PSAR. However, as far as the HTS is concerned, the Divisions 1, 2 and 3 power supplies are fully redundant serving the Loops 1, 2 and 3 Class 1E loads, respectively. Sections 8.1.2 and 8.3.1.1 of the PSAR have been revised to add the above clarification.

Question CS430.5 (8.3.1)

You state in Section 8.3.1.2.1 that "the standby onsite power supply network has provisions to manually cross-connect the 4.16kV buses of the Division 1 and 2 power supplies in case of extreme emergency". Enumerate and define each case of extreme emergency that would necessitate the use of the interconnections. For each case listed justify its noncompliance with the independence requirement of criterion 15 listed in Section 3.1 of the PSAR.

Response:

Manual cross-connection of 4.16kV Class 1E Division 1 and Division 2 Standby Onsite Power Supplies will be initiated if all of the following extreme emergency conditions occur:

a) Loss of Plant, Preferred, and Reserve Power to 4.16kV Class 1E buses 12N1E003A and 12N1E003B;

b) Diesel 12N1E022A or 12N1E022B failed to start and is determined to be inoperable, and

c) Critical safety-related loads associated with the operative diesel generator have failed and become unavailable.

The manual cross-connection will be disconnected as soon as one of the above conditions cease to exist.

PSAR Section 3.1, Criterion 15, Electric Power Systems, states that "the two diesel generator units will be physically and electrically independent of each other and the offsite AC power supplies".

The Class 1E Division 1 and Division 2 Standby Onsite AC Power Supplies, with a provision for manual cross-connection, meet the criteria for independence of Regulatory Guide 1.6 as follows:

1) No provisions exist for automatically connecting one Class 1E load group to another Class 1E load group;

2) No provisions exist for automatically transferrring loads between redundant Class 1E power sources;

3) Mechanical and electrical interlocks have been provided to prevent an operator error that would result in paralleling of standby power sources;

4) The circuit breakers used for the cross-connection will normally be stored in separate locked dummy compartments. Opening of the doors of these compartments shall be alarmed in the Control Room.

5) The insertion of breakers in the operating compartments used for the cross-connection will be annunciated to the Control room operator.

Therefore, there is no non-compliance with the Regulatory Requirements. PSAR Section 3.1 will be revised to include the following paragraph:

Provision has been made in the safety-related AC distribution system design, for manual cross-connection between the 4.16kV switchgear buses of Class 1E Divisions 1 and 2. Manual cross-connection details are as described in Section 8.2.1.2.1 of the PSAR.

Question CS430.6 (8.2) (8.3.1) (8.3.2)

The response to Criterion 16 in Section 3.1 of the PSAR indicates that periodic tests of the transfer of power between onsite and offsite sources and between the normal offsite supply and the preferred (reserve) supply are performed only during prolonged plant shutdown periods. The response to Criterion 16 implies that the power transfer has not been designed to be testable during operation of the nuclear plant as recommended by IEEE Standard 338-1977 and Regulatory Guide 1.118. In addition it has been implied that the onsite AC and DC systems have all not been designed to be testable during operation of the nuclear plant. Describe compliance with IEEE Standard 338-1977 and Regulatory Guide 1.118 and justify areas of noncompliance.

Response

The design of the power transfer schemes of CRBRP for transfer of power between the normal offsite supply and the preferred (reserve) supply and the onsite AC and DC systems are in full compliance with Criterion 16, IEEE Standard 338-1977 and Regulatory Guide 1.118.

Section 3.1 of the PSAR has been revised to further clarify the conformance of CRBRP design with Criterion 16, IEEE Standard 338-1977 and Regulatory Guide 1.118.

Question CS430.7 (8.3.1) (8.3.2)

You state in Section 8.3.1.1.2 of the PSAR under the subheading "Testing and Inspection", that "In the case an emergency signal is generated during the testing, the circuit breaker cannot be closed immediately." Describe how the design implied by this statement meets the recommendations of IEEE Standard 338-1977.

Response

The periodic testing procedure for the safety-related electrical distribution system meets the recommendations of IEEE Standard 338-1977. The PSAR Section 8.3.1.1.2 subheading "Testing and Inspection" has been revised to reflect the recommendations.

Question CS430.8 (8.3.1) (8.3.2)

Section 8.3.1.2.11 of the PSAR indicates that conductors of the penetration are designed to withstand the maximum short-circuit currents based on the interrupting capability of the protection device associated with the penetration assembly conductors. Position C.1 of Regulatory Guide 1.63, on the other hand, states that the electric penetration asembly versus the conductor should be designed to withstand the maximum short-circuit condition. Justify noncompliance to Position C.1 of Regulatory Guide 1.63.

Response

The electrical penetration conductors and the assembly will be designed to withstand the maximum short-circuit current versus time conditions that could occur given single random failures of circuit overload protection devices in accordance with Position C.1 of Regulatory Guide 1.63. PSAR Section 8.3.1.2.11 has been revised.

Question CS430.9 (8.3.1) (8.3.2)

You state in Section 8.3.1.4 of the PSAR that environmental type test will be performed on cables and terminations that are required to function in a hostile environment. This statement implies that cables or terminations that are not required to function in a hostile environment, will not be environmentally qualified and may not be in compliance with IEEE Standard 323-1974. Justify noncompliance.

Response

All cabling and terminations will be designed, qualified and tested in accordance with IEEE Standard 323-1974 supplemented by Regulatory Guide 1.131.

PSAR Section 8.3.1.4, Part B, has been revised to reflect the above.

Question CS430.10 (8.3.1)(8.3.2)

Section 8.3.1.2.14 of the PSAR indicates that physical separation of circuits and equipment comprising or associated with the Class 1E power system, Class 1E protection systems and Class 1E equipment, will be in accordance with criteria set forth in paragraph 8.3.1.4 of the PSAR. Separation criteria described in Sections 8.3.1.2.14 and 8.3.1.4 of the PSAR is not clear and does not meet the guidelines of IEEE Standard 384 and Regulatory Guide 1.75. For example, the PSAR indicates that non-Class 1E cables in panels will be separated from Class 1E cables so that they will not provide a combustion path between different divisions. Section 5.6.5 of IEEE Standard 384-1974 states that non-Class 1E cables shall be separated by six inches or a barrier. In general no criteria has been described for separation of Class 1E and non-Class 1E cables. Other examples include: (1) no criteria for separation between cables trays and conduits of another division, (2) confusing criteria for the separation of the third division (the design indicates there are three divisions but only two redundant divisions. Separation criteria refers to only two redundant divisions in many cases versus the three divisions), (3) confusing definition for associated cables, (4) no criteria for separation between associated cables and non-Class 1E cables, and (5) no criteria before and after an isolatoin device. Revise your PSAR description of physical separation of circuits to comply with the recommendations of IEEE Standard 384-1974 and guidance of R.G. 1.75 or justify noncompliance.

Response:

The CRBRP physical separation design criteria is fully consistent with the guidelines set forth in IEEE Standard 384-1974 and Regulatory Guide 1.75.

The PSAR Section 8.3.1.4 has been revised to further clarify consistency with IEEE Standard 384-1974 and Regulatory Guide 1.75 for the following items:

1. Separation of Class 1E and non-Class 1E cables within control board and other panels.

2. Separation of Class 1E and non-Class 1E cables.

3. Separation between cable trays and conduits of another division.

4. Criteria for the separation of third division.

5. Criteria for separation between associated cables and non-Class 1E cables.

6. Separation criteria before and after an isolation device.

<u>Question CS430.11 (8.3.1) (8.3.2)</u>

You state in section 8.3.1.4.E of the PSAR that only one safety division is routed in a fire hazard zone and that this one division is suitably protected so that a fire in the zone will not effect the safety functions of the other safety groups. This statement does not meet current regulatory guidelines. Current guidelines require that the one division be suitably protected so that fire in the zone will not affect the safety function of the one division located in the zone. The other safety groups must be separated by a three-hour fire rated barrier from the zone.

In addition to current guidelines, it is proposed that if the one division cannot be protected from the effects of fire in the zone (such as in areas of potential sodium fires) there must be a minimum of two remaining safety divisions outside the fire zone and separated by a barrier sufficient to contain the fire. The remaining safety divisions must be capable of safely shutting down the reactor in compliance with the single failure criteria. Indicate compliance with the above current and proposed guidelines in the PSAR or describe and justify an acceptable alternative.

<u>Response</u>

CRBRP equipment arrangements and fire suppression system design has been developed in a manner as to preclude the likelihood of a fire in an area reaching safety-related equipment. Spacial separation and/or walls are provided between fire hazard and safety-related equipment, and general area sprinkler coverage has been provided wherever feasible to protect safety related equipment from potential exposure to fires.

In the event of a fire in a fire zone containing a safety division, which affects that division, there will be two remaining safety divisions outside the fire zone, separated by three-hour fire rated barriers and capable of safely shutting down the reactor. This will be in compliance with the proposed NRC guidelines. Furthermore, the CRBRP design will comply with BTP CMEB 9.5-1 position C.5.d governing the control of combustibles.

Question QCS430.12 (8.3.1) (8.3.2)

Fire hazard zones have been defined in the PSAR as areas in which a potential fire hazard could exist as a consequence of the credible accumulation of a significant quantity of flammable material. Current regulatory guidelines define areas of credible accumulation as any open areas of the plant where transient combustables can be placed. This definition encompasses most areas of the plant including switchgear and cable spreading rooms. Revise the PSAR to incorporate the above definition or describe an alternative definition with justifications.

Response

Those areas of the plant where transient combustibles can be placed; will be considered in the fire hazard analysis and will be considered in the selection of fire suppression systems and arrangement of the fire barriers. The definition of Fire Hazard Zones is contained in updated sections 8.3.1.4 and 9.13.1.

> A Fire Hazard Zone is "Areas in which a potential fire hazard could exist as a consequence of the credible accumulation of a significant quantity of fixed or transient combustible material."

The specific areas where transient combustibles are considered will be identified in the Fire Hazard Analysis. Our review of the plant layout indicated that neither the cable spreading room nor the Class 1E switchgear rooms need to be considered for placement of transient combustibles since they are not part of a pathway of any combustible traffic.

Furthermore, administrative controls governing the handling of transient fire loads will be implemented in accordance with BTP CMEB 9.5-1 position C.2c.

Question CS430.13

Separation of Class 1E raceways from high energy pipelines as defined in the PSAR is to be greater than 15 feet or less than 15 feet if the pipe is suitably restrained so as not to whip and strike the raceway. Current regulatory guidelines require that the Class 1E raceway be protected by a barrier so that pipe whip missiles, jet impingement or environmental effects of the pipe break will not cause failure of the Class 1E raceway. Fifteen feet of space is not considered adequate protection. Indicate compliance with the above guidelines in the PSAR or propose, describe, and justify an acceptable alternative.

Response

CRBRP has three (3) Class 1E Divisions with complete physical separation between divisions. Any damage to cable trays caused by pipe whip missiles, jet impingement, or environmental effect will be limited to the same safety division to which the pipe belongs, and the two other divisions capable of safely shutting down the plant will remain unaffected.

Additional protection will be provided against any single Class 1E Division cable tray damage due to high energy pipe whip missiles by restraint of high energy pipe lines in the vicinity of Class 1E raceways. The design of restraints and/or barriers will be determined by analysis to meet BTP APCSB 3-1, rather than the arbitrary 15 foot distance.

Protection against single Division damage due to high energy jet impingement or environmental effect is considered impractical and unnecessary since two additional safe shutdown Divisions will be available as noted above.

Question CS430.14

Separation between redundant raceways as defined in the PSAR takes into consideration the presence of rotating equipment, monorails, and equipment removal paths and the possibility that heavy equipment could be lifted and dropped and possibly cause failure of two raceway channels. Minimum separation between the two raceway channels is to be such as to preclude failure of both channels. Current regulatory guidelines, however, requires protection of each raceway as well as separation so that the dropped equipment will not cause failure of either raceway. An alternative to protection would be a design that provides an additional two independent systems each capable of shutting down the reactor and separated such that neither will be affected by the "dropped equipment" or failure of rotating equipment. Indicate compliance with the above guidelines in the PSAR or describe and justify an acceptable alternative.

Response

The routing of the safety-related raceways of CRBRP is such that any "dropped equipment" will not result in a failure of any of these raceways.

The CRBRP raceway design is in full compliance with IEEE Standard 384-1974 as supplemented by Regulatory Guide 1.75.

In addition, the safety systems design for CRBRP includes three physically and electrically independent divisions, each capable of shutting down the reactor. Equipment of each of these divisions, are located and cables are routed in separate plant areas such that failure of rotating equipment will not cause failure of more than one safety division.

The PSAR Section 8.3.1.4 has been revised.

Question CS430.15 (8.3.1) (8.3.2)

Section 8.3.1.2.14 of the PSAR indicates that Non-Class 1E loads will be connected to one division of the Class 1E system through an isolation device.

a) The proposed design for the isolation device addresses primarily protection of the Class 1E system due to worst case faults in the Non-Class 1E system. Justify why other failures of the Non-Class 1E system such as hot shorts are not considered in the design of the isolation devices.

b) The isolation device is to be designed as indicated in the PSAR so that voltage on the Class 1E system buses will not drop below 70 or 80 percent of nominal given a worst case fault in the Non-Class 1E system. With most Class 1E equipment designed to operate at not less than 90 percent of nominal, justify your design that allows lower voltage.

c) Describe the methods to be used to demonstrate the design capability of the isolation device.

Response

Faults and failure modes other than the worst case three phase fault have also been addressed in the design of the isolation system. However, the analysis provided in the PSAR includes the worst case condition only in order to demonstrate that even under this extreme condition the degradation of the Class 1E system will be within the acceptable limits. Protective devices have been provided in the design to clear any fault on the Non-Class 1E system such as phase to ground, phase to phase, and three phase faults, within a reasonable time such that there is no degradation to the Class 1E system.

a) A phase to ground fault (which is the most likely mode of failure) on a Non-Class 1E circuit will have no effect on the Class 1E system since the isolation system includes a 4.16kV/480V delta-wye connected transformer with the high resistance grounded neutral. The neutral is grounded through a 55.4 ohm resistor which will limit the phase to ground fault current to approximately 5 amperes. The Class 1E 480V and 4.16kV circuit breakers will be tripped to clear a ground fault in the case that the affected Non-Class 1E breaker fails to trip.

   Any phase to phase or three phase fault on the Non-Class 1E circuits will be isolated by instantaneous operation of the affected branch feeder circuit breaker. Back-up protection is provided by fast operation of the 480V supply circuit breaker (0.2-0.3 sec clearing time) or by the 4.16kV unit substation transformer feeder circuit breaker (0.6-0.7 sec clearing time). In addition undervoltage sensors are provided at the input terminals of the 480V supply circuit breaker. These undervoltage sensors will initiate tripping of the 480V and 4.16kV circuit breakers within five (5) seconds upon sensing the undervoltage caused by loss of power or failure of the circuit breakers to clear a fault.

b) The isolation system is designed so that impedance of the system is high enough that the worst possible fault (three phase bolted fault) on the 480V Non-Class 1E bus will not degrade the voltage at 4.16kV Class 1E bus below the following levels:

(1) When the 4.16kV Class 1E bus is being supplied from offsite power supply, the voltage at the bus will not drop below 80 percent of nominal.

(2) When the 4.16kV Class 1E bus is being supplied from onsite (standby) power supply the voltage at the bus will not drop below 75 percent.

The minimum voltage levels of 75 and 80 percent of nominal are chosen to be the same as the allowable minimum voltage levels during the sequential loading of the 4.16kV Class 1E bus or during starting of the largest motor after the bus has been fully loaded.

As discussed in a) above, any fault on 480V Non-Class 1E system will be cleared within five (5) seconds. After the fault has been cleared the voltage at the 4.16kV bus will be restored to a minimum of 90 percent of nominal within two (2) seconds, which will allow all connected loads to operated continuously.

c) The high impedance transformer used as an isolation device will be subjected to a short-circuit withstand test as part of the shop testing program at the manufacturer's facility. After the transformer has been energized a three phase fault will be applied at the secondwary windings for the maximum duration of the fault. The purpose of this test is to demonstrate the mechanical and thermal capability of the transformer to withstand short-circuit stresses which the transformer could experience and to verify the transformer current limiting capability.

Section 8.3.1.2.14 of the PSAR has been revised to add the above discussion.

Question CS430.16 (8.3.1) (8.3.2)

Section 8.3.1.2.14 of the PSAR indicates that analyses and testing of associated circuits will be performed in accordance with paragraphs 4.5(3), 4.6.2 and 5.1.1.2 of IEEE Standard 384-1974. Describe in the PSAR and in detail the analyses and testing that will be performed. The description should include the minimum separation distance between associated and Non-Class 1E cables that will be demonstrated by the proposed analyses and testing.

Response:

All associated circuits as defined in IEEE Standard 384-1974, paragraph 3, will be treated and routed as Class 1E circuits of the same division. The criteria governing routing of Class 1E circuits are given in Section 8.3.1.4 as supplemented by the response to NRC Question CS430.10.

Based upon the above considerations, analysis and testing of associated circuits will not be required, per paragraph 4.5(1) of IEEE Standard 384-1974.

At the present time there are no exceptions to the above criteria; however, if in the future any exceptions are known and the need of an analysis is identified, the details of the analysis and any testing that has been performed to demonstrate that Class 1E circuits are not degraded below an acceptable level will be included in the FSAR.

Revised PSAR Section 8.3.1.2.14 reflects the above.

Question CS430.17 (8.3.1) (8.3.2)

Section 8.3.1.2.22 of the PSAR indicates that the Class 1E system will be designed to assure that a design basis event will not cause loss of electric power to more than one Class 1E load group at one time. This proposed design does not meet IEEE Standard 308-1974, justify noncompliance. Also provide the results of a failure mode and effects analysis in accordance with Section 4.8 of IEEE Standard 308-1974 for a design basis event that causes failure of one load group and a single failure in another load group.

Response

CRBRP electrical power distribution system design is in full compliance with IEEE Standard 308-1974 as described below:

1. All Class 1E electrical equipment will be specified and qualified such that the environmental conditions resulting from any design basis event will not cause loss of electric power to any Class 1E loads related to safety, surveillance or protection, thereby maintaining the safety of the plant at all times.

2. Loss of electric power to any Class 1E equipment or to any Class 1E division will not cause damage to the fuel or to the reactor coolant system.

3. In addition, Class 1E AC and DC Power Supplies and distribution systems have been designed as three physically and electrically independent safety divisions, each capable to safely shutdown the plant and conform to the requirements of Class 1E electrical system.

An analysis of the failure modes of Class 1E power systems and the effect of these failures on the electric power available to Class 1E loads will be performed in accordance with IEEE Standard 308-1974, to demonstrate that a single component failure will not prevent satisfactory performance of the minimum Class 1E loads required for safe shutdown and maintenance of post-shutdown or post-accident plant security. The results of this analysis will be included in the FSAR.

The Section 8.3.1.2.22 of the PSAR has been revised to reflect the above discussion.

Question CS430.18 (8.3.1) (8.3.2)

Section 8.3.1.2.22b of the PSAR states that "A loss of electric power to equipment that could result in a reactor power transient capable of causing significant damage to the fuel or to the plant operation." (See Section 15.1.2.) The last words of the above statement "to the plant operation" are not clear and are inconsistent with Section 4.1 (2) of IEEE Standard 308-1974. Provide clarification and justify noncompliance to IEEE Standard 308-1974.

Response

See the Response to Question CS430.17.

Question CS430.19 (8.3.1) (8.3.2)

You state in Section 8.3.1.2.22 of the PSAR that indicators and controls will be provided outside the control room in compliance with Section 4.4 of IEEE Standard 308-1974. Provide a description of the design provisions that assure electrical isolation between controls and indicators located in the control room and remote locations. The current staff position requires that no single failure in the control room shall cause failure at the remote locations.

Response

Controls and indicators located in the control room are electrically separated from controls and indicators at remote locations. Separation is by independent overcurrent protection for each source, so that overcurrent in the power source for control and indication at the control room does not affect operation of the power source for remote control and indication. Both control circuits (control room and remote) interface in the common control logic in the solid State Programmable Logic System Cabinet where they are electrically isolated. This design satisfies the staff position that no single failure in the control and indication at the control room shall cause failure in the control and indication at the remote location.

Question CS430.20 (8.3.1) (8.3.2)

Describe the source of control power to Division 3 AC switchgear and diesel generator.

Response

Control power to Division 3 AC switchgear and Division 3 diesel generator unit is provided from Division 3 DC power supply described in the PSAR Section 8.3.2.

Table 8.3-2C, "Class 1E Division 3 125V DC Load List", of the PSAR has been revised to include all DC loads required to support operation of Division 3 AC switchgear and Division 3 diesel generator unit.

Question CS430.21 (8.3.1)

Operating experience at certain nuclear power plants which have two cycle tubocharged diesel engines manufactured by the Electromotive Division (EMD) of General Motors driving emergency generators have experienced a significant number of turbocharger mechanical gear drive failures. The failures have occurred as the result of running the emergency diesel generators at no load or light load conditions for extended periods. No load or light load operation could occur during periodic equipment testing or during accident conditions with availability of offsite power. When this equipment is operated under no load conditions insufficient exhaust gas volume is generated to operate the turbocharger. As a result the turbocharger is driven mechanically from a gear drive in order to supply enough combustion air to the engine to maintain rated speed. The turbocharger and mechanical drive gear normally supplied with these engines are not designed for standby service encountered in nuclear power plant application where the equipment may be called upon to operate at no load or light load condition and full rated speed for a prolonged period. The EMD equipment was originally designed for locomotive service where no load speeds for the engine and generator are much lower than full load speeds. The locomotive turbocharged diesel hardly ever runs at full speed except at full load. The EMD has strongly recommended to users of this diesel engine design against operation at no load or light load conditions at full rated speed for extended periods because of the short life expectancy of the turbocharger mechanical gear drive unit normally furnished. No load or light load operation also causes general deterioration in any diesel engine.

To cope with the severe service the equipment is normally subject to and in the interest of reducing failures and increasing the availability of their equipment EMD has developed a heavy duty turbocharger drive gear unit that can replace existing equipment. This is available as a replacement kit, or engines can be ordered with the heavy duty turbocharger drive gear assembly.

To assure optimum availability of emergency diesel generators on demand, applicant's who have in place an order or intend to order emergency generators drive by two cycle diesel engines manufactured by EMD, should be provided with the heavy duty turbocharger mechanical drive gear assembly as recommended by EMD for the class of service encountered in nuclear power plants. Discuss your plans to incorporate this improvement.

Response

The onsite (standby) AC power supplies for CRBRP consist of three diesel generator units. Two of these diesel generators, used for Class 1E

Divisions 1 and 2 have been procured from DeLaval Turbine Inc., Engine and Compressor Division; Oakland, California and do not have the turbocharger related design problems as identified in the NRC concern. The final vendor information regarding the diesel generator for Class 1E Division 3 is presently not available pending completion of the procurement process. However, if the engine of this diesel generator unit (Class 1E Division 3) is manufactured by the Electromotive Division (EMD) of General Motors, the following action will be taken:

a) The unit will be specified with a heavy duty turbocharger gear unit suitable for no load or light load operation of the diesel generator unit for a prolonged time, or

b) If the diesel generator is already manufactured without a heavy duty turbocharger gear unit, the turbocharger gear unit will be replaced with a heavy duty turbocharger gear assembly using the replacement kit from the Electromotive Division of General Motors.

c) The required modifications as discussed under a) and b) above will be completed prior to plant startup.

Question CS430.22 (8.3.1)

Provide a detailed discussion (or plan) of the level of training proposed for your operators, maintenance crew, quality assurance, and supervisory personnel responsible for the operation and maintenance of the emergency diesel generators. Identify the number and type of personnel that will be dedicated to the operations and maintenance of the emergency diesel generators and the number and type that will be assigned from your general plant operations and maintenance groups to assist when needed.

In your discussion, identify the amount and kind of training that will be received by each of the above categories and the type of ongoing training program planned to assure optimum availability of the emergency generators.

Also discuss the level of education and minimum experience requirements for the various categories of operations and maintenance personnel associated with the emergency diesel generators.

Response

There are currently no plans for personnel to be dedicated only to the above listed tasks. The level of training, including the amount and kind of training, that will be received by each of the above categories, the type of training program planned, and the level of education and minimum experience requirements for the various categories of operations and maintenance personnel have not been determined. When these are finalized, information will be included in the PSAR. It is anticipated that the above plans will be very similar to those used by TVA and that manufacturer's recommendations and requirements will be utilized in developing these plans.

Question CS430.23 (8.3.1)

Periodic testing and test loading of an emergency diesel generator in a nuclear power plant is a necessary function to demonstrate the operability, capability and availability of the unit on demand. Periodic testing coupled with good preventive maintenance practices will assure optimum equipment readiness and availability on demand. This is the desired goal.

To achieve this optimum equipment readiness status the following requirements should be met:

1. The equipment should be tested with a minimum loading of 25 percent of rated load. No load or light load operation will cause incomplete combustion of fuel resulting in the formation of gum and varnish deposits on the cylinder walls, intake and exhaust valves, pistons and piston rings, etc., and accumulation of unburned fuel in the turbocharger and exhaust system. The consequences of no load or light load operation are potential equipment failure due to the gum and varnish deposits and fire in the engine exhaust system.

2. Periodic surveillance testing should be performed in accordance with the applicable NRC guidelines (R.G. 1.108), and with the recommendations of the engine manufacturer. Conflicts between any such recommendations and the NRC guidelines, particularly with respect to test frequency loading and duration, should be identified and justified.

3. Preventive maintenance should go beyond the normal routine adjustments, servicing and repair of components when a malfunction occurs. Preventive maintenance should encompass investigative testing of components which have a history of repeated malfunctioning and require constant attention and repair. In such cases consideration should be given to replacement of those components with other products which have a record of demonstrated reliability, rather than repetitive repair and maintenance of the existing components. Testing of the unit after adjustments or repairs have been made only confirms that the equipment is operable and does not necessarily mean that the root cause of the problem has been eliminated or alleviated.

4. Upon completion of repairs or maintenance and prior to an actual start, run, and load test, a final equipment check should be made to assure that all electrical circuits are functional, i.e., fuses are in place, switches and circuit breakers are in their proper position, no loose wires, all test leads have been removed, and all valves are in the proper position to permit a manual start of the equipment. After the unit has been satisfactorilfy started and load tested, return the unit to ready automatic standby service and under the control of the control room operator.

Provide a discussion of how the above requirements have been implemented in the emergency diesel generator system design and how they will be considered when the plant is in commercial operation, i.e., by what means will the above requirements be enforced.

Response

1. During periodic testing and test loading, each diesel generator unit will be tested at load in excess of the minimum 25 percent of the unit rated load, as described in Section 8.3.1.1.1 of the PSAR.

2. Diesel engine surveillance testing will be performed in accordance with NRC Regulatory Guide 1.108 (Rev. 1, 8/77) as described in Section 8.3.1.1.1 of the PSAR and in accordance with recommendations of the diesel engine manufacturer. Any conflicts between the manufacturer's recommendations and the NRC guidelines will be identified and discussed after receipt of the manufacturer's surveillance testing recommendations.

3. The Plant Maintenance Group, through the review of Work Requests, Licensee Event Reports and Surveillance Test Reports, will maintain awareness of problems associated with the diesel generator units. Repeated problems with any equipment or component important to safety will become a subject for a plant investigation to determine if the cause of the problem is related to improper maintenance, improper operation, poor design, or manufacturing deficiencies. If the problem is determined to be caused by improper maintenance or operation, preventative measures such as proper training or procedure changes will be implemented. If the problem is determined to be caused by design or manufacture, a request will be made to engineering for an evaluation and/or solution.

4. Administrative Procedure will specify for all systems, including the diesel generator units, that shift supervision shall "require a checklist to be performed on the affected system and on portions of other systems located in the areas in which significant maintenance was performed". Based on the activities performed, this checklist will include such items as valves, electrical and instrument alignments, tests to ensure that electrical circuits are functional, wiring check for loose connections, visual checks to ensure that proper fuses are in place and that the circuit breakers and disconnect switches are in proper position, etc.

Question CS430.24 (8.3.1)

The availability on demand of an emergency diesel generator is dependent upon, among other things, the proper functioning of its controls and monitoring instrumentation. This equipment is generally panel mounted and in some instances the panels are mounted directly on the diesel generator skid. Major diesel engine damage has occurred at some operating plants from vibration induced wear on skid mounted control and monitoring instrumentation. This sensitive instrumentation is not made to withstand and function accurately for prolonged periods under continuous vibrational stresses normally encountered with internal combustion engines. Operation of sensitive instrumentation under this environment rapidly deteriorates calibration, accuracy and control signal output.

Therefore, except for sensors and other equipment that must be directly mounted on the engine or associated piping, the controls and monitoring instrumentation should be installed on a free standing floor mounted panel separate from the engine skids, and located on a vibration free floor area. If the floor is not vibration free, the panel shall be equipped with vibration mounts.

Confirm your compliance with the above requirements or provide justification for noncompliance.

Response

Except for sensors and other equipment that must be directly mounted on the engine or associated piping, the controls and monitoring instrumentation for each diesel generator unit are installed on two (2) free standing floor mounted panels separate from the diesel generator unit skids. The control panels will be equivalent to NEMA Type 12 in order to protect the control devices and components from dust and other environment.

The diesel generator units are located in a Seismic Category I building separate from all other plant buildings. The diesel generator units will be installed on their own foundations which are isolated from the main building slab and are designed to eliminate any vibration to control panels. The control panels are located on the main building slab and will not be subjected to engine vibration, and as such, no vibration mounts are required.

Section 8.3.1.1.1 of the PSAR has been revised to include the above clarification.

Question 430.25 (8.3.2)

In Chapter 8 of the PSAR, you discuss three (3) emergency diesel generators. In Chapter 9, however, the discussion of emergency diesel generator auxiliary systems includes only two (2) diesel generators. Revise your PSAR so Chapters 8 and 9 are in agreement. The PSAR revisions should cover the text material, as well as applicable P&ID's and General Arrangement Drawings showing plan, elevation, and section views. Questions asked in Chapter 9 are applicable to all emergency diesel generators.

Response

Chapter 9.14 of the PSAR has been updated to include the description of the three (3) emergency diesel generators. The updated PSAR Chapter 9.14 is provided herewith. The revised PSAR Chapter 9.14 includes the design basis for the Diesel Generator auxiliary system. The generic description of the system is also provided. The P&ID's and General Arrangements are under development and will be provided in later revisions of the PSAR.

Question CS430.26 (8.3.1)

In Section 8.3.1.1.2 of the PSAR, under the heading Circuit Protection, you list the emergency diesel generator protective trips. However, there is no discussion of protection in the event of excessive jacket water temperature of turbo-charger malfunctions. Expand your PSAR to discuss these protective features, or explain why such protection is not required.

Response

The diesel generator units will be provided with surveillance systems permitting Main Control Room and local surveillance and to indicate the occurrence of abnormal, pretrip or trip conditions.

Adequate instrumentation will be provided to monitor the variables for successful operation and to generate the abnormal, pretrip and trip signals required for alarm of the following conditions:

Starting Air System
Lubricating Oil System
Fuel Oil System
Jacket Water Cooling System
Combustion Air Intake System
Exhaust System
Generator
Generator Field
Generator Excitation System

The alarms and indicating devices provided at the Diesel Generator Local Control Panel and the engine mounted control panel (as indicated by an *) are as follows:

Diesel Generator Unit Functions	Indicating Devices	Alarms
- Start	Pilot Light	
- Stop	Pilot Light	
- Unit in Standby Mode	Pilot Light	X
- Unit in Test Mode	Pilot Light	X
- Unit in Maintenance	Pilot Light	X
- Unit Ready to Start	Pilot Light	X
- Unit Fail to Start	Pilot Light	X
- Engine Vibration		X
- Unit Disabled		X
- Generator Vibration		X
- Unit Running Time	Meter	
- Generator Differential Current	Relay Target	X
- Generator Overcurrent	Relay Target	X
- Generator Reverse Power	Relay Target	X
- Generator Loss of Field	Relay Target	
- Generator Field Ground	Relay Target	X
- Generator Ground	Relay Target	X
- Sequence Starting	Pilot Light	
- Generator Field Volts	Meter	
- Generator Field Amps	Meter	
- Generator Kilowatts	Meter	
- Generator Kilovars	Meter	
- Generator Amps	Meter	
- Generator Volts	Meter	
- Generator Frequency	Meter	
- Generator Output Circuit Breaker	Pilot Lights	
- Generator Space Heater	Pilot Lights	

- Generator Lockout	Pilot Light	X
- Unit Loss of DC Control	Pilot Light	X
- Voltage Unbalance (due to blown PT fuses)		X
- Generator Stator Temperature	Meter	
Phase "A" Winding		HI
Phase "B" Winding		HI
Phase "C" Winding		HI
- Each Generator Bearing Temperature	Meter	HI

Engine Starting System Functions:

- Air Receiver #1 - Pressure	*	HI/LO
- Air Receiver #2 - Pressure	*	HI/LO
- Air Compressor #1	Pilot Lights	
- Air Compressor #2	Pilot Lights	
- Air Dryer #1	Pilot Lights	
- Air Dryer #2	Pilot Lights	
- Moisture @ Air Receiver #1		HI
- Moisture @ Air Receiver #2		HI
- Fuel Oil Day Tank Level	Meter	HI/LO
- Fuel Injector Header Pressure	*	LO
- Main Engine-driven Pump Suction Filter Differential Pressure	*	HI
- Main Engine-driven Pump Discharge Filter Differential Pressure	*	HI
- AC Pump Suction Filter Differential Pressure	*	HI
- AC Pump Discharge Filter Differential Pressure	*	HI
- Fuel Oil Day Tank Conductivity	Meter	HI
- AC Fuel Pump	Pilot Lights	HI

- F.O. Transfer Pump #1	Pilot Lights	
- F.O. Transfer Pump #2	Pilot Lights	
- F.O. Transfer Pump #1 Suction Strainer Differential Pressure	Meter	HI
- F.O. Transfer Pump #2 Suction Strainer Differential Pressure	Meter	HI
- F.O. Storage Tank Level	Meter	LO
- F.O. Storage Tank Conductivity	Meter	HI
- Turbo Aftercooler Water Inlet Temperature	Meter	
- Turbo Aftercooler Water Outlet Temperature	Meter	
- Turbo After Cooler Water Outlet Temperature	Meter	

Engine Cooling System Functions:

- Jacket Water Expansion Tank Level		LO
- Jacket Water Header Pressure		LO
- Jacket Water Temperature	*	HI/LO
- Jacket Water Heater	Pilot Lights	
- Jacket Water Heater Pump	Pilot Lights	
- Flow Service Water	Meter	LO
- Lubricating Oil Sump Level	Meter	LO
- Lubricating Oil Header Pressure	*	LO
- Lubricating Oil Temperature	*	HI/LO
- Crankcase Pressure	*	HI
- Lubricating Oil Heater	Pilot Lights	
- Lubricating Oil Heater Pump	Pilot Lights	
- Lubricating Oil Discharge Filter Differential Pressure	*	HI

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Engine Speed and Load Control System Functions:		
- Governor		
- Unit Speet	Tachometer	HI
Excitation System Functions:		
- Static Exciter Diode Failure	Pilot Lights	X
- Generator Voltage Regulator		
- Generator Voltage Regulator		

*denotes that indicating devices are provided on the engine-mounted control panel.

The alarms and indicating devices provided in the Main Control Room are as follows:

DIESEL GENERATOR UNIT FUNCTION	INDICATING DEVICES	ALARMS
Engine Trouble		X
Crankcase Pressure		HI
Unit in Standby Mode	Pilot Light	
Unit not available	Pilot Light	X
Synchronization	Synchroscope	
Power Output	Wattmeter	
Generator Output	Ammeter	
Generator Frequency	Frequence Meter	
air Receiver Pressure		LO
Diesel Generator Trip		X
Engine overspeed		X
Generator Differential Protection		X
Lube oil Pressure		LO
Jacket Water Temperature		HI/LO
Generator Field Ground		X
Bearing Temperature		HI
Engine Vibration		HI

The following protections are provided to trip the Diesel Generator unit during the testing mode:

Engine overspeed
Low Lubricating Oil Pressure
Generator Differential Overcurrent
Generator Overcurrent
Reverse Power Flow to Generator
Generator Loss of Field
Generator Ground
Generator Field Ground
High Jacket Water Temperature
Excessive Engine Vibration

After an automatic start of the Diesel Generator under a plant emergency condition, all protective functions will be bypassed except for the following as described in Section 8.3.1.1.2 of the PSAR:

Generator Differential Overcurrent
Engine Overspeed

The emergency Diesel Generator will be provided with protection against excessive jacket water temperature, such that the operator will be alarmed if the temperature exceeds 190 F and the unit will be tripped on temperature in excess of 200 F during the unit testing. This protective trip feature will be bypassed when the unit is running in an emergency mode.

The turbo-charger will be provided with alarms for low lube oil pressure, excessive vibration and high jacket water temperature to alert the operator of potential turbo-charger malfunction. The performance of the turbo-charger will be periodically observed during the testing of the unit. Should a failure of some part of the turbo-charger prevent its operation, the engine can be operated as a normally aspirated engine until repairs can be made to the turbo-charger.

The malfunction of the turbo-charger will result in some loss of power output, however, since there is substantial margin in the load capability of the units, the ability of these units to perform their intended function during an emergency will not be affected. This will be confirmed with the vendor at a later date.

Question CS430.27

The PSAR Section covering onsite communications should be expanded to include the following information:

a) Identify all areas from which it will be necessary for plant personnel to communicate with the control room or the emergency shutdown panel during and following transients and/or accidents (including loss of offsite power) in order to mitigate the consequences of the emergency and to attain a safe, cold plant shutdown.

b) Indicate the types of communications that will be available in each of the above areas to provide an adequate communications under all normal operations and design basis accident conditions, including the safe shutdown earthquake.

Response

a) Table QCS430.27-1 identifies the vital areas by building, cell and cell designation from which it will be necessary for plant personnel to communicate with the control room or the emergency shutdown panels during the full spectrum of accident or incident conditions (including loss of offsite power).

b) Table QCS430.27-1 also identifies the types of communications that will be available in each of the above areas to communicate with the control room or the emergency shutdown panel during normal operation and accident conditions.

   The communication system is designed for high reliability during normal and emergency operation of the plant within the plant and between the plant and other TVA facilities.

   The communication system is not required to perform any safety function. Therefore, the operation of the communication system, except the portable radio system, cannot be ensured during and after a safe shutdown earthquake.

   The system is designed to provide effective and diversified means of communication in all vital areas of the plant during the full spectrum of accident or incident conditions under the maximum potential noise levels. The various means of communications as described in PSAR Section 9.11 complement one another. Should for some reason one or more communication means be unavailable, diverse means should continue to be available.

The portable radio units which will be handcarried by plant personnel will provide them with the capability to communicate among themselves on an alternate frequency in case of loss of base station, antenna, satellite receiver and transmitter of portable radio system.

The communication equipment located in Seismic Category I structures will be mounted on seismically qualified supports.

LEGEND

PA-IC = Public Address Intra-plant Communications System

PAX = Private Automatic Exchange (Telephone System)

MCJ = Maintenance Communication Jacking System (Sound Powered Communication System)

PRS = Portable Radio System

CB = Control Building

RSB = Reactor Service Building

RCB = Reactor Containment Building

SGB = Steam Generator Building

DGB = Diesel Generator Building

ECT = Emergency Cooling Towers

FPH = Fire Protection Pump House

CR = Control Room

RSP = Remote Shutdown Panel

HVAC = Heating, Ventilating, and Air Conditioning

USS = 480V AC Unit Substation

MCC = Motor Control Center

AFW = Auxiliary Feedwater

SWGR = Medium Voltage Switchgear

SSPLS = Solid State Programmable Logic System

EI&C = Electrical Instrumentation & Control

EVST = Ex-vessel Storage Tank

EVSS = Ex-vessel Storage Subsystem

ABHX = Air Blast Heat Exchanger

TABLE 1 QCS430 27-1

X = AVAILABLE

AREA			TYPE OF COMMUNICATION FROM CR & RSP TO AREA			
BLDG.	CELL	CELL DESIGNATION	PA-IC	PAX	MCJ	PRS*
CE	410A	Control Room HVAC Cell	X		X	X
	410B	Control Room Filter Cell	X		X	X
	411A	Control Room HVAC Cell	X		X	X
	411B	Control Room Filter Cell	X		X	X
	412	Air Handling Unit Area	X	X	X	X
	413	Return Fan Area	X	X	X	X
	421	Security Room (Reserved)	X	X		X
	431	Main Control Room	X	X	X	X
	432	Computer Room	X	X	X	X
	446	USS and MCC Area	X	X	X	X
	451	125V Division 1 Battery Room	X		X	X
	453	250V Division 3 Battery Room	X		X	X
	454	Division 1 AC/DC Equipment Room	X		X	X
	455	Secondary Rod Control Room	X		X	X
	456	Prim. Rod Control MG Set Cell	X		X	X
	457	Prim. Rod Control Room	X		X	X
	458	125V Division 3 AC/DC Equipment Room	X		X	X
	459	Division 3 AC/DC Equipment Room	X	X	X	X
	460	Division 2 AC/DC Equipment Room	X	X	X	X

*Portable radios will be hand carried by plant personnel

TABLE 1
(cont'd)

X = AVAILABLE

AREA			TYPE OF COMMUNICATION FROM CR & RSP TO AREA			
BLDG	CELL	CELL DESIGNATION	PA-IC	PAX	MCJ	PRS*
SGB	202	Auxiliary Bay Loop 1	X	X	X	X
	202A	Turbine AFW Pump			X	X
	202B	AFP Cooler Room			X	X
	204	Auxiliary Bay Loop2	X	X	X	X
	204A	AFW Pump A			X	X
	204B	AFW Pump B			X	X
	206	Auxiliary Bay Loop 3	X	X	X	X
	207	Steam Gen. Cell Loop 1	X		X	X
	208	Steam Gen. Cell Loop 2	X		X	X
	209	Steam Gen. Cell Loop 3	X		X	X
	215	SGAHRS PWST Room Auxiliary Bay	X		X	X
	216	Emer. Chiller Room Int. Bay	X		X	X
	217	Emer. Chiller Room Int. Bay	X		X	X
	221	Auxiliary Bay Loop 1	X	X	X	X
	222	Auxiliary Bay Loop 2	X		X	X
	223	Auxiliary Bay Loop 3	X	X	X	X
	241	Auxiliary Bay Loop 1	X	X	X	X
	242	Auxiliary Bay Loop 2	X	X	X	X
	243	Auxiliary Bay Loop 3	X	X	X	X
	244	Steam Gen. Cell Loop 1	X		X	X
	245	Steam Gen. Cell Loop 2	X		X	X
	246	Steam Gen. Cell Loop 3	X		X	X
	247	Intermediate Bay West	X	X	X	X

TABLE 1
(cont'd.)

X = AVAILABLE

AREA			TYPE OF COMMUNICATION FROM CR & RSP TO AREA			
BLDG.	CELL	CELL DESIGNATION	PA-IC	PAX	MCJ	PRS*
SGB	253	Intermediate Bay East	X		X	X
	262	Intermediate Bay Floor El. 816'-0"	X	X	X	X
	271	Intermediate Bay Floor El. 836'-0"	X	X	X	X
	272A	Remote Shutdown Cell A	X	X	X	X
	272B	Remote Shutdown Cell B	X	X	X	X
	272C	Remote Shutdown Cell C	X	X	X	X
	273	Motor Control Center Division 3 Cell	X		X	X
	281	Auxiliary Bay Loop 1	X	X	X	X
	282	Auxiliary Bay Loop 2	X		X	X
	283	Auxiliary Bay Loop 3	X	X	X	X

TABLE 1
(cont'd.)

X = AVAILABLE

AREA			TYPE OF COMMUNICATION FROM CR & RSP TO AREA			
BLDG	CELL	CELL DESIGNATION	PA-IC	PAX	MCJ	PRS*
EEB	521	SWGR Bus and USS Cell	X	X	X	X
	524	SWGR Bus and USS Cell	X	X	X	X
	525	Fire Pump Area	X		X	X
	541	Fire Pump Area	X		X	X

TABLE 1
(cont'd.)

X = AVAILABLE

AREA			TYPE OF COMMUNICATION FROM CR & RSP TO AREA			
BLDG	CELL	CELL DESIGNATION	PA-IC	PAX	MCJ	PRS*
DGB		Diesel Generator A and Auxiliaries	X	X	X	X
		Diesel Generator B and Auxiliaries	X	X	X	X
		Diesel Generator C and Auxiliaries	X	X	X	X
		DG A HVAC Equipment Room	X	X	X	X
		DG B HVAC Equipment Room	X	X	X	X
		DB C HVAC Equipment Room	X	X	X	X

Question CS430.28 (9.11)

The final design of the onsite communications systems will be reviewed with regard to functional capability of all normal operating and accident conditions. Therefore, the PSAR should be expanded, to the extent practicable, to include the following:

a) A list of all working stations including locations and the type of communication system(s) provided at each location.

b) The maximum sound levels that will exist at each of the above identified working stations for all transient accident conditions.

c) The maximum background noise level that will exist at each working station during normal operation and accident condition and yet reliably expect effective communication with the control room using the communication system(s) available at that station.

d) Communication systems performance requirements and test procedures (including frequency) which will be imposed to ensure that effective communication with the control room or emergency shutdown panel is possible under all conditions.

e) A discussion of protective measures to be taken to ensure functional onsite communication systems, including considerations for component failure, loss of power, and severing of a communication line or trunk as a result of an accident or fire.

Response

a) The response to question CS430.27 provides a list of communications system locations.

b) The maximum sound level (noise) that will exist at each of the working stations identified in item (a) above for all transient accident conditions will be within the sound levels as shown under item (c) below.

   The sound levels of the PA-IC speakers will be adjusted 5 db above the maximum background noise level.

c) The maximum background noise levels that will exist at each working station during normal operation and accident conditions is not determined at this time and will be included in FSAR. However, the maximum expected noise level in each area is given below.

Building	Area	Maximum Expected Noise Level (db)
Reactor Service Building	General Areas	90
	ABHX Unit Cooler Cell	95
	Containment Cleanup Scrubber and Washer Cell	95
Steam Generator Building	General Areas	90
	Emer. Chiller Room	95
	Auxiliary Bays	95
Control Building	General Areas	85
	HVAC Cell	100
	Equipment Rooms	90
Diesel Generator Building	General Areas	90
Turbine Generator Building & Other Balance of Plant Buildings	General Areas	90

The working stations for communication systems will be located to provide voice communication between two or more locations in the plant, even in areas of extreme noise levels. In the areas of high ambient noise (> 90 dbA) supplementary red flashing indicating lights are provided at a visible location above the working station to draw the attention of the operating personnel for an incoming call. The handsets will be located in sound absorbing booths in high noise areas. Headsets are provided for use at the maintenance communication jacking stations throughout the plant.

Tests will be made to determine ambient noise levels in all plant areas in order to verify the communication system design and to make any system adjustments, if required.

d) Communication systems performance requirements and test procedures (including frequency of testing) which will be imposed to ensure that effective communication with the control room or emergency shutdown panels is possible under all conditions will be included in the Plant Communication System test procedures and in the FSAR.

e) The following protective measures are taken to ensure functional onsite communication systems:

1. Diverse and redundant means of communication systems are used to ensure reliable and effective means of communication both intra-plant and external to the plant for all modes of plant operation including emergency conditions.

2. The communication subsystems are designed such that the failure of the power supply or the component of a subsystem or a communication loop, will not impair the operation of other subsystems or other communication loops of the subsystem. The power supplies are designed such that the complete Public Address Intra-plant Communication system is not lost in any area of the plant due to a single failure of the equipment or the power supply circuit.

3. The communication subsystems (except the maintenance communication jacking (MCJ System)) are powered from the non-Class 1E uninterruptible power supplies (UPS). The MCJ system is sound powered and requires no power for its operation.

4. Communication equipment location in the Reactor Containment Building are connected to their communications subsystem through a number of independent electrical containment penetrations. The failure of a penetration due to a single localized accident will not cause failure of the remaining communication subsystem(s) in the Reactor Containment Building.

5. The maintenance communication jacking (MCJ) sound powered system provides six independent and separate sound-powered telephone communication loops with three circuits each for communications between the ControlRoom and the different plant buildings. All of the five Nuclear Island Building sound powered loops are available for communication use between the remote shutdown panel and the Nuclear Island Buildings for supporting remote plant shutdown.

6. The communication equipment located in Seismic Category I structures will be mounted on seismically qualified supports.

Question CS430.29 (9.12)

Provide a tabulation of vital areas where emergency lighting is required for safe shutdown of the reactor and evacuation of personnel in the event of an accident.

Response

Emergency lighting for CRBRP is provided by the Standby Lighting System and the Emergency Lighting System as described in Sections 9.12.2 and 9.12.3 of the PSAR.

Table 430.29-1 tabulates areas of the plant where emergency lighting is utilized.

TABLE 430.29-1

LEGEND

ABHX	Air Blast Heat Exchanger
AFW	Auxiliary Feedwater
CB	Control Building
DGB	Diesel Generator Building
ECT	Emergency Cooling Tower
EEB	Electrical Equipment Building
EVSS	Exvessel Storage Subsystem
EVST	Ex-vessel Storage Tank
IB	Intermediate Bay
MG	Motor Generator
PWST	Protected Water Storage Tank
RCB	Reactor Containment building
RSB	Reactor Service Building
SGAHRS	Steam Generator Auxiliary Heat Removal System
SGB	Steam Generator Building

TABLE 430.29-1

BLDG.	CELL NO.	CELL DESIGNATION	REMARKS
RCB	105A	Corridor	Access to 105F, G
RCB	105D	Corridor	Access to 105F
RCB	105E	Personnel & Equipment Access	Access to 105F
RCB	105F	Makeup Pump & Valve Cell	
RCB	105G	Personnel & Equipment Access	
RCB	105H	Corridor & Valve Gallery	
RCB	105L	Cable Tray & Access Corridor	
RCB	105M	Corridor	Access to 105Z
RCB	105T	Corridor	Access to 105Z
RCB	105Z	Makeup Pump Cooler Cell	
RCB	109	Stairwell	Access to 105G, H, M
RCB	151	Head Access Area	
RCB	161A	RCB Main Operating Floor	
RCB	161C	PHTS Pump Motor Cavity	
RCB	161D	PHTS Pump Motor Cavity	
RCB	161E	PHTS Pump Motor Cavity	
RCB	163	I&C Cubicle	
RCB	165	I&C Cubicle	
RCB	167	I&C Cubicle	
SGB	201	Stairwell	Access to 202, 241, 281
SGB	202	Auxiliary Bay Loop 1	
SGB	202A	Turbine AFW Pump	
SGB	202B	AFW Pump Cooler Room	
SGB	204A	AFW Pump A	
SGB	204B	AFW Pump B	
SGB	206	Auxiliary Bay Loop 3	
SGB	207	Steam Generator Cell Loop 1	
SGB	208	Steam Generator Cell Loop 2	
SGB	209	Steam Generator Cell Loop 3	
SGB	210	Intermediate Bay	Access to 216, 217

BLDG.	CELL NO.	CELL DESIGNATION	REMARKS
SGB	212	Stairwell	Access to 210,271
SGB	214	Stairwell	Access to 253,262,271
SGB	215	SGAHRS PWST Room	
SGB	216	Emergency Chiller Room	
SGB	217	Emergency Chiller Room	
SGB	221	Auxiliary Bay Loop 1	
SGB	222	Auxiliary Bay Loop 2	
SGB	223	Auxiliary Bay Loop 3	
SGB	233	Stairwell	Access to 247,262,271
SGB	241	Auxiliary Bay Loop 1	
SGB	242	Auxiliary Bay Loop 2	
SGB	243	Auxiliary Bay Loop 3	
SGB	244	Steam Generator Cell Loop 1	
SGB	245	Steam Generator Cell Loop 2	
SGB	246	Steam Generator Cell Loop 3	
SGB	247	Intermediate Bay West	
SGB	253	Intermediate Bay East	
SGB	262	IB Cell	
SGB	263	Protected Corridor	
SGB	271	IB Cell	
SGB	272A	Remote Shutdown Cell A	
SGB	272B	Remote Shutdown Cell B	
SGB	272C	Remote Shutdown Cell C	
SGB	273	Motor Control Center	
SGB	281	Auxiliary Bay Loop 1	
SGB	282	Auxiliary Bay Loop 2	
SGB	283	Auxiliary Bay Loop 3	
RSB	301	Stairwell	Access to 306,306A
RSB	303	Stairwell	Access to 311
RSB	304	Stairwell	Access to 30, 347, 349, 350, 359, 360
RSB	305A	El. 733' Access Area	Access to 305B

BLDG.	CELL NO.	CELL DESIGNATION	REMARKS
RSB	305B	El. 733' Access Area	
RSB	305E	Unit Substation Cell	
RSB	305F	Unit Substation Cell	
RSB	305G	Heat Exchanger Cell	
RSB	305H	RSB HVAC Equipment Room	Access to 305G, I
RSB	305I	Heat Exchanger Cell	
RSB	306A	El. 755' Access Area	
RSB	306B	El. 755' Access Area	
RSB	306D	El. 765' Access Area	Access to 350
RSB	307H	El. 788' Access Area	Access to 353A
RSB	308A	RSB Operating Floor	Access to 301,309, 324,326, 392
RSB	309	Motor Control Center	
RSB	311	Refueling Communication Center	
RSB	314	Instrumentation Area	Access to 341,349
RSB	325	EVS Pump & Pipeways Cooler Cell	
RSB	326	ABHX Cell Unit Cooler Cell	
RSB	327	ABHX Cell Unit Cooler Cell	
RSB	333	Stairwell	Access to 350,357
RSB	347	Containment Cleanup Filter Cell	
RSB	247A	Radiation Monitor Cell	
RSB	348	RCB Cleanup Chase	
RSB	349	RCB Cleanup Chase	
RSB	352A	EVST ABHX Loop A Cell	
RSB	353A	EVST ABHX Loop B Cell	
RSB	357	EVS Cooling Loop B Cell	
RSB	359	RCB Cleanup Scrubber & Washer Cell	
RSB	360	EVS Cooling Loop A Cell	
RSB	384	El. 755' Access Area	Access to 359
RSB	391	RCB Cleanup Filter Cell	
RSB	392	Access Area & Laydown Space	Access to 304,325, 327,391, 395,398
RSB	395	Annulus Filter Unit Cell	
RSB	398	Annulus Filter Unit Cell	

BLDG.	CELL NO.	CELL DESIGNATION	REMARKS
CB	410A	Control Room HVAC Cell	
CB	410B	Control Room Filter Cell	
CB	411A	Control Room HVAC Cell	
CB	411B	Control Room filter Cell	
CB	412	Air Handling Unit Area	
CB	413	Return Fan Area	
CB	416A	Airlock	Access to 410B
CB	416B	Airlock	Access to 410A
CB	417A	Airlock	Access to 411B
CB	417B	Airlock	Access to 411A
CB	421	Industrial Security System Cell	
CB	422	Technical Support Center	
CB	423	Tech. Support Center Conference Room	
CB	424	Stairwell	Access to 413, 446, 450,467, 524
CB	431	Control Room	
CB	432	Computer Room	
CB	440	Corridor	Access to 442, 443,4
CB	441	Corridor	Access to 440,513
CB	442	Corridor	Access to 431,440
CB	443	Stairwell	Access to 429,440
CB	446	Unit Substation Area	
CB	448	Corridor	Access to 424,431, 440
CB	450	Corridor	Access to 421,422, 424

BLDG.	CELL NO.	CELL DESIGNATION	REMARKS
CB	451	Division 1 Battery Room	
CB	453	Division 3 Battery Room	
CB	454	Division 1 AC/DC Equipment Room	
CB	455	Secondary Rod Control Room	
CB	456	primary Rod Control MG Set Room	
CB	457	Primary Rod Control Room	
CB	458	Division 2 Battery Room	
CB	459	Division 3 AC/DC Equipment Room	
CB	460	Division 2 AC/DC Equipment room	
CB	467	Corridor	Access to 424,451, 453,454, 455,456, 457,458, 459,460
EEB	513	Equipment Removal Hatch Area & Corridor	Access to 441,2t 5
EEB	521	Switchgear Bus & USS Cell	
EEB	524	Switchgear Bus & USS Cell	
EEB	525	Equipent Removal Hatch Area	
EEB	540	Switchgear Bus Area	Access to 541
EEB	541	Equipment Removal Hatch Area	
EEB	542	Primary Sodium Pump MG Set Room	Access to 543
EEB	543	Intermediate Sodium Pump MG Set Room	Access to 540
DGB		Diesel Generator A and Auxiliaries	
DGB		Diesel Generator B and Auxiliaries	
DGB		Diesel Generator	
DGB		DG A HVAC Equipment Room	
DGB		DG B HVAC Equipment Room	
DGB		DG C HVAC Equipment Room	
DGB		DG A Filter Bank	
DGB		DG B Filter Bank	
DGB		DG C Filter Bank	
DGB		Passageway to DG A HVAC Equipment	
DGB		Passageway to DG B HVAC Equipment	
DGB		Passageway to DG C HVAC Equipment	
ECT		Emergency Cooling Tower Pumphouse A	
ECT		Emergency Cooling Tower Pumphouse B	

Question CS430.30 (9.12)

Identify the types of lighting that will be provided in the above tabulated vital areas. Show that lighting will be available in the event of a design basis accident, including the safe shutdown earthquake.

Response:

The CRBRP Lighting System provides normal, standby and emergency lighting as described in Section 9.12 of the PSAR. The Normal Lighting System provides illumination under all normal plant operating conditions with power available from the Plant, Preferred, or Reserve power supply systems. The Standby Lighting System provides adequate illumination under all normal and emergency plant operating conditions with power available from the Plant, Preferred, Reserve or Class 1E Onsite AC Power System. Under an emergency condition, resulting in loss of all offsite power sources, the standby lighting system will be powered from the Class 1E onsite AC power system (Emergency Diesel Generators). Both Normal and Standby Lighting Systems utilize high pressure sodium and fluorescent light fixtures. The Emergency Lighting System provides adequate illumination at points of egress, in the Control Room, at remote shutdown locations and at all locations required for access to safety-related equipment. The Emergency Lighting System utilizes self-contained individual eight (8) hour rated battery powered units with sealed beam lamps and self-contained eight (8) hour rated battery powered exit signs.

All lighting fixtures in Nuclear Island buildings are seismically qualified to maintain structural integrity in accordance with IEEE Std. 344-1975. The lighting fixtures and raceways are supported to meet Seismic Category 1 requirements as described in Sections 3.7.2 and 3.7.3 of the PSAR.

The Standby Lighting System is classified as 1E up to and including the lighting panel. The circuits to the Standby Lighting System light fixtures are also 1E and are routed to maintain required separation from non-Class 1E or Class 1E cables of other Divisions as described in Section 8.3.1.2 of the PSAR. However, the lighting fixtures are non-Class 1E and as such these circuits from the lighting panels to the lighting fixtures of the standby lighting system are considered associated 1E.

PSAR Section 9.12 has been revised to reflect the above.

Question CS430.31 (9.12)

For all vital areas identified, indicate that illumination levels during accident conditions will be adequate for performance of any tasks associated with safe shutdown of the reactor, and for maintaining the reactor in a safe shutdown condition. Demonstrate that sufficient lighting will be available in the vital areas in the event of a prolonged loss of offsite power illumination levels should be in conformance with applicable sections of the Illumination Engineering Society (IES) Lighting Handbook.

Response:

The Normal Lighting System provides illumination to the level recommended by the IES Handbook. Where illumination is required for operation or maintenance of safety-related equipment, the Standby Lighting System receives power from the Emergency Diesel Generator and provides an average illumination of twenty (20) foot candles. During loss of offsite power, access routes to areas containing safety-related equipment are illuminated by the Standby Lighting System to a level of three (3) foot candles. The Emergency Lighting System provides one foot candle illumination, per NFPA 101, Section 5-8, and IES recommendation, in all egress routes and where access is required for fire fighting in areas containing safety related equipment. The emergency lighting system utilizes self-contained individual eight (8) hour rated battery powered units with sealed beam lamps and self-contained eight(8) hour rated battery powered exit signs for a period of 8 hours, per Branch Technical Position CMEB 9.5-1, paragraph 5g. Lighting in the Control Room at all operator work stations will be powered from the plant Class 1E uninterruptible power supply (UPS) system and will provide an illumination of minimum 10 foot candles in accordance with the requirements of Section 6.1.5.4 of NUREG 0700 during loss of all offsite power.

QCS430.32 (9.14.1)

Provide a general arrangement drawing for the Emergency Diesel Generator Fuel Oil Storage and Transfer System. Show storage tank locations and piping runs in relation to the diesel generator building and any other structures in the vicinity. Include section views, as necessary, for clarity.

Response

The general arrangement and piping drawings will be developed on the basis of the design bases and system description provided with the responses to Question 430.25. The development of the general arrangement and piping drawings is in process and will be provided in a later revision of the PSAR.

Question CS430.33 (9.14.1)

Describe the instruments, controls, sensors and alarms provided for monitoring the diesel engine fuel oil storage and transfer system, and describe their function. Identify the temperature, pressure, and level sensors which alert the operator when these parameters are exceeded, and state where the alarms are annunciated. Discuss the system interlocks provided, to the extent practical.

Provide a discussion of the testing and maintenance program which will be implemented to ensure a highly reliable instrumentation, controls, sensors, and alarm system.

Response

The emergency diesel engine fuel oil storage and transfer system will provide sensors and alarms to monitor and control the fuel oil parameters for all three diesel generators. Monitoring and control of the Diesel Generator 7-day storage tank assemblies will be provided by the following sensors:

1. Low-low storage tank level.
2. High-high storage tank level.
3. High/low storage tank level.
4. Storage tank level transmitter.

The low/low and high/high tank level switches will annunciate alarms locally at the diesel engine control panel and actuate the diesel generator trouble alarm in the control room. The high/low level switches will provide interlocks to automatically start and stop the fuel oil transfer pumps. The storage tank level transmitter will provide level indication locally.

A Seismic Category I truck fill connection, condensate sump, and inspection-dipstick gauge manholes will be provided for each embedded 7-day storage tank assembly.

For the Diesel Generators electric motor driven fuel oil transfer pumps will be provided to transfer fuel from the embedded 7-day storage tank assembly to the day tank. Each of these pumps will be independently capable of supplying fuel to the day tank.

The following level instrumentation and controls will be provided for each day tank and associated transfer pumps:

1. High/high level alarm.

2. High level switch to automatically stop the fuel oil transfer pump.

3. Low level switch to automatically start the primary fuel oil transfer pump.

4. Low/low level switch to automatically start the standby fuel oil transfer pump and for alarm.

A selector switch will be provided on the engine control cabinet which will allow the operator to administratively select the primary pump. The high/high and low/low alarms will annunciate both locally and actuate the Diesel Generator trouble alarm in the Control Room. A local level meter will be provided to indicate day tank level.

From the day tank fuel will be supplied to the diesel injectors by a shaft driven pump. An electric motor-driven fuel pump will be provided as a backup for the engine driven fuel pump. Separate suction and discharge lines will serve each pump. Each pump will have a suction duplex strainer and discharges to a duplex filter downstream from the discharge junction. Pressure indication will be provided on the suction and discharge of each fuel pump and a high fuel oil filter differential pressure alarm is provided locally and actuates a Diesel Generator trouble alarm in the Control Room.

Fuel oil pressure will be monitored just upstream of engine injectors. Low fuel oil pressure will be indicated on the diesel engine control panel.

Periodic testing will be performed on the Diesel Generators to demonstrate that the units are operational as described in Section 8.3.1.1.1 of the PSAR. Portions of these surveillance requirements include:

- Verify the proper fuel oil levels in the day tank

- Verify the proper fuel oil level in the 7-day storage tanks

- Verify the fuel oil transfer pump can be started and that it can transfer fuel from the storage system to the day tank

- Verify the diesel starts and accelerates from standby condition to rated speed in 10 seconds

In addition, testing and maintenance of all fuel oil instruments will be performed in accordance with the scheduled maintenance and calibration program for the Clinch River Plant.

Question CS430.34 (9.14.1)

Provide a discussion of e design provisions which will be used to protect the fuel oil storage tank fill and vent lines from damage by tornado missiles.

Response

The Fuel Oil Storage and Transfer System storage tank vent and fill lines will be protected from tornado damage by the application of:

- appropriate thickness earth cover or
- concrete tornado missile shielding or
- the combination of the two methods described above.

The tornado missile protection will be in accordance with the requirements of SRP 3.3.2 "Tornado Loading and SRP 3.5.3 "Barrier Design Procedures".

Question CS430.35 (9.14.1)

Expand the PSAR to include a discussion of the fuel oil storage tank and how your design will conform to the requirements of ANSI N-195 and R.G. 1.137. Provide specific information on:

1. The method to be used in calculating the capacity of the fuel oil storage tanks.

2. The types of coatings or coating systems to be used to prevent internal and external corrosion of the fuel oil storage tanks and underground piping.

3. A discussion of the cathodic protection system which will be applied to the fuel oil storage tanks, or the rationale of why cathodic protection will not be used.

Response

The calculation of the storage tank capacity is based on the requirements of Regulatory Guide 1.137, utilizing the continuous seven (7) day operating method at full loaded capacity of the diesel engines.

The internal and external coating system for the storage tanks will meet the ANSI N-195 requirements.

The cathodic protection system design is pending completion of the site survey for cathodic protection. The final cathodic protection design for the storage tanks will be in accordance with ANSI N-195.

The next update of Chapter 9.14 of the PSAR will include the applicable description of how the fuel oil storage tank design meets the requirements of ANSI N-195 and Regulatory guide 1.137.

Question CS430.36 (9.14.1)

Expand the PSAR to include a discussion of the following:

1. The means for detecting or preventing growth of algae in the diesel fuel oil storage tanks. If it were detected, describe the methods which will be employed for cleaning the affected tank(s).

2. The method(s) to be employed for removal of water from the diesel fuel oil storage tanks and the day tanks, should water accumulate in either tank.

3. The provisions to be made to prevent the entrance of deliterious material into the diesel fuel oil storage tanks during filling, and as a consequence of adverse environmental conditions.

Response

The procedures for the maintenance of the diesel fuel oil quality will be in accordance with Regulatory guide 1.137 and ANSI N195, specifically:

1. The fuel oil storage tank will be sampled and tested monthly. The test will include check for biological growth. If biological growth is found, a biocide will be used to controlit, based on the recommendation of the fuel supplier and diesel manufacturer.

2. The monthly fuel oil storage tank sample will be checked for presence of water. If water accumulation is detected, it will be pumped out. The tanks will be slightly sloped toward the pump out connection to facilitate the water removal.

3. A procedure will be established to sample and test all new fuel oil deliveries prior to entering the fuel oil into the storage tank. The same procedure will provide instructions how to avoid entrance of deliterious material into the fuel oil storage tank during filling and it will specify the use of filters during filling operations.

Question CS430.37 (9.14.1)

Assume an unlikely event has occurred requiring operation of a diesel generator for a prolonged period that would require replenishment of fuel oil without interrupting operation of the diesel generator. What provision will be made in the design of the fuel oil storage fill system to minimize the creation of turbulence of the sediment in the bottom of the storage tank. Stirring of this sediment during addition of new fuel has the potential of causing the overall quality of the fuel to become unacceptable and could potentially lead to the degradation or failure of the diesel generator.

Response

A filter will be provided on the fill lines to the diesel oil storage tanks. The filters will be rated 5 micron, 98% removal.

Minimization of turbulence in the tanks will be accomplished by providing a flow distributor inside each tank on the fill line. This flow distributor will consist of a section of pipe capped at the end, projecting approximately 12 inches into the tank, and containing a multiple number of holes. The flow distributor will act to minimize turbulence by distributing the flow of new fuel oil over a large surface area in the tank.

Question CS430.38 (9.14.1)

In the PSAR, you state that fuel can be delivered to the site within 24 hours. Expand your PSAR to include a discussion of how the fuel will be delivered, both in normal operations and in the event of extremely unfavorable environmental conditions. In your discussion, include the sources where quality diesel fuel is available and the distances to be traveled from the source to the site, to the extent practical.

Response:

The principle fuel oil distributor utilized by TVA has many local outlets within 100 miles of the site. Fuel oil will be purchased and allocated one year in advance of delivery, however, fuel oil is available on an emergency basis from numerous other suppliers. The list of suppliers is attached herewith.

Access to the site under extremely unfavorable environmental conditions, such as flooding, is available by several alternate paths.

Other extremely unfavorable environmental conditions, such as tornados, would not be long lasting and any necessary access routes could be opened in a short period of time. Onsite diesel oil storage is sufficient to allow operation of each diesel generator for a week. This is more than adequate time to replenish the diesel oil supply under the most unfavorable environmental conditions.

FUEL OIL SUPPLIERS

Ashland Chemical Co.
P.O. Box 2271
Knoxville, TN 37901

Express Marketing Int'l. (ENI)
4420 Bonny Oaks Drive
Chattanooga, TN 37416

Tri County Oil Company
P.O. Box 12237
Knoxville, TN 37912

Morton Oil Company
P.O. Box 1130
Maryville, TN 37801

Midtown Oil Company
P.O. Box 205
Kingston, TN 37763

Prater Oil Company
P.O. Box 1334
Morristown, TN 37814

Southern Oil Service
P.O. Box 1104
Chattanooga, TN 37404

Benton Oil Service, Inc.
4831 Bonny Oaks Drive
Chattanooga, TN 37416

General Oil Company
P.O. Box 68
Chattanooga, TN 37401

Kelso Oil Company
641 Atlanta Avenue
Knoxville, TN 37917

Harriman Oil Company
P.O. Box 262
Harriman, TN 37748

Pettway Oil Company
3324 Alton Park Blvd.
Chattanooga, TN 37410

Ace Oil Company
P.O. Box 5253
Chattanooga, TN 37406

Question CS430.39 (9.14.1)

Discuss the design considerations that will determine the physical location of the diesel engine fuel oil day tank(s) at your facility. Assure that the proposed physical location of the fuel oil day tank(s) meet(s) the requirements of the diesel engine manufacturers.

Response:

The diesel engine fuel oil day tanks will be located in the Diesel Generator Building. For each diesel generator room, a separate day tank room will be provided with 3 hour rated fire enclosures, in accordance with the BTP CSMB 9.5-1 requirements. The elevation of the day tanks will assure slight positive pressure at the engine driven fuel oil pumps. The actual elevation of the day tanks will be established on the basis of the diesel engine manufacturers' recommendation.

Question CS430.40 (9.14.1)

What is the purpose of the standby motor driven fuel oil pump shown of Figure 9.14.7? Expand the PSAR to include a description of this pump, its function, the pump control scheme, and the source of electrical power for the motor.

Response

The standby motor driven fuel oil pump shown on Figure 9.14.7 is indicated to provide fuel oil supply during the engine starting cycle. This pump will be provided with a battery power supply and will be arranged to operate when the engine receives a start signal and it will operate until the system fuel oil pressure is established by the engine driven fuel oil pump. The actual use for this booster pump is dependent on the design of the selected vendor. The PSAR will be revised upon the receipt of the actual vendor design.

Question CS430.41 (9.14.1)

What is the source of electrical power for the diesel fuel oil transfer pumps? Also, provide the salient pump characteristics; i.e., capacity, discharge head, NPSH requirements, and motor HP; to the extent possible.

Response

The electrical power for each diesel fuel oil transfer pump is provided from the same diesel generator for which the fuel oil transfer pump provides service. The transfer pump will be designed to provide fuel supply in excess of the maximum diesel engine consumption by a factor of 3 or more. The specific pump characteriestics are not available at this time and will be provided in the FSAR.

Question CS430.42 (9.14.1)

Discuss the precautionary measures that will be taken to assure the quality and reliability of the fuel oil supply for emergency diesel generator operation. Include the type of fuel oil, impurity and quality limitation as well as diesel index number or its equivalent, cloud point, entrained moisture, sulfur, particulates and other deliterious insoluble substances; procedure for testing newly delivered fuel, periodic sampling and testing of on-site fuel oil (including interval between tests), interval of time between periodic removal of condensate from fuel tanks and periodic system inspection. In your discussion include reference to industry (or other) standard which will be followed to assure a reliable fuel oil supply to the emergency generators.

Response

The procedure for assurance of the quality and reliability of the fuel oil supply has not been finalized. The procedure will be completed in accordance with Reg. Guide 1.137, ANSI N195 and SRP 9.5.4. Chapter 9.14 of PSAR will be extended to include the procedural requirements relating to assurance of the fuel oil quality and reliability following the completion of the operating procedures.

Question CS430.43 (9.14.1)

Discuss what precautions have been taken in the design of the fuel oil system in locating the fuel oil day tank and connecting fuel oil piping in the diesel generator room with regard to possible exposure to ignition sources such as open flames and hot surfaces.

Response:

The diesel generator day tanks will be enclosed in rooms with 3-hour fire barriers separate from the diesel generators. Each day tank room will be served by a sprinkler system that is automatically actuated in the event of fire. A curb will be provided under the tanks to contain any oil spillage. Except where the fuel oil piping connects to the tanks and diesels, all fuel oil supply lines will be embedded in the floor surrounding the diesel generator. There are no ignition sources or hot surfaces, which can affect the fuel oil piping.

Question CS430.44 (9.14.1)

What is the purpose of the piping run identified as 3-HBDW-D6B on Figure 9.14.1? Also, what is the actual location of line 2-HBCW-D4 on Figure 9.14.1; i.e., inside or outside the diesel generator building?

Response

The pipe lines 6A and 6B are connected to the fuel oil transfer pump discharge line and they transfer fuel oil from the storage tank to an outdoor hose connection for the purpose of the storage tank cleaning. The pipe line D4 and the fuel oil transfer pumps will be located inside the Diesel Generator Building.

Question CS430.45 (9.14)

Diesel generator auxiliary systems should be designed to Seismic Category 2, ASME Section III, Class 3, or Quality Group C requirement in conformance with Regulatory Guides 1.26 and 1.29. Expand your PSAR to include a discussion of the engine mounted fuel oil piping and components, and provide the industry standards that were used in the design, manufacturing, and inspection of the piping and components. Also, show on the appropriate drawings where the Quality Group Classification changes from Quality Group C.

Provide similar discussions and drawings for the other diesel generator auxiliary systems, i.e., lubricating oil, cooling water, air starting, and combustion air intake and exhaust systems, to the extent practical.

Response:

The diesel engine and all casted diesel vendor supplied components, including the fuel oil filters, will be designed in accordance with ANSI N-195 and B31.1 requirements. All other piping and components will be designed to ASME Section III, Class 3, Quality Group C requirements per the requirements of Regulatory Guides 1.26 and 1.29. The specific interface boundaries between the various code and quality components will be identified in future P&ID revisions.

Question CS430.46 (9.14)

Identify all high and moderate energy lines and systems that will be installed in the diesel generator room. Discuss the measures that will be taken in the design of the diesel generator facility to protect the safety related systems, piping and components from the effects of high and moderate energy line failure to assure availability of the diesel generators when needed.

Response:

The only high energy line in the diesel generator room will be the diesel exhaust pipe, which is seismically qualified and provided with expansion joints to accommodate thermal growth to 950 F. The line will be provided with 8-inch thick, ceramic, fibrous blanket type insulation. The blankets will be 1-inch thick and have staggered joints. Stainless steel jacketing will be provided.

The moderate energy lines will be the emergency service water lines, which provide cooling water to the diesel engine, the starting air (250 psig) piping between the accumulators and the engine/generator skid and the diesel oil lines connected to the diesel engine. These moderate energy lines are also seismically qualified.

The diesel generator rooms will be provided with a drainage system to prevent accumulation of water in case of a pipe break. All high and moderate energy piping will be analyzed in accordance with BTP ASB 3-1 and MEB 3-1. If needed, spray shields will be provided to prevent direct water impingement on the diesel generator or on any electrical components.

NRC Question CS430.47 (9.14)

The diesel generator structures are designed to seismic and tornado criteria and are isolated from one another by a reinforced concrete wall barrier. Describe the barrier (including openings) in more detail and, its capability to withstand the effects of internally generated missiles resulting from a crankcase explosion, failure of supports for one or all of the starting air receivers, or failure of any high or moderate energy line and initial flooding from the cooling system so that the assumed effects will not result in loss of an additional generator.

Response:

The three emergency diesel generators will be located in separate diesel generator rooms of a seismic Category I building. This building is being designed as discussed below.

The assumed effects from the events described will not result in loss of an additional generator due to the design as described below. The Diesel Generator Building is designed to provide complete separation between the independent divisions. This is accomplished by providing completely separate bays for housing the redundant diesel generators, diesel auxiliaries, and cell cooling equipment. Each bay is separated by a concrete wall barrier with no openings. Separate outside access is provided to each bay.

The separation walls are sized to withstand the worst case internally generated missile within each bay without resulting in concrete spalling. These evaluations are performed using criteria such as the modified Petry, the modified NDRS formulas and the equivalent static load formula from the paper by R. A. Williamson and R. R. Alvy, November, 1973 (Reference 7, PSAR Section 3.5). See PSAR Section 3.5.4 for additional details on the calculation methods outlined above.

Failure of the structural supports for the starting air receivers is precluded by designing as Seismic Category I supports.

Equipment housed in each of the diesel generator bays are mounted on concrete pads to prevent failure of essential equipment in the event of the worst case internal flooding condition. Since no openings are provided between independent bays, propagation of internal flooding accidents to an adjacent bay is prevented.

Question CS430.48 (9.14)

Expand the PSAR to include a discussion of non-seismic systems or structures in the diesel generator building or near the fuel oil storage tanks and piping. Show that the failure of any non-seismic system or structures will not result in damage to any of the diesel generator auxiliary system with the attendant loss of its respective diesel generator.

Response:

The Diesel Generator Building will be located far away from the non-seismic category structures, such that failure of the non-seismic structures will not result in damage to any of the diesel generator auxiliary systems. The non-seismic category components located in the diesel rooms will be supported and/or restrainted in such way that their failure will not affect the safety related components.

Question CS430.49 (9.14.2)

Expand your PSAR to include a section on how the diesel generator cooling water system design conforms to the design criteria and bases detailed in SRP 9.5.5 (NUREG-0800). Provide justification for non-conformance, as applicable.

Response:

The updated PSAR Chapter 9.14.2 "Diesel Generator Cooling Water System" provides the description of the design basis demonstrating that the system design criteria are in accordance with SRP 9.5.5.

Question CS430.50 (9.14.2)

Describe the instrumentation, controls, and sensors and alarms provided for monitoring of the diesel engine cooling water system and describe their function. Discuss the testing necessary to maintain and assure a highly reliable instrumentation, controls, sensors, and alarm system, and where the alarms are annunciated. Identify the temperature, pressure, level, and flow (where applicable) sensors which alert the operator when these parameters exceed the ranges recommended by the engine manufacturer and describe what operator actions are required during alarm conditions to prevent harmful effects to the diesel engine. Discuss the systems interlocks provided, to the extent practical.

Response

The emergency diesel engine cooling (jacket) water sensors and alarms for all three diesel generators will be provided for control of the diesel engine jacket cooling water parameters during normal operation and standby mode. These sensors and alarms will consist of the following:

1. High jacket water temperature.

2. Low jacket water temperature.

3. Low jacket water pressure.

4. Low jacket water expansion tank level.

All of the above jacket water sensors will actuate an alarm locally on the diesel engine control panel. High jacket water temperature will actuate an individual alarm in the control room. All other sensors will actuate the diesel generator trouble alarm in the control room. The high jacket water temperature will effect a trip of the diesel engine in the test mode. However, if the diesel engine is operating in the emergency mode the trip function will be bypassed. Refer to Question/Response 430.26.

A thermostatically controlled jacket water immersion heater and an electric motor drive keepwarm pump will be provided for each engine to maintain the recommended jacket water standby temperature to allow immediate starting at the minimum ambient temperature.

Periodically, during shutdown, a simulated loss of offsite power test will be conducted. A portion of this test will be to verify the Diesel Generator jacket cooling water system trips are bypassed during the emergency mode of operation. In addition, the testing and maintenance of all the jacket cooling water instrumentation will be performed in accordance with the scheduled maintenance and calibration program for the Clinch River Plant.

Question CS430.51 (9.14.2)

Provide a more complete description of how the diesel generator cooling water system functions. Include a description of all components that make up, or interface with the cooling water system, and describe their function. Show how cooling water temperature is maintained at a predetermined level during operation in any condition from no load to maximum load. Include seismic and quality group classifications.

Response:

The updated PSAR Chapter 9.14.2 "Diesel Generator Cooling Water System" includes the available information for the diesel generators.

Question CS430.52 (9.14.2)

In PSAR sections 9.14.2.2 d and e, you discuss the diesel engine jacket water "keepwarm" system for use when the engine is not running. The information presented in these PSAR sections and on Figure 9.14-2 is not sufficient for a comprehensive review of the system design and function. Therefore, expand your PSAR to include a complete description of the cooling water system design and functions with respect to the "keepwarm" or standby mode of operation. Show that the entire cooling water system is maintained at 125°F. Include details of the circulating pump, electric heater, source of power, flow path, and controls scheme. Revise Figure 9.14-2, as required. In the event of a failure in this system, describe how the failure will be detected, and what actions must be taken by the operator(s) to insure that diesel engine standby temperatures are maintained. Provide seismic and quality group classifications for this system.

Response:

The updated PSAR Chapter 9.14.2 "Diesel Generator Cooling Water System" includes the available information for the jacket water keep warm system of the diesel generators.

Question CS430.53 (9.14.2)

A three-way, air operated temperature control valve is shown on Figure 9.14-8. Provide more detail on this valve and how it operates. Describe the control air system, including the air supply, how the pressure is regulated, consequences of a malfunction resulting in either too high or too low pressure, provisions for manual override, if any, alarms and indictiors, and any other pertinent data, to the extent practical.

Response:

The air operated temperature control valve shown on Figure 9.14-8 was based on another engine manufacturer. For CRBRP design, there shall be no control air system for controlling diesel auxiliary systems.

The updated PSAR Chapter 9.14.2 "Diesel Generator Cooling Water System" provides the design of the three-way control valve.

Question CS430.54 (9.14.2)

Indicate the measures to preclude long-term corrosion and organic fouling in the diesel engine cooling water system that would degrade system cooling performance, and the compatibility of any corrosion inhibitors or antifreeze compounds used with the materials of the system. Indicate if the water chemistry is in conformance with the engine manufacturer's recommendations, or the plan to verify conformance.

Response:

The updated PSAR chapter 9.14. 2 "Diesel Generator Cooling Water System" provides the available information for the diesel generators.

The jacket water will be sampled and analyzed periodically in accordance with the diesel engine maintenance schedule. Based on the result of the sampling analysis, a corrosion inhibitor will be added to the jacket water. The applied corrosion inhibitor will be selected on the basis of the diesel Manufacturers' recommendation. Provisions are existing in the design of the diesel engine jacket water systems to permit the addition of the chemical treatment material.

Question CS430.55 (9.14.2)

Describe the provisions made in the design of the diesel engine cooling water system to assure that all components and piping are filled with water.

Response:

The updated PSAR Chapter 9.14.2 "Diesel Generator Cooling Water System" includes the available information for the diesel generators. For all three diesel engines, the highest point of the system will be vented to atmosphere to assure that all system components and piping are filled with water.

Question CS430.56 (9.14.2)

In the PSAR, you state that the expansion tank has sufficient capacity to replace water evaporated in the jacket water system. The final design of the cooling water system will be reviewed with regard to the system capacity for makeup due to minor system leaks at pump shaft seals, valve stems, and other components, and to maintain required NPSH on the system circulating pump. Therefore, to the maximum extent possible, expand your PSAR to provide the size of the expansion tank size will be adequate to maintain required pump NPSH and makeup water for seven days continuous operation of the diesel engine at full rated load without makeup, or provide a seismic Category I, safety Class 3 makeup water supply to the expansion tank.

Response:

The updated PSAR Chapter 9.14.2 "Diesel Generator Cooling Water System" includes the available information for the diesel generators.

For Divisions 1 and 2 engines, the standpipe is sized to provide reserve capacity to offset the system water losses due to minor leakages through the pump shaft seals and valve steams, and evaporation through vents for seven days at rated load without make-up. The available reserve water capacity in the standpipe will be defined as water contained from the water level above the system circulating pump suction needed to maintain required NPSH of the circulating pump, to the operating water level of the standpipe. For Division 3 engine, the expansion tank is sized similarly to the standpipes for Division 1 and 2 engines. The expansion tank for the Division 3 diesel engine will be designed to ASME Section III, Class 3, Seismic Category I requirements (and the tank will be provided with a lo-level alarm). The actual leakage from the jacket water system will be determined during station performance testing.

If the leakage observed exceeds the required capacity of the standpipe or expansion tank for the 7 days of operation, a backup supply from the Category I emergency plant service water system will be added.

The normal makeup water is supplied from the Category III demineralized water supply. Water can also be added manually should the Category III demineralized water supply be unavailable. Adequate NPSH will be available to the jacket water pump at all times.

A sight glass and low level alarm are provided on the standpipe or expansion tank.

Question CS430.57 (9.14.2)

Provide a tabulation showing the individual and total heat removal rates for each major component and subsystem of the diesel generator cooling water system. Discuss the design margin (excess heat removal capability) included in the design of major components and subsystems.

Response:

The updated PSAR Chapter 9.14.2 "Diesel Generator Cooling Water System" includes the available information for the diesel generators.

Each engine cooling water system and system components shall be designed to provide adequate heat removal capability for the engine it serves at rated load and heat transfer capability to the Emergency Plant Service Water System. The detailed tabulation of the individual heat removal rates will be provided in a later revision of the PSAR.

Question CS430.58 (8.14.2)

Recent licensee event reports have shown that tube leaks are being experienced in the heat exchangers of diesel engine jacket cooling water systems. Provide a discussion on the provisions which will be made to detect tube leakage, and the corrective actions that will be taken. Include jacket water leakage into the lube oil system (standby mode), lube oil leakage into the jacket water (operating mode), jacket water leakage into the engine combustion air intake and governor oil systems (operating or standby modes). Provide the permissable inleakage or outleakage in each of the above conditions which can be tolerated without degrading engine performance or causing engine failure. The discussion should also include the effects of jacket water/service water systems leakage, to the extent practical.

Response:

The updated PSAR Chapter 9.14.2 "Diesel Generator Cooling Water System" includes the available information for the diesel generators.

Question CS430.59 (9.14.2)

The diesel generators are required to start automatically on loss of all offsite power and in the event of a DBA. The diesel generator sets should be capable of operation of less than full load for extended periods without degradation of performance or reliability. Should a DBA occur with availability of offsite power, discuss the design provisions and other parameters that have been considered in the selection of the diesel generators to enable them to run unloaded (on standby) for extended periods without degradation of engine performance or reliability. Expand your PSAR to include and explicitly define the capability of your design with regard to these requirements.

Response

The diesel generator sets for CRBRP will be designed to have the capability to operate at less than full load for extended periods without degradation of performance or reliability.

The manufacturer of the diesel generators for Class IE Divisions 1 and 2 (DeLaval Turbine Inc., Engine and Compressor Division in Oakland, California) has conducted no-load endurance tests on a diesel generator set essentially identical to those intended for use on CRBRP. The objective of this test was to establish that the diesel generator set could successfully pick up and carry the designated loads after operating at a no-load and synchronous speed for an extended period of time.

The engine was run in a no-load rated speed condition for 168 hours and performed without developing abnormal engine responses, noise or vibration. The engine successfully performed with a load of 4000KW after the no-load run.

The diesel generator set of Division 3 will also be tested to ensure its capability to operate at less than full load for extended periods.

Upon receipt of an emergency signal (as a result of a DBA), the diesel generator sets will automatically start and will run on no-load (on a standby mode) if the offsite power is still available. Administrative controls will be used to shutdown the units within a reasonable time after ensuring the stability of the offsite power. The operation of the units at no-load during this time will not result in any degradation of engine performance or reliability as demonstrated by the no-load test described above.

In order to eliminate the problems of carbon build up due to prolonged diesel generator operation under light load or no load conditions, requirements will be included in the periodic testing procedure to run the diesel generators on load. This periodic loading of the diesel generators will result in blow out of built in carbon deposits and prevent any possible degradation of the engine performance.

The testing of the diesel generators is described in Section 8.3.1.1.1 of the PSAR.

Periodic testing of the diesel generator units during the plant preoperational test program and at least once every 18 months (during refueling or prolonged plant shutdown) will be performed to demonstrate full load carrying capability for an interval of not less than 24 hours of which 22 hours will be at a load equivalent to the continuous rating of the diesel generator unit and 2 hours at a load equivalent to the 2 hour rating of the diesel generator units.

Provisions have been made in the system design to synchronize the diesel generator with the offsite power sources in order to achieve the rated loading as discussed above during this testing.

Question CS430.60 (9.14.2)

Provide the source of power for the diesel engine motor driven jacket water keepwarm pump and electric jacket water heater. Provide the motor and electric heater characteristics, i.e., motor hp., operating voltage, phase(s), frequency and kw output as applicable. Also include the pump capacity and discharge head, if available.

Response:

The updated PSAR Chapter 9.14.2 "Diesel Generator Cooling Water System" includes the available information for the diesel generators.

The motor and electric heater characteristics as well as pump capacity and discharge head shall be provided in the FSAR.

Question CS430.61 (9.14.3)

Expand your PSAR to include a section on how the emergency diesel engine air startng system will conform to the design criteria and bases detailed in SRP 9.5.6 (NUREG-0800). Provide justification for non-conformance, as applicable.

Response:

The updated PSAR Chapter 9.14.3 "Diesel Generator Starting System" provides the description of the design basis demonstrating that the system design criteria are in accordance with SRP 9.5.6.

Question CS430.62 (9.14.3)

Expand your PSAR to include a detailed description of the diesel engine mounting portion of the air start system. Include such things as the function of the air line to the fuel rack, activation of the air start solenoid and air relay valves, type and number of air start motors, and any other pertinent data, if available.

Response:

The updated PSAR Chapter 9.14.3 "Diesel Generator Starting System" includes the available information for the diesel generators.

Question CS430.63 (9.14.3)

Describe the operation of the emergency diesel engine air start system. Begin with an engine start signal and continue through engine running. Include all components in the system and the function of each. Show how a component failure will not result in total failure of an engine air start system. Also, state whether the air start system, once activated, will continue to operate until all compressed air is exhausted, or will it shut down after a specified period of time to allow successive starting attempts. Refer to Figure 9.14-3, as applicable.

Response:

The description of the operation of the emergency diesel engine air start system and the safety analysis of the system is provided in the updated PSAR Chapter 9.14.3.

Question CS430.64 (9.14.3)

Describe the air dryers in the air start system. State whether they are refrigerant or dessicant type, and the air quality levels they will maintain. Provide a discussion of how the compressd air quality will be monitored, and the provisions that will be made in your operation and maintenance programs to ensure consistently high quality compressed air to the receivers.

Response:

The design basis for air dryers for all three divisions is included in the revised PSAR Chapter 9.14.3. The description of the air dryers for the diesel engines is provided in the updated PSAR Chapter 9.14.3.

Question CS430.65 (9.14.3)

Describe the instrumentation, controls, sensors and alarms provided for monitoring the diesel engine air starting system and describe their function. Describe the testing necessary to maintain a highly reliable instrumentation, control, sensors and alarm system and where the alarms are annunciated. Identify the temperature, pressure and level sensors which alert the operator when these parameters exceed the ranges recommended by the engine manufacturer and describe any operator actions required during alarm conditions to prevent harmful effects to the diesel engine. Discuss system interlocks provided, to the extent practical.

Response

The emergency diesel engine air starting system sensors and alarms for all three diesel generators will be provided for control and monitoring of the starting air parameters during normal and standby operation. These sensors will consist of the following:

1. High/low air receiver pressure
2. High-high/low-low air receiver pressure
3. High air receiver moisture

Items 2. and 3. above will actuate local alarms on the diesel engine control panel and also will be an input to a diesel engine trouble alarm in the Control Room. Control switches for the air compressors and the air dryers will be located on the local control cabinet. When the air compressor control switch is in "Automatic", the high/low air receiver pressure switches will automatically start and stop the air compressors. Pressure gages will be provided with each air receiver.

The testing and maintenance of all starting air instrumentation will be performed in accordance with the scheduled maintenance and calibration program for the Clinch River Plant.

Question CS430.66 (9.14.4)

Expand your PSAR to include a section on how the emergency diesel engine lubricating oil system will conform to the design criteria and bases detailed in SRP 9.5.7 (NUREG-0800). Provide justification for non-compliance.

Response:

The updated PSAR Chapter 9.14.4 "Diesel Generator Lubrication System" provides the description of the design basis demonstrating that the system design criteria are in accordance with SRP 9.5.7.

Question CS430.67 (9.14.4)

Expand your description of the emergency diesel engine lubricating oil system. The PSAR text should include a detailed system description of what is shown on Figure 9.14-4. The PSAR text should also describe: 1) components and their function, 2) instrumentation, controls, sensors and alarms, and 3) a diesel generator starting sequence for a normal start and an emergency start. Also Figure 9.14-4 should show the diesel engine lubrication circuits, to the extent practical.

Response:

The updated PSAR Chapter 9.14.4 "Diesel Generator Lubrication System" includes the available information for the diesel generators.

Question CS430.68 (9.14.4)

An emergency diesel generator unit in a nuclear power plant is normally in the ready standby mode unless there is a loss of offsite power, an accident, or the diesel generator is under test. Long periods on standby have a tendency to drain or nearly empty the engine lube oil piping system. On an emergency start of the engine as much as 5 to 14 or more seconds may elapse from the start of cranking until full lube oil pressure is attained even though full engine speed is generally reached in about five seconds. With an essentially dry engine, the momentary lack of lubrication at the various moving parts may bearing surfaces producing incipient or actual component failure with resultant equipment unavailability.

The emergency condition of readiness requires this equipment to attain full rated speed and enable automatic sequencing of electric load within ten seconds. For this reason, and to improve upon the availability of this equipment on demand, it is necessary to establish as quickly as possible an oil film in the wearing parts of the diesel engine. Lubricating oil is normally delivered to the engine wearing parts by one or more engine driven pump(s). During the starting cycle, the pump(s) accelerate slowly with the engine and may not supply the required quantity of lubricating oil where needed fast enough. To remedy this condition, as a minimum, an electrically driven lubricating oil pump, powered from a reliable DC power supply, should be installed in the lube oil system to operate in parallel with the engine driven main lube pump. The electric driven prelube pump should operate only during the engine cranking cycle or until satisfactory lube oil pressure is established in the engine main lube distribution header. The installation of this prelube pump should be coordinated with the respective engine manufacturer. Some diesel engines include a lube oil circulating pump as an integral part of the lube oil preheating system which is in use while the diesel engine is in the standby mode. In this case an additional prelube oil pump may not be needed.

Confirm your compliance with the above requirement or provide your justification for not installing an electric prelube oil pump.

Response:

The Divisions 1 and 2 diesels use a four-stroke engine design and are designed with a continuous prelube system to enhance starting capability after diesel shutdown periods. The design incorporates a circulating oil pump and heater which operates to circulate warm oil through the engine when not in operation. The circulating oil pump operates whenever the engine is running below 280 rpm. The heater operates when the oil temperature drops below 120°F. The Divisions 1 and 2 diesel engines have Transamerica Delaval serial numbers 77034 and 77035 and are included in item 12 of the enclosed Transamerica Delaval notification. These engines were originally to be used by Tennessee Valley Authority at the Phipps Bend Nuclear Plant near Rogersville, Tennessee. The Divisions 1 and 2 diesel engines will be altered to correct the potential problems with lubrication of the turbocharger thrust bearings reported by Transamerica Delaval under the 10CFR21 provisions.

The Division 3 diesel engine is provided with a continuous lubrication system. In addition to the engine driven lube oil pump, two motor driven pumps are provided for standby lubrication; one pump for the turbocharger and one pump for the other engine components. The motor driven turbocharger pump also operates when the engine is running. During the pre-lube period, the oil level is maintained below the camshaft level to prevent oil entering into the exhaust manifold. The lube oil cooler is acting as a heater during the pre-lube period utilizing the heat from the jacket water keep warm system.

TENNESSEE VALLEY AUTHORITY
KNOXVILLE, TENNESSEE 37902
W7C126, 400 West Summit Hill Drive

August 4, 1982

Mr. P. Brewington
Deputy Manager for Projects
CRBRP Project
Post Office Box U
Oak Ridge, Tennessee 37830

Attention: Mr. D. Hicks

Gentlemen:

CLINCH RIVER BREEDER REACTOR PROJECT
DIESEL-DRIVEN GENERATOR UNITS
CONTRACT TV-38624A, SUPPLEMENT NO. 3
LETTER NO. CR-4

10 CFR 21 NOTIFICATION

Per telecon of July 26, 1982, between your Jim Krass and our Tom Hogan, attached is all information concerning a 10 CFR 21 notification to the NRC by Transamerica Delaval Incorporated on the lubrication of the thrust bearings of the turbochargers.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

C. A. Chandley, Chief
Mechanical Engineering Branch

Enclosures

P.O. Box 2161
Oakland, California 94621
(415) 577-7400

December 22, 1980

Tennessee Valley Authority
W10 D224-400 Commerce Avenue
Knoxville, TN 37902

Attention: C. A. Chandley
Chief, Mechanical Engineering Branch

Subject: 10 CFR 21 Notification
S/N 77024/35 (TVA, Stride)

Gentlemen:

Enclosed please find a copy of a 10 CFR 21 Notification dated December 16, 1980.

A solution to the problem tailored to your particular facility is under development and will be forwarded shortly.

Very truly yours,

TRANSAMERICA DELAVAL INC.
Engine and Compressor Division

John Wilder
Engineer, Customer Service

ncb

Enclosure

TO ADD ATTACHMENTS

MEB'81 01 05 521

CAC
HCJ
FGG
CE 1/6
LTG 1/6
REG

Make sure they provide us a schedule and follow through with fixing our units.

SENT JAN 17 '81

CAC:WEA:NMP---11-16-81
cc: MEDS, 100 UB-K, w/1

MEB MASTER FILE

MEDS, E4B37 C-K

NGM-16

Transamerica Delaval

Engine and Compressor Division
550 85th Avenue
P.O. Box 2161
Oakland, California 94621
(415) 577-7400

December 16, 1980

RECEIVED
DEC 18 1980
Quality Control Dept.

Director
Office of Inspection and Enforcement
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

In accordance with the requirements of Title 10, Chapter 1, Code of Federal Regulations, Part 21, Transamerica Delaval hereby notifies the Commission of a potential defect in a component of DSR and DSRV Standby Diesel Generators. There exists a potential problem with lubrication of the thrust bearings of the turbochargers which could result in engine non-availability.

Transamerica Delaval has supplied the DSR and DSRV series engines with the potential defect to the following sites:

1.	Long Island Lighting Co., Shorham Nuclear Power Station	SN 74010/12	DSR 8
2.	Middle South Energy, Grand Gulf Nuclear Station	SN 74033/36	DSRV 16
3.	Duke Power, Catawba Station	SN 75017/20	DSRV 16
4.	Southern California Edison, San Onofre	SN 75041/42	DSRV 20
5.	Cleveland Electric, Perry Nuclear Station	SN 75051/54	DSRV 16
6.	Tennessee Valley Authority, Bellefonte Station	SN 75080/83	DSRV 16
7.	Washington Public Power Supply System WPPSS #1	SN 75084/85	DSRV 16
8.	Texas Utilities Services Incorporation, Commanche Peak 1 and 2	SN 76001/4	DSRV 16
9.	Washington Public Power Supply System, WPPSS #4	SN 76031/32	DSRV 16

Transamerica Delaval

U.S. Nuclear Regulatory Commission
December 16, 1980
Page 2

10. Consumers Power, Midland 1 and 2 — SN 77001/04 DSRV 12

11. Tennessee Valley Authority, Hartsville Station — SN 77024/31 DSRV 16

12. Tennessee Valley Authority, Rogersville Station — SN 77032/35 DSRV 16

The units at Southern California Edison are the only units that have been placed in commercial operation.

These turbochargers are manufactured by Elliott Company of Jeannette, Pa. They are installed on the engines by Transamerica Delaval and lubricated in accordance with Elliott Co. recommendations.

The potential defect exists in the lubricating oil system that supplies oil to the turbocharger bearings. The design of this system permits lubricating oil to flow to the bearings only when the engine is running and prevents oil flow to the bearings when the engine is in the standby mode. The oil seal of the turbocharger is a labyrinth type seal and is only effective when the turbocharger is running. Because of the possibility of seal leakage when the turbocharger is at rest (engine standby mode) the turbocharger L.O. system is by-passed at this time.

Turbocharger thrust bearings may experience rapid wear because of the unique operations of nuclear standby engines. Prematurely worn thrust bearings can be found by inspection of the turbochargers. If the system defect is not corrected, engine availability could be affected. The problem will be eliminated by modifying the turbocharger lube oil system so that the turbocharger thrust bearing receives adequate oil during pre-lubing. The modification to the system must also insure the turbo is not over-lubed.

Transamerica Delaval has designed the system modification correcting the problem. We will supply drawings and all the information necessary to modify the turbocharger lube oil system. Parts and technical services required will be furnished by Transamerica Delaval on request and in accordance with each individual contract. A copy of this letter is being sent to each cognizant party listed in Para. 2. Detailed instructions for performing the inspection of the turbocharger thrust bearings and for performing the modification will be sent by December 31, 1980.

cc: MEDS, 100 UR-K

MKM-16

We estimate that the inspection and piping modification will be completed by January 20, 1981 at the Southern California Edison San Onofre site.

This report confirms an initial telephone report on December 16, 1980 to Mr. Robert Dodds, Region 5, Chief, Engineering Section.

Our evaluation of this matter was concluded on December 15, 1980.

Sincerely,

Clinton S. Mathews
Assistant General Manager

CSM:pt

cc: Mr. Robert Dodds, NRC, 1990 N. California Blvd., Walnut Creek, CA 94596

bcc: DPT Group
Alan Barich
V. Dilworth

Note to all bcc's: Dick Boyer will coordinate customer/A.E. notification with Dilworth and Durie.

CSM:pt

Question CS430.69 (9.14.4)

Several fires have occurred at some operating plants in the area of the diesel engine exhaust manifold and inside the turbocharger housing which have resulted in equipment unavailability. The fires were started from lube oil leaking and accumulating on the engine exhaust manifold and accumulating and igniting inside the turbocharger housing. Accumulation of lube oil in these areas, on some engines, is apparently caused from an excessively long prelube period, generally longer than five minutes, prior to manual starting of a diesel generator. This condition does not occur on an emergency start since the prelube is minimal.

When manually starting the diesel generators for any reason, to minimize the potential fire hazard and to improve equipment availability, the prelube period should be limited to a maximum of three to five minutes unless otherwise recommended by the diesel engine manufacturer. Confirm your compliance with this requirement or provide your justification for requiring a longer prelube time interval prior to manual starting of the diesel generators. Provide the prelube time interval your diesel engine will be exposed to prior to manual start.

Response:

The Division 1 and 2 Diesel engine turbochargers are not continuously prelubricated at any magnitude with the exception of the turbocharger thrust bearings. Therefore, no accumulation of oil will occur thus precluding any fire hazard.

For the Division 3 diesel engine, see response to Question 430.68.

Question CS430.70 (9.14.4)

A three-way, air operated, temperature control valve in the lube oil discharge circuit is shown on Figure 9.14-4. Provide more detail on this valve and how it operates. Describe the control air system and how it is used to regulate lube oil temperature. Indicate the source of the control air, and show how the pressure is regulated, the consequences of a malfunction resulting in either too high or too low pressure, any provision for manual override, all alarms and indications, and any other pertinent data, to the extent practical.

Response

The air operated temperature control valve shown on Figure 9.14-4 was based on another engine manufacturer. For CRBRP design, there will be no control air system for controlling the diesel auxiliary system.

Question CS430.71 (9.14.4)

Describe the instrumentation, controls, sensors and alarms provided for monitoring the emergency diesel engine lubricating oil system, and describe their function. Describe the testing necessary to maintain a highly reliable instrumentation, control, sensors and alarm system and where the alarms are annunciated. Identify the temperature, pressure and level sensors which alert the operator when these parameters exceed the ranges recommended by the engine manufacturer and describe any operator actions required during alarm conditions to prevent harmful effects to the diesel engine. Discuss system interlocks provided. Coordinate the text material with the instrumentation and controls shown on Figure 9.14-4, to the extent practical.

Response:

The emergency diesel engine lubricating oil pressure and temperature sensors and alarms for all three diesel generators will be provided for control and monitoring of the diesel engine lubricating oil parameters during normal operation and standby mode. The sensors and alarms will consist of the following:

1. High lubricating oil temperature
2. Low lubricating oil temperature
3. Low lubricating oil header pressure
4. High lubricating oil filter discharge pressure
5. Low lubicating oil reservoir level
6. High crankcase oil pressure
7. High generator bearing oil temperature

All of the above lubricating oil sensors will actuate an individual alarm both locally at the diesel engine control panel and in the Control Room, except low lube oil temperature and high oil filter discharge which will actuate the diesel generator trouble alarm in the Control Room. The low lubricating oil header pressure and high generator bearing oil temperature will effect a trip of the diesel engine in the test mode. However, if the diesel engine is operating in the emergency mode the trip function will be bypassed. Refer to Question/Response 430.26.

The oil will be heated by either an AC motor driven lubricating oil pump or an immersion heater in the lube oil sump tank to insure rapid starting.

At least once every 18 months, during shutdown, a simulated loss of offsite power test will be conducted. A portion of this test will be to verify the diesel generator lubricating system trips are bypassed during the emergency mode of operation. In addition, testing and maintenance of all the lubricating instruments will be performed in accordance with the scheduled maintenance and calibration program for the Clinch River Plant.

Question CS430.72 (9.14.4)

A lube oil storage tank in the diesel generator room is shown on Figures 1.2-77 and 9.14-4. Explain the purpose of this tank, and state whether the stored lube oil will be used to replenish the emergency diesel engine sump during normal operation and prolonged emergency (seven days) operation. If this is the case, then the storage tank and interconnecting piping must meet Seismic Category 1 and ASME Section III Class 3 requirements. Revise your PSAR accordingly.

Response:

The purpose of the lube oil storage tank is for convenience only. The emergency diesel engine sump will contain a sufficient amount of oil to maintain the engine during normal operation and prolonged emergency (seven days) operation without the need for additional oil. The tank will be designed to ASME Section VIII and seismically supported. The tank piping to the engine will be provided with two isolation valves designed to the ASME Section III Class 3 requirements so that the failure of this tank will not cause any damage to any safety related systems.

Question CS430.73 (9.14.4)

What measures have been taken to prevent entry of deliterious materials into the engine lubrication oil system due to operator error during recharging of lubricating oil or normal operation? What provisions have been made to prevent corrosion of the storage tank interior surfaces with resulting contamination of the stored lube oil?

Response:

The updated PSAR Chapter 9.14.4 "Diesel Generator Lubrication System" includes the available information for the diesel generators.

Question CS430.74 (9.14.4)

For the diesel engine lubrication system in Section 9.5.7 provide the following information: 1) define the temperature differential flow rate, and heat removal rate of the interface cooling system external to the engine and verify that these are in accordance with recommendations of the engine manufacturer; 2) discuss the measures that will be taken to maintain the required quality of the oil, including the inspection and replacement when oil quality is degraded; 3) describe the protective features (such as blowout panels) provided to prevent unacceptable crankcase explosion and to mitigate the consequences of such an event; and 4) describe the capability for detection and control of system leakage, to the extent practical.

Response:

The updated PSAR Chapter 9.14.4 "Diesel Generator Lubrication System" includes the available information for the diesel generators.

The specific information requested above will be provided in a later revision of the PSAR.

<u>Question CS430.75 (9.14.5)</u>

Provide a description of the emergency diesel engine combustion air intake and exhaust system complete with test material and P&IDs. This description should conform to RG 1.70 and SRP 9.5.8 (NUREG-0800). Revise your PSAR accordingly.

<u>Response</u>:

The updated PSAR Chapter 9.14.5 "Diesel Generator Combustion Air Intake and Exhaust System" provides the description of the design basis demonstrating that the system design criteria are in accordance with SRP 9.5.8.

Question CS430.76 (9.14.5)

Describe the instrumentation, controls, sensors and alarms provided in the design of the diesel engine combustion air intake and exhaust system which alert the operator when parameters exceed ranges recommended by the engine manufacturer and describe any operator action required during alarm conditions to prevent harmful effects to the diesel engine. Discuss systems interlocks provided, to the extent practical.

Response

The description of the instrumentation, sensors, and alarms provided in the design of the diesel engine combustion air intake and exhaust system is provided in the updated PSAR Chapter 9.14.5. There are no controls or interlocks associated with the combustion air system.

Question CS430.77 (9.14.5)

Provide the results of an analysis that demonstrates that the function of your diesel engine air intake and exhaust system design will not be degraded to an extent which prevents developing full engine rated power or cause engine shutdown as a consequence of any meteorological or accident condition. Include in your discussion the potential and effect of fire extinguishing (gaseous) medium, recirculation of diesel combustion products, or other gases that may intentionally or accidentally be released on site, on the performance of the diesel generator, to the extent practical.

Response

The design for the diesel engine combustion air intake and exhaust system is included in the revised PSAR Chapter 9.14.5. The description demonstrates that the function of the system will not be degraded as a consequence of any meteorological or accident condition.

Question CS430.78 (9.14.5)

Discuss the provisions made in your design of the diesel engine combustion air intake and exhaust system to prevent possible clogging, during standby and in operation, from abnormal climatic conditions (heavy rain, freezing rain, dust storms, ice and snow) that could prevent operation of the diesel generator on demand.

Response

The design basis for the diesel engine combustion air intake and exhaust system is included in the revised PSAR Chapter 9.14.5. The provisions made in the design to prevent possible clogging from abnormal climatic conditions are also included.

Question CS430.79 (9.14.5)

Show that a potential fire in the diesel generator building together with a single failure of the fire protection system will not degrade the quality of the diesel combustion air so that the remaining diesel will be able to provide full rated power.

Response:

The design basis for the diesel engine combustion air intake and exhausst system is included in the revised PSAR Chapter 9.14.5. The description demonstrates that a potential fire in the diesel generator building will not degrade the quality of the diesel combustion air.

Question CS430.80 (9.14.5)

Experience at some operating plants has shown that diesel engines have failed to start due to accumulation of dust and other deliterious material on electrical equipment associated with starting of the diesel generators (e.g., auxiliary relay contacts, control switches - etc.). Describe the provisions that have been made in your diesel generator building design, electrical starting system, and combustion air and ventilation air intake design(s) to preclude is condition to assure availability of the diesel generator on demand.

Also describe under normal plant operation what procedure(s) will be used to minimize accumulation of dust in the diesel generator room; specifically address concrete dust control to the extent practical.

Response

The design basis for the diesel engine combustion air intake and exhaust system is included in the revised PSAR Chapter 9.14.5. The description indicates the provisions that have been made in the design to prevent the accumulation of dust and other deliterious material, including concrete dust.

Question CS430.81 (10.2)

Expand your discussion of the turbine speed control and overspeed protection system. Provide additional explanation of the generator electrical load following capability for the turbine speed control system with the aid of system schematics (including turbine control and extraction steam valves to the heaters). Tabulate the individual speed control protection devices (normal, emergency and backup), the design speed (or range of speed) at which each device begins operation to perform its protective function (in terms of percent of normal turbine operating speed). In order to evaluate the adequacy of the control and overspeed protection system, provide schematics and include identifying numbers to valves and mechanisms (mechanical and electrical) on the schematics. Describe in detail, with reference to the identifying numbers, the sequence of events in a turbine trip including response times, and show that the turbine stabilizes. Provide the results of a failure mode and effects analysis for the overspeed protection system. Show that a single steam valve failure cannot disable the turbine overspeed trip from functioning. (SRP 10.2, Part III, Items 1, 2, 3 and 4.)

Response:

The discussion of the turbine speed control and overspeed protection systems in the PSAR has been expanded (see update to PSAR Section 10.2.2.6). Specifically, the turbine load following capability is discussed in Section 10.2.2.6 and 10.2.2.8, while the response of the extraction system to a transient is discussed in Section 10.2.2.7. The turbine speed control and emergency trip systems are explained in Section 10.2.2.6. Attached for information only purposes is a flow diagram of the Emergency Trip System. The system arrangement to prevent a turbine overspeed due to the failure of a single main steam valve is discussed in Sections 10.2.2.6. A description of the possible failures in the turbine generator system and the effects on the turbine control system is also included in Section 10.2.2.6.

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Question CS430.82 (10.2)

The turbine speed control and overspeed protection system does not incorporate stop and intercept valves between the high pressure and low pressure elements of the main turbine. Provide a discussion why such valves are not required, and show that the turbine stabilizes following a trip without the aid of stop and intercept valves. Revise your PSAR accordingly.

Response

See revised PSAR Section 10.2.2.7 for the requested information.

Question CS430.83 (10.2)

In the turbine generator section discuss: 1) the valve closure times and the arrangement for the main steam stop and control valves in relation to the effect of a failure of a single valve on the overspeed control functions; 2) the valve closure times and extractioin steam valve arrangements in relation to stable turbine operation after a turbine generator system trip; 3) effects of missiles from a possible turbine generator failure on safety-related systems or components. (SRP 10.2, Part III, items 3 and 4.)

Response

1. See PSAR Sections 10.2.2.1 and 10.2.2.6 for the requested information.

2. See PSAR Section 10.2.2.7 for the requested information.

3. The turbine generator is located in a non-safety-related building which does not contain safety-related systems or components. PSAR Section 10.2.3 presents the results of an evaluation of the potential for turbine missiles to impact safety-related equipment in adjacent buildings.

Question QCS430.84 (10.2)

Expand your PSAR to include a discussion of the steam extraction valves design and operation. Provide the closure times for the extraction steam valves installed in the extraction steam lines to the feedwater heaters. Show that stable turbine operation will result after a turbine trip. (SRP 10.2, Part III, item 4)

Response

See revised PSAR Section 10.2.2.7 for the requested information.

Question CS430.85

Provide a discussion of the inservice inspection program for throttle stop and control steam valves and the capability for testing essential components during turbine generator system operation.

Response:

The turbine stop and control valves are not safety-related items: therefore, the requirements of the ASME Boiler and Pressure Code, Section XI, Division I - Inservice Inspection are not applicable.

However, the turbine stop and control valves will be subject to a surveillance testing program. These requirements, though not fully developed at this time, are expected to include periodic cycling of each stop and control valve and applicable requirements of the Standard Review Plan 10.2.

These activities will be in addition to the planned maintenance for this equipment. The details of the complete surveillance program will be discussed in the FSAR.

Question QCS430.86 (10.2)

Discuss the effects of a high and moderate energy piping failure or failure of the connection from the low pressure turbine to condenser on nearby safety related equipment or systems. Discuss what protection will be provided the turbine overspeed control system equipment, electrical wiring and hydraulic lines from the effects of a high or moderate energy pipe failure so that the turbine overspeed protection system will not be damaged to preclude its safety function. (SRP 10.2, Part III, Item 8)

Response:

As stated in PSAR Sections 10.3.3 and 10.3.1, failure of the main steam (or any high or moderate energy piping) line cannot jeopardize any safety related equipment since there is no safety related equipment in the turbine generator building. The possibility of a turbine missile being generated as a result of overspeed is discussed in 10.2.3.

Even though the turbine is a non-safety related system, it does incorporate redundant overspeed protection systems as described in Section 10.2.2.6. A high or moderate energy pipe break would have to do the following to disable the overspeed trip protection system. The electrical and mechanical trip valves would have to be disabled in such a way as to prevent them from operating to their denergized states and dumping high pressure hydraulic fluid from the stop and control valves. At the same time, the pressure integrity of the hydraulic fluid system would have to be maintained following the steam line break so that high pressure hydraulic fluid can continue to be applied to the stop and control valves keeping them open. It is extremely unlikely that any high or moderate energy pipe break would lead to this situation thereby causing the overspeed protection system to fail. Failure of the connection from the low pressure turbine to the condenser will result in loss of condenser vacuum, thereby initiating a turbine trip.

Question QCS430.87

In the PSAR, you do not discuss the in-service inspection, testing and exercising of the extraction steam valves. Provide a detailed description of:

1. The extraction steam valves.

2. Your in-service inspection and testing program for these valves. Also provide the time interval between periodic valve exercising to assure the extraction steam valves will close on turbine trip.

Response:

See revised PSAR Section 10.2.2.7 for the requested information.

The Extraction Steam System is classified as a Non-Safety Related item and as such the requirements of the ASME Boiler and Pressure Vessel Code, Section XI, Division 1 - Inservice Inspection are not applicable.

However, the Extraction Steam Check valves will be subject to a surveillance testing program which has not yet been fully developed. This testing will include periodic mechanical operation of the extraction check valve (including solenoids, operating cylinders, etc.).

Question QCS430.88 (10.2)

Provide P&IDs for the generator hydrogen control and bulk storage system. Identify all components in the system, and revise the PSAR text to include a description of the components and their function in the systems. Show the bulk hydrogen storage system in relation to other buildings on the site.

Response:

The design of the Turbine Generator Hydrogen Control and Storage System is still under development at this time; however, design basis and criteria are as follows:

1. The storage system is located outdoors, southeast of the maintenance bay (see PSAR Fig. 2.1-5a) away from safety related equipment.

2. The control system maintains essentially pure hydrogen (97% - 98%) in the generator casing.

3. Hydrogen is only distributed to the non-safety related TGB and distribution piping in the TGB is guard-piped.

4. The generator housing is designed with a minimum number of gas tight joints to minimize leakage of hydrogen. In addition, the generator housing is designed to withstand the effects of the pressure generated by an internal explosion of a mixture of hydrogen and air.

5. The hydrogen control panel contains a gas tight partition separating electrical equipment from hydrogen tubing and explosion proof instruments are used throughout.

6. The bulk storage unit consists of 2 sets of hydrogen bottles, one in reserve and one on line. The reserve bottles automatically come on line at a predetermined low pressure. In addition, there is a header isolation valve which shuts at a predetermined maximum flow in the event of a hydrogen pipe break.

7. A carbon-dioxide system is provided to purge the generator when changing from hydrogen to air or air to hydrogen to preclude a hydrogen/air mixture from occuring.

Attached are P&IDs BM562 AND GE13303568 for information only.

Question CS430.89

(10.3) As explained in Issue No. 1 of NUREG-0133, credit it taken for all valves downstream of the Main Steam Isolation Valve (MSIV) to limit blowdown of a second steam generator in the event of a steam line break upstream of the MSIV. In order to confirm satisfactory performance following such a steam line break provide a tabulation and descriptive text (as appropriate) in the PSAR of all flow paths that branch off the main steam lines between the MSIVs and the turbine stop valves. For each flow path originating at the main steam lines, provide the following information:

a) System identification
b) Maximum steam flow in pounds per hour
c) Type of shut-off valve(s)
d) Size of valve(s)
e) Quality of the valve(s)
f) Design code of the valve(s)
g) Closure time of the valve(s)
h) Actuation mechanism of the valve(s) (i.e., Solenoid operated motor operated, air operated diagram valve, etc.)
i) Motive or power source for the valve actuating mechanism

In the event of the postulated accident, termination of steam flow from all systems identified above, except those that can be used for mitigation of the accident, is required to bring the reactor to a safe cold shutdown. For these systems describe what design features have been incorporated to assure closure of the steam shut-off valve(s). Describe what operator actions (if any) are required.

If the systems that can be used for mitigation of the accident are not available or decision is made to use other means to shut down the reactor describe how these systems are secured to assure positive steam shut-off. Describe what operator actions (if any) are required.

If any of the requested information is presently included in the PSAR text, provide only the references where the information may be found.

Response:

Section 15.3.3 of the PSAR, as revised, addresses steam or feed line pipe break event. Section 5.5 of the PSAR describes the design of the steam generator system. An updated steam generator system valve data list is provided in the revised Section 5.5.3.4 and Table 5.5-8a.

Question QCS430.90 (10.4.1)

Provide a tabulation in your PSAR showing the physical characteristics and performance requirements of the main condensers. In your tabulation include such items, as: 1) the number of condenser tubes, material and total heat transfer surface, 2) overall dimensions of the condenser, 3) number of passees 4) hot well capacity, 5) special design features, 6) minimum heat transfer, 7) normal and maximum steam flows, 8) normal and maximum cooling water temperature, 9) normal and maximum exhaust steam temperature with no turbine by-pass flow and with maximum turbine by-pass flow, 10) limiting oxygen content in the condensate in cc per liter, and 11) other pertinent data. (SRP 10.4.1, Part III, item 1).

Response

1) See revised PSAR Table 10.4-1
2) See revised PSAR Table 10.4-1
3) See revised PSAR Table 10.4-1
4) See revised PSAR Table 10.4-1
5) None
6) No minimum heat transfer.
7) See PSAR Figure 10.1-2 and 10.1-3
8) See revised PSAR Table 10.4-1
9) See revised PSAR Table 10.4-1
10) See revised PSAR Table 10.4-1
11) None

Question CS430.91 (10.4.1)

Discuss the effect of main condenser degradation (leakage, vacuum loss) on reactor operation. (SRP 10.4.1, Part II, Item 1.)

Response

Main condenser degradation falls essentially into two categories.

1. Circulating water inleakage will contaminate the condensate. See revised PSAR Section 10.4.6.1 for design basis for the Condensate Cleanup System. Should the circulating water inleakage be excessive, sufficient monitoring/sampling is provided to assess the effects on continued operation and technical specification limits will be established in the FSAR to address operation above design limits.

2. Loss of condenser vacuum is discussed in revised PSAR Section 10.4.2.

Question QCS430.92 (10.4.1)

Discuss the measures taken; 1) to prevent loss of vacuum, and 2) to prevent corrosion/erosion of condenser tubes and components (SRP 10.4.1, Part III, Item 1).

Response

See revised PSAR Section 10.1 for the requested information.

Question CS430.93 (10.4.1)

Indicate and describe the means of detecting and controlling radioactive leakage into and out of the condenser and the means for processing excessive amounts. (SRP 10.4.1, Part III, item 2.)

Response

See revised PSAR paragraph 11.3.6.2 for tritium production and disposal.

Question CS430.94 (10.4.1)

Discuss the measures taken for detecting, controlling and correcting condenser cooling water leakage into the condensate stream. (SRP 10.4.1, Part III, item 2.)

Response

PSAR Section 5.5.3.11.4 presents monitoring and alarms for the condensate stream. A condenser leak within the design parameters will be controlled by the condensate cleanup system (see revised PSAR Section 10.4.6.1). See revised PSAR Section 10.4.1.2 for provisions to correct a condenser cooling water inleakage problem.

Question CS430.95

Provide the permissible cooling water inleakage and time of operation with inleakage to assure that condensate/feedwater quality can be maintained within safe limits.

Response

See revised PSAR Section 10.4.6.1 for the requested information.

Question OCS430.96

In section 10.4.1.4 you have discussed tests and initial field inspection but not the frequency and extent of inservice inspection of the main condenser. Provide this information in the PSAR.

Response

The Main Condenser is classified as a non-safety related item and as such it does not fall under the requirements of the ASME Boiler and Pressure Vessel Code, Section XI, Division 1 - Inservice Inspection.

However, the Main Condenser will be subject to a surveillance program. These requirements are not fully developed at this time.

This activity will be in addition to the planned maintenance for this equipment. The details of the complete surveillance program will be discussed in the FSAR.

Question QCS 430.97 (10.4.1)

Indicate what design provisions have been made to preclude failures of condenser tubes or components from turbine by-pass blowdown or other high temperature drains into the condenser shell. (SRP 10.4.1, Part III, Item 3)

Response

See revised PSAR Section 10.1 for the requested information.

Question QCS430.98 (10.4.1)

Discuss the effect of loss of main condenser vacuum on the operation of the main steam isolation valves (SRP 10.4.1, Part III, item 3).

Response

Loss of condenser vacuum has no direct effect on the main steam isolation valves (superheater outlet isolation valves).

Question CS430.99 (10.4.4)

Provide additional description (with the aid of drawings) of the turbine bypass system (condenser dump valves and atmosphere dump valves) and associated instruments and controls. In your discussion include:

1. The size, principle of operation, construction and set points of the valves.

2. The malfunctions and/or modes of failure considered in the design of the system.

3. The maximum electric load step change the reactor is designed to accommodate without reactor control rod motion or steam bypassing. (SRP 10.4.4, Part III, items 1 and 2).

Response

See revised PSAR Figure 10.3-1 for the drawing of the turbine bypass system. See PSAR Figure 5.1-4 for drawings showing the location of pressure relief devices.

See revised PSAR Section 10.3.2 for details of the pegging steam control valve, condenser dump valves and desuperheaters.

The safety/power relief valves are discussed in revised Section 5.5.2.4 of the PSAR.

The maximum electric load step change the reactor is designed to accommodate without reactor control rod motion or steam bypassing is plus or minus two percent reactor power. See PSAR Section 7.7.1.2 and 7.7.1.8 for additional information.

Question QCS430.100 (10.4.4)

Provide a P&ID for the turbine by-pass system showing system components and all instrumentation. (SRP 10.4.4, part III, item 1)

Response

See Figure 10.3-1 of the PSAR for a basic flow diagram of the turbine bypass system. P&ID BM502 and Instrument Loop Diagram BE4107 have been transmitted for your information by separate transmittal.

Question QCS430.101 (10.4.4)

Provide the maximum electric load step change that the condenser dump system and atmospheric dump system will permit without reactor trip.

Response:

CRBR is designed to take a ten percent step reduction in electric load without a reactor trip or action by the condenser dump system. Greater reductions in load will cause action by the condenser dump and/or atmospheric dump systems and a possible reactor trip initiated by the Steam to Feedwater Flow Mismatch subsystems. The exact load step which will result in a trip will depend on instrument uncertainties with a trip always occurring at values over thirty percent.

Additional information regarding these systems is located in PSAR Sections 10.3, 5.7.2, and 7.4.2.

Question OCS430.102

In Section 10.4.4.4 you have discussed tests and initial field inspection but not the frequency and extent of inservice testing and inspection of the turbine bypass system. Provide this information in the FSAR.

Response:

The Turbine Bypass System is not a safety related system and as such the requirements of ASME Boiler and Pressure Code, Section XI, Division 1-Inservice Inspection are not applicable.

However, the Turbine Bypass System will be subject to a surveillance test program. These requirements, are not developed at this time; however, they will include periodic cycling of the bypass valves and periodic testing of the control system using simulated inputs.

These activities will be in addition to the planned maintenance for this equipment. The details of the complete surveillance program will be discussed in the FSAR.

Question OCS430.103 (10.4.4)

Provide the results of an analysis indicating that failure of the turbine by-pass system high energy line will not have an adverse effect or preclude operation of the turbine speed control system or any safety related components or systems located close to the turbine bypass system. (SRP 10.4.4, Part III, item 4)

Response:

The bypass steam line is basically an extension of the main steam header; therefore, the response to Question 430.86 regarding a high or moderate energy pipe break of a main steam line is also applicable.

Question CS430.104

Provide the results of a failure mode and effects analysis to determine the effect of malfunction of the turbine bypass system on the operation of the reactor and main turbine generator unit (SRP 10.4.4, Part III).

Response

A failure mode and effects analysis addressing the effect of this malfunction is not available at this time and will be provided as input to the FSAR. These events are discussed in revised PSAR Section 10.4.4 and revised PSAR Section 15.3.2.4.

ATTACHMENT

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Upon loss of all 161kV power sources, the diesel generators start automatically and are capable of accepting the required safety loads. Any of these diesel generators or any of the 161kV power sources are capable of providing sufficient power to safely shutdown the plant during the anticipated operational occurrences and to power the necessary engineered safety features in the event of postulated accidents.

The three diesel generators are independent including the distribution systems which they supply as described in Section 8.3.1.1. Automatic starting and loading of each diesel generator to perform the safety function of the distribution systems they supply can be tested by simulating loss of AC power supply to each 4.16kV ESF distribution bus that is supplied by a diesel generator. Each diesel will start automatically and, if required, after 10 seconds the diesel generator on the disrupted distribution system will be automatically loaded with engineered safety features equipment in a timed sequence. The battery systems are redundant and independent including the distribution systems which they supply as described in Section 8.3.2.

In addition to the features detailed in Sections 8.2.1.1, 8.2.1.2 and 8.2.1.3, compliance with Criterion 15 is further demonstrated by the following:

a. The plant is provided with two separate and independent switchyards - the generating switchyard and the reserve switchyard. The generating switchyard is connected to the power grid by two 161kV transmission lines. The reserve switchyard is connected to the grid by two separate and physically independent 161kV transmission lines. Each of the four transmission lines and each of the two switchyards are designed to be capable of providing power to the Non-Class 1E and Class 1E auxiliary loads required for plant startup, normal operation and to facilitate and maintain a safe plant shutdown.

   The generating switchyard provides power to the plant auxiliary loads through the main power transformer and the two (2) unit station service transformers. Each unit station service transformer is sized to supply 50 percent of the plant auxiliary loads required during the plant startup and the maximum power plant generation. (When the main generator is operating the plant auxiliary loads receive power from the main generator via the generator circuit breaker and the unit station service transformers). One of two unit station service transformers also supplies 100 percent power to Class 1E loads of Divisions 1 and 3 and the other unit station service transformer provides 100 percent power to Class 1E loads of Division 2.

   The plant reserve switchyard provides power to the plant auxiliary loads through two (2) reserve station service transformers. Each reserve station service transformer is sized to supply 50 percent of the plant auxiliary loads required during the plant startup and the maximum power plant generation. One of the two reserve station service transformers also supplies 100 percent power to Class 1E loads of Division 1 and 3 and the other reserve station service transformer provides 100 percent power to Class 1E loads of Division 2.

b. The 161 kV transmission lines are protected from lightning by overhead shield lines.

c. The switchyards are provided with two independent DC supplies. Each supply system consists of a separate 125V DC battery, two battery chargers and a distribution system. A single failure caused by a malfunction of either of the two 125V DC systems will not affect the performance of the other system. The ability of the switchyard to supply offsite power to the plant will not be affected by the loss of one of the two 125V DC systems. The surveillance of battery charger operation and battery voltage for each system is provided by individual alarms monitored in the control room.

ATTACHMENT 1
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Criterion 16 - Inspection and Testing of Electric Power Systems

Electric power systems important to safety shall be designed to permit appropriate periodic inspection and testing of important areas and features, such as wiring, insulation, connections, and switchboards, to assess the continuity of the systems and the condition of their components. The systems shall be designed with a capability to test periodically (1) the operabiltiy and functional performance of the components of the systems, such as onsite power sources, relays, switches, and buses, and (2) the operability of the systems as a whole and, under conditions as close to design as practical, the full operational sequence that brings the systems into operation, including operation of applicable portions of the protection system, and the transfer of power among the nuclear power unit, the offsite power system, and the onsite power system.

Response

The following transfers are testable during operation of the nuclear plant.

1. Automatic transfer from the normal power source (nuclear power unit) to the reserve power source (preferred offsite power system) initiated by fault sensing relays in the normal power supply. Testing is accomplished by inserting simulated signals in relay inputs which initiates the transfer.

2. Manual transfer from normal to reserve power source and vice versa.

3. Automatic transfer of Class 1E Bus from normal or reserve power source to the diesel generator (onsite power supply) on degraded voltage at the Class 1E Bus.

   3.1 Prolonged degraded voltage between 70% and 85% of nominal voltages is simulated at input to undervoltage relays.

   3.2 Instantaneous degraded voltage below 70% of nominal voltage is simulated by tripping of the normal incoming breaker.

   Operation of the sequencer logic is also tested by simulating inputs and monitoring the sequencer outputs to actuators (such as breakers) without actuating them. The load sequencer has intrinsic automatic testing of its circuitry which works continuously when the sequencer is not actuated by protective or testing input signals.

4. Manual transfer of Class 1E Bus from normal or reserve power source to the diesel generator.

   4.1 Testing of the diesel with the Class 1E Bus disconnected from the offsite source is performed by starting the diesel, deenergizing the Class 1E Bus by tripping the incoming breaker, closing the diesel generator breaker and closing the load breakers.

4.2 Testing of the diesel with the Class 1E Bus energized by the offsite source is performed by starting the diesel, synchronizing it with the Class 1E Bus and loading it in steps consistent with actual loading requirements.

The AC and DC systems will be designed to be testable during operation of the plant in accordance with IEEE Standard 338-1977 and Regulatory Guide 1.118.

Periodic inspections and testing of important features, such as wiring, insulation, and connections, to assess the continuity of systems and the condition of their components will be performed during equipment shutdown.

Initial operational system tests will be performed with components installed and connected to demonstrate that the system operates within design limits and meets the performance specification, and to verify the independence between redundant AC power sources and load groups.

After being placed in service, the standby diesel generators and their respective associated supply systems will be inspected and tested periodically to detect any degradation of the system. (See Section 8.3.1.1.1)

Initial pre-operational tests will be performed with equipment and components installed and connected to demonstrate that the equipment is within design limits and the system meets performance specifications. This test will also demonstrate that loss of the Plant Power Supply and offsite AC power supplies can be detected.

Periodic equipment tests will be performed to detect any degradation of the system and to demonstrate the capability of equipment which is normally de-energized. The test methods utilized are detailed in Section 8.3.1.1.2.

Periodic tests of the transfer of power between the Plant Power Supply and offsite AC power supplies will be performed to demonstrate that:

a. Sensors can properly detect loss of the Plant Power Supply and the offsite AC power supplies.

b. Components required to accomplish the transfer from the Plant Power Supply to the Preferred AC Power Supply are operable.

c. Components required to accomplish the transfer from the Normal AC Power Supply to the Reserve AC Power Supply are operable.

d. Components required to accomplish the transfer from the Reserve AC Power Supply to the Standby AC Power Supply are operable.

e. Components required to accomplish the transfer from the Plant Power Supply (simulating the unavailability of the offsite AC power supplies) to the Standby AC Power Supply are operable.

f. Instruments and protective relays are properly set and operating correctly.

The 161kV circuit breakers connecting the generating and reserve switchyard to the power grid will be inspected and tested on a routine basis with the generators in service, since either of the two breakers, each fully rated, is capable of connecting the generator to the two buses of the generating switchyard.

Criterion 17 - Control Room

A control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions (including those conditions addressed in NRC Criterion 4 - Protection Against Sodium Reactions). Adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem whole body, or its equivalent to any part of the body, for the duration of the accident.

Equipment at appropriate locations outside the control room shall be provided with a design capability for prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, and with a design capability for subsequent control of the reactor at any coolant temperature lower than the hot shutdown conditions.

Response

The control room design is based on proven power plant design philosophy. All control situations, switches, controllers, and indicators necessary to operate and shutdown the plant and to maintain safe control of the reactor will be located in the control room.

The design of the control room will permit safe occupancy during abnormal conditions. The doses to personnel during accident conditions from containment building shine, radioactive clouds and ingress/egress to the exclusion boundary are less than 5 rem whole body, or its equivalent to any part of the body. These doses and criteria are detailed in Section 6.3.

Criterion 26 - HEAT TRANSPORT SYSTEM DESIGN

The heat transport system shall be designed to reliably remove heat from the reactor and transport the heat to the turbine-generator or ultimate heat sinks under all plant conditions including normal operation, anticipated operational occurrences and postulated accidents. Consideration shall be given to provision of independence and diversity to provide adequate protection against common mode failures. The system safety functions shall be to:

(1) Provide sufficient cooling to prevent exceeding specified acceptable fuel design limits during normal operation and following anticipated operational occurrences, and

(2) Provide sufficient cooling to prevent exceeding specified acceptable fuel damage limits and to maintain integrity of the reactor coolant boundary following postulated accidents.

Following the loss of a flow path, the heat transport system shall include at least two independent flow paths, each capable of performing the safety functions following shutdown. (1)

The system shall include suitable interconnections, leak detections, isolation and containment capability to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the safety function can be accomplished, assuming a single failure.

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(1) This requirement is not intended to preclude two-loop operation provided the system safety functions can be appropriately met.

Response:

The primary heat transport system (PHTS) is being designed to accommodate the thermal transients resulting from the normal, upset, emergency (anticipated operational occurrences), and faulted conditions (postulated accidents) described in Appendix B.

The system will be designed such that a normal or upset event does not adversely affect the useful life of any HTS components.

Following an emergency condition, resumption of operation will be possible following repair and re-inspection of the components, except that the primary coolant pumps (damaged or undamaged) will maintain capability to provide pony motor flow following all emergency conditions except in the affected loop for pump mechanical failure.

Following a faulted condition (postulated accident), the heat transport system will remain sufficiently intact to be capable of performing its decay heat removal function, including maintenance of primary coolant pump pony motor flow.

The Heat Transport and Connected Systems include those systems and boundaries which provide the necessary functions to safely remove and transport reactor heat to the steam generators under all plant operating conditions. At rated power, the overall cooling requirement of the Heat Transport System is 975 MWt equally divided among three parallel, essentially identical cooling circuits. The general configuration of the Heat Transport and Steam Generation Systems is illustrated in Figure 5.1-1. The major Heat Transport and Steam Generator System components have been sized on the basis of the Heat Transport System Thermal Hydraulic Design Conditions given in Table 5.1-1.

In the event of loss of one flow path during three loop operation, the remaining two loops are capable of safely removing the shutdown heat either with pony motor flow or natural circulation. In the event of loss of one loop during two loop operation, the remaining loop is capable of removing the shutdown heat either with pony motor flow or natural circulation. Further an additional flow path is provided through the Direct Heat Removal Service (DHRS), which is designed to have full capability for decay heat removal following shutdown even from a three-loop full power operation. Details on the DHRS design are provided in Section 5.6.2 of this PSAR.

The overall heat transport system encompasses the PHTS, the Intermediate Heat Transport System (IHTS), the Steam Generator System (SGS), and the Residual Heat Removal systems which comprises the Steam Generator Auxiliary Heat Removal System (SGAHRS) and the DHRS. The IHTS design is described in Section 5.4, the SGS in Section 5.5, and the SGAHRS in Section 5.6.1. Consideration of design bases relating to safety functions is discussed in Response to Criterion 31 for the IHTS and in Response to Criterion 35 for the Residual Heat Removal Systems.

The three parallel loops of the PHTS will be housed in three isolated, inerted cells. To timely detect even small leaks, reliable redundant, diversified leak detection systems will be provided. Details of these systems are provided in Section 5.1 of Reference 2 listed in Section 1.6.2 of this PSAR.

The PHTS is physically confined in inerted cells in the lower portion inside the CRBRP Reactor Containment Building. Functionally, it is isolated by the IHTS from the SGS which is located outside the Containment. Therefore, the PHTS is contained in total inside the Reactor Containment.

Power operators shall be sized to operate successfully under the maximum differential pressure determined in the design specification.

The main steam isolation valves (superheater outlet isolation valves) are capable of being closed to stop the venting of steam into the steam generator or turbine buildings in case of a steam line pipe break downstream of the isolation valves. The maximum steam flow rate is expected from a steam line break immediately downstream of the isolation valve. The disc and stem will be designed to withstand the forces produced when closing the valve under choke flow conditions.

Figure 5.5-2A shows a main steam isolation valve. It is a conventional gate valve to provide a minimum resistance flow path when the valve is wide open. A closed system hydraulic-pneumatic operator, shown in Figure 5.5-2B, is provided for opening and closing the valve during normal operation or during valve exercising. Upon loss of electrical power, the pneumatic and hydraulic solenoids are opened by springs, which causes pneumatic pressure to shuttle the valve operating cylinder. The oil below the valve operating cylinder returns to the reservoir through the pilot check valves, which are piloted open by pressure acting through the hydraulic solenoid valves. The gate valve is accelerated during the initial period of the blowdown and is decelerated at the end of the closing stroke by a hydraulic damper which enables soft seating of the gate while providing fast closing of the valve. A pressure compensated flow regulator ensures uniform closing times over variations in load. Position switches are provided to indicate gate position remotely. The valve is repositioned by energizing the motor and solenoids.

A superheater bypass valve is installed in parallel with the main superheater outlet isolation valve and check valve for use during plant startup for preheating the BOP steam lines and following plant shutdown to maintain the BOP pressurized. This is an active valve, designed to fail closed.

Each valve used in the SGS will be evaluated as to its performance relative to plant safety and mode of operation in the event of failure (fail open, fail closed, etc.). As part of these evaluations, the need for a pneumatic accumulator adjacent to a valve and solenoid requirements for emergency operation will be determined.

Tests and Inspections

Line valves will be shop tested by the manufacturer for performance according to the design specifications for leakage past seating surfaces and for integrity of the pressure retaining parts. Selected line valves will be manually operated during loop shutdown periods to assure operability.

5.5.2.3.2 Recirculation Pumps

The recirculation pump will be a single stage, centrifugal type, driven by a constant speed, 4.0 KV, 1000 HP motor. It will take suction from the steam drum, and provide 2.22×10^6 pounds of water per hour to the evaporators.

The pump and its support will be designed and fabricated per ASME Section III, Class 3 as shown in Table 5.5-6.

Functionally, the drum receives a saturated water/steam mixture from the evaporators and subcooled feedwater and produces saturated steam of low moisture content for the superheater and subcooled water of low steam content for the recirculation pump. The water/steam mixture from the evaporators enters the drum through the water/steam nozzles and flows into an annular volume along the sides of the inner drum wall created by a girth baffle volume along the sides of the inner drum wall created by a girth baffle extending along the side of the drum for the length of the cylinder. Centrifugal steam separators mounted along the length of the drum draw from this annular volume, separate the mixture into phases, and direct the steam upward and the water downward into the inner volume of the drum. The main feedwater enters the drum through a single nozzle which feeds two distribution pipes through a "Y" connection inside the drum. The feedwater is distributed along the length of the drum by rows of orifice holes in the two pipes which are located along each side of the drum beneath the steam separators. The auxiliary feedwater enters through a separate nozzle and is distributed along the length of the drum by two rows of spray nozzles in a single distribution pipe located above the water level in the drum. Feedwater mixes with the water from the separators and is drawn downward and out through the water outlet nozzles by the recirculation pump. The steam passes upward through chevron type dryers in the upper portion of the drum and out through the steam outlet nozzles to the superheater. The dryers remove all but the last fractional percent of the moisture from the steam and drain this moisture back to mix with the resident drum water. Drum drain piping, located along either side of the drum in the region where the water from the separators enters the drum inner volume, draws water of high impurity concentration from the drum.

5.5.2.4 Overpressure Protection

Location of Pressure Relief Devices

Safety/power relief valves are located in the steam generation system to:

1. Prevent a sustained pressure rise of more than 10 percent above system design pressure at the design temperature within the pressure boundary of the system protected by the valve under any pressure transients anticipated; and

2. Provide steam generator module blowdown capability.

Installation of the valves will comply with the requirements as specified in Section 3.9.2.5. Safety/power relief valves are installed on the outlet lines from each evaporator to provide venting capability and a portion of the required safety/relief capability. Safety valves are installed on the steam drum to provide the remainder of the safety capability for the recirculation loop. Additional safety/power relief valves are installed on the steam exit line from the superheater because the steam lines to and from the superheater have isolation valves. The P&ID for the Steam Generation System, Figure 5.1-4 shows the locations of these safety/power relief valves. The power operation feature of the relief valves is fail closed to assure continued integrity of the system. In addition, an acoustic sensor is located on the outlet of each valve to inform the operator that the valves are not opening or not closing. Additional details of sizes and pressure rating are given in Table 5.5-8.

Safety/power relief valves are installed on the outlet line of the evaporator units, on the steam drum and on the outlet line from the superheater. These valves all meet the requirements of Section III of the ASME Boiler and Pressure Vessel Code for protection against overpressure. Table 5.5-8 indicated design pressures and valve settings for the steam generator safety/relief valves. Additional valve data is provided in Table 5.5-8A.

5.5.3.5 Steam Generator Module Characteristics

Each evaporator module will produce 1.11×10^6 lb/hr of 50% quality steam from subcooled water. Each superheater module will produce 1.11×10^6 lb/hr of superheated steam from saturated steam. The thermal hydraulic normal design operating conditions are given in Table 5.5-9.

The steam generator modules will supply the turbine with steam at design conditions over a 40% to 100% thermal power operating range for both clean and fouled conditions. The steam generator modules are also capable of removing reactor decay heat with the natural convection in both the intermediate sodium loop and the recirculaton water loop.

This hockey stick unit is of the same basic design as that of the Atomics International-Modular Steam Generator (AI-MSG) unit which was tested in a test program carried out at the Sodium Component Test Installation. The AI-MSG employed a 158-tube module with an overall length of 66 feet, as compared to the 757-tube CRBRP Steam Generator which has an overall length of 65 feet. The AI-MSG heat exchanger was operated for a total of 4,000 hours including operation both as an evaporator (slightly superheated steam out) and as a once through evaporator-superheater (from sub-cooled liquid to completely superheated steam).

The AI-MSG served as a proof test of the AI prototype hockey-stick steam generator design. The unit was operated for 4,000 hours under steaming conditions; all of these 4,000 hours, the unit was at the same temperature level at which the prototype will operate, with a steam pressure equal to or greater than prototype conditions. Table 5.5-9A compares various design operating conditions for the CRBRP Units to the AI-MSG, and lists the number of hours which the AI-MSG operated under respective conditions. The AI-MSG operated at steam pressures equal to or greater than the CRBRP Units for essentially the whole 4,000 hrs., and at CRBRP superheater inlet temperature for 750 hrs.

Since the AI-MSG unit was operated in the once-through mod, simultaneous simulation of both inlet and outlet CRBRP conditions for the separate CRBRP evaporator and superheater units was not achieved, but operation over the CRBRP temperature and pressure range was achieved on both the sodium and steam conditions for significant portions of the test.

TABLE 5.5-8A

VALVE DATA SUMMARY

(a) VALVE IDENTIFICATION STEAM GENERATOR SYSTEM	(b) MAX FLOW lb/hr	(c) TYPE	(d) SIZE INCHES	(e, f) ASME SECTION III DIVISION	(g) CLOSURE TIME SEC	(h) ACTUATOR MECHANISM	(i) POWER SOURCE
Superheater Outlet (53SGV012)	$1.11x10^6$	Gate	16	Class 3	3 max.	Electro-Hydraulic	1E Electric *
Superheater Bypass (53SGV016)	$3.41x10^4$	Flow Control	4	Class 3	3 max.	Electro-Hydraulic	1E Electric *
Superheater Inlet (53SGV011)	$1.11x10^6$	Gate	12	Class 3	3 max.	Electro-Hydraulic	1E Electric *
Evaporator Inlet (53SGV008)	$1.11x10^6$	Gate	10	Class 3	3 max.	Electro-Hydraulic	1E Electric
Steam Generator Bldg. Feedwater Inlet Isolation (53SGV001)	$1.22x10^6$	Gate	10	Class 3	3	Electro-Hydraulic	1E Electric *
Main Feed Water Inlet (53SGV002)	$1.22x10^6$	Flow Control	10	Class 3	5	Air Diaphram	Instrument Air
Start-up Feedwater Inlet (53SGV003)	$2.44x10^5$	Flow Control	4	Class 3	5	Air Diaphram	Instrument Air
Steam Drum Drain Valves (53SGV014,15)	$1.1x10^5$	Gate	6	Class 3	3	Electro-Hydraulic	1E Electric *

*Active Function (Safe Position) is 1E Electric

Figure 5.5-2A Main Steamline Isolation Valve (Superheater Isolation Valve Outlet)

See Figure 5.5-2B for valve operator schematic

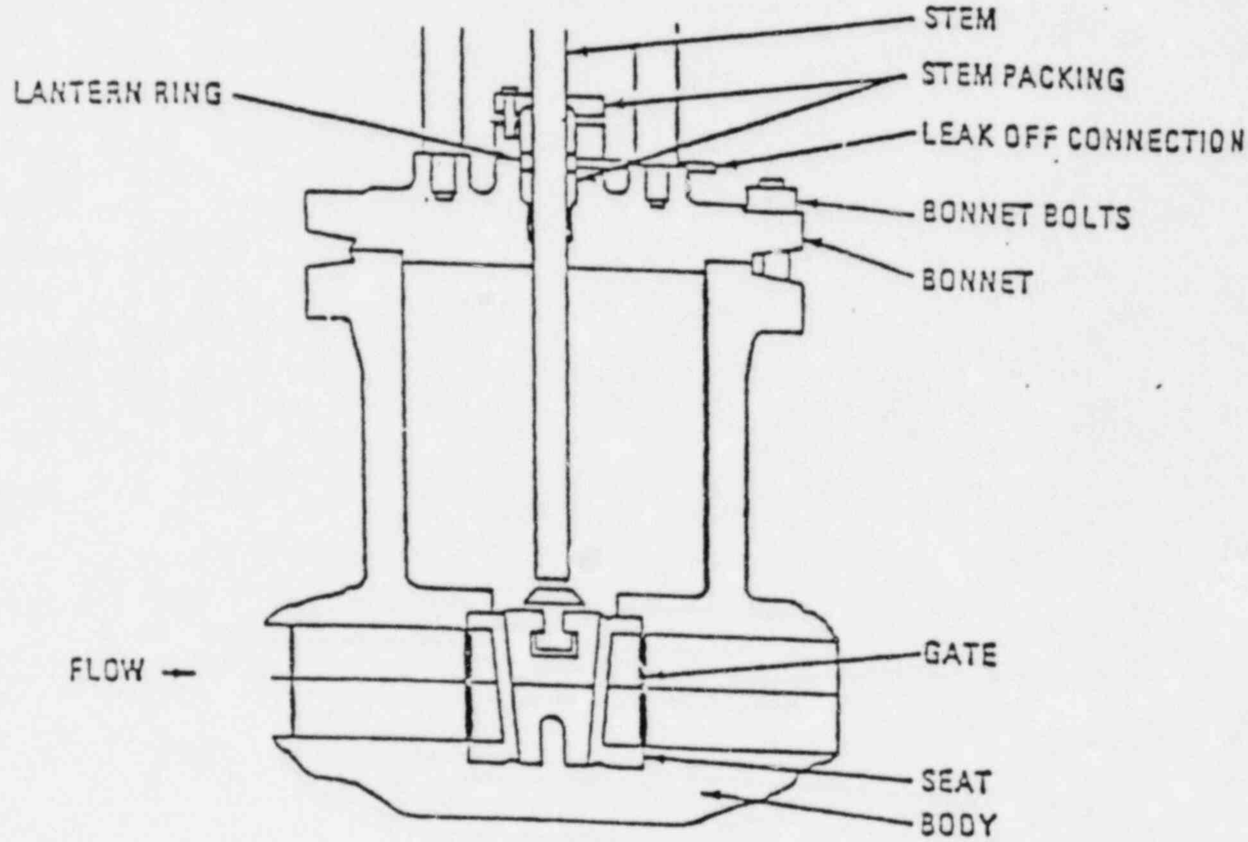
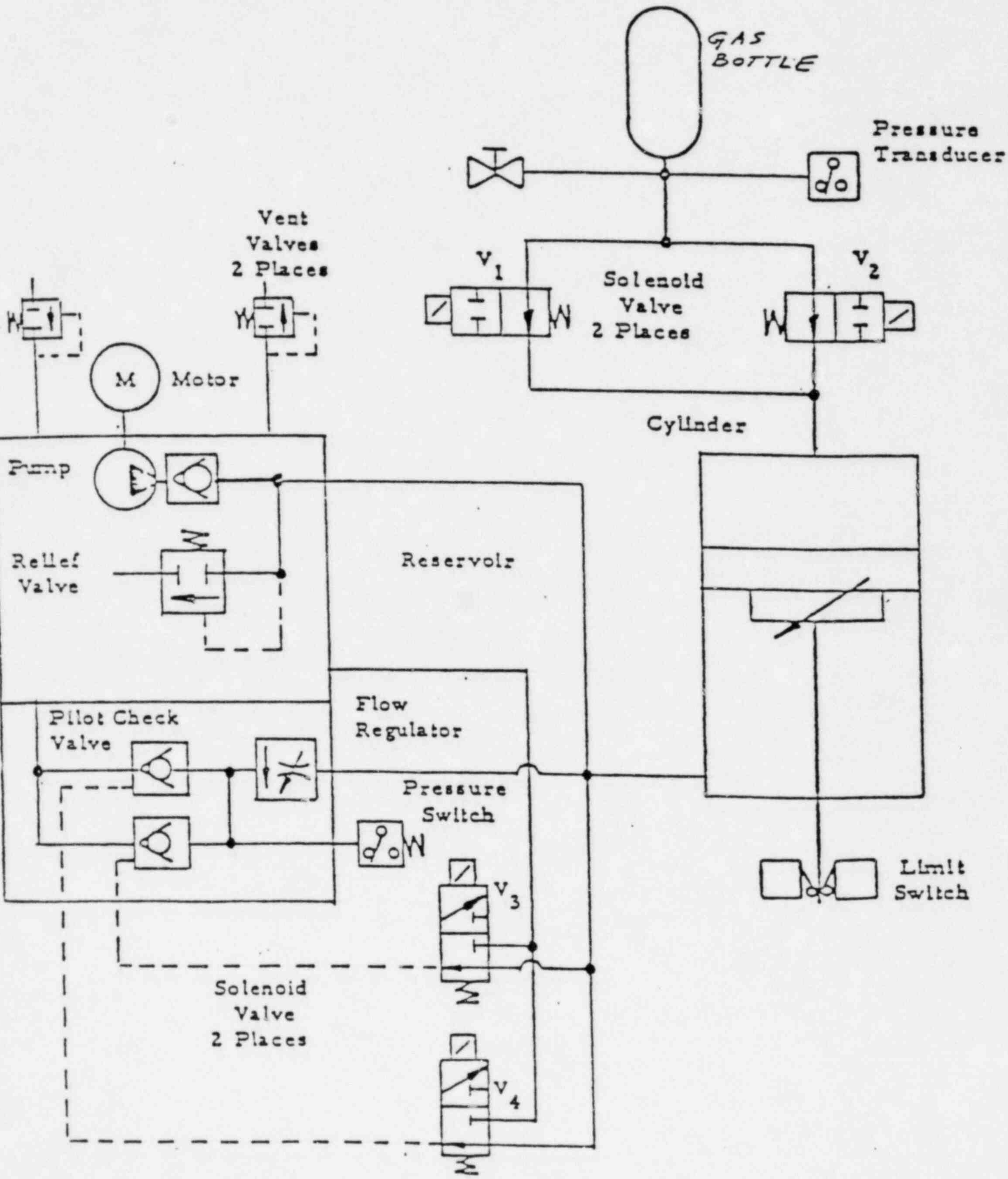


Figure 5.5-2B Operator Hydraulic-Schematic (Shown in Blowdown Model)



affecting the three steam supply systems and is provided if needed on a per loop basis. By definition, this zone of protection will include the high pressure steam supply system downstream from the individual loop check valves.

7.4.2.1.2 Equipment Design

A high steam flow-to-feedwater flow ratio is indicative of a main steam supply leak down stream from the flow meter or insufficient feedwater flow. The superheater steam outlet valves shall be closed with the appropriate signal supplied by the heat transport instrumentation system (Section 7.5). This action will assure the isolation of any steam system leak common to all three loops and also provide protection against a major steam condenser leak during a steam bypass heat removal operation.

7.4.2.1.3 Initiating Circuits

The OSIS is initiated by the SGAHRS initiation signal described in Section 7.4.1.1.3. This initiation signal closes the superheater outlet isolation valves in all 3 loops when a High Steam-to-Feedwater Flow Ratio or a Low Steam Drum Water level occurs in any loop. In each Steam Generator System loop, the trip signals for High Steam-to-Feedwater Flow Ratio and the Low Steam Drum Water level are input to a two of three logic network. If two of three trip signals occur in any of the 3 loops, SGAHRS is initiated, and all 3 loops are isolated from the main superheated steam system by closure of the superheater outlet isolation valves.

7.4.2.1.4 Bypasses and Interlocks

Control interlocks and operator overrides associated with the operation of the superheater outlet isolation valves have not been completely defined.

Bypass of OSIS may be required to allow use of the main steam bypass and condenser for reactor heat removal. In case the OSIS is initiated by a leak in the feedwater supply system, the operator may decide to override the closure of certain superheater outlet isolation valves.

7.4.2.1.5 Redundancy and Diversity

Redundancy is provided within the initiating circuits of OSIS. The primary trip function takes place when a high steam-to-feedwater flow ratio is sensed by two of three redundant subsystems on any one level sensed by two of three redundant channels in any one loop provides a backup trip function. Additional redundance is provided by three independnt SGS steam supply loops serving one common turbine header. Any major break in the high pressure steam system external from the individual loop check valves will be sensed as a steam feedwater flow ratio trip signal in all three loops.

7.4.2.1.6 Actuated Device

The superheater outlet isolation and superheater bypass valves utilize a high reliability electro-hydraulic actuator. These valves are designed to fail closed upon loss of electrical supply to the control solenoid.

7.4.2.1.7 Separation

The OSIS Instrumentation and Control System, as part of the Decay Heat Removal System is designed to maintain required isolation and separation between redundant channels (see Section 7.1.2).

7.4.2.1.8 Operator Information

Indication of the superheater outlet isolation valve position is supplied to the control room. Indicator lamps are used for open-close position indication to the plant operator.

7.4.2.2 Design Analysis

To provide a high degree of assurance that the OSIS will operate when necessary, and in time to provide adequate isolation, the power for the system is taken from energy sources of high reliability which are readily available. As a safety related system, the instrumentation and controls critical to OSIS operation are subject to the safety criteria identified in Section 7.1.2.

Redundant monitoring and control equipment will be provided to ensure that a single failure will not impair the capability of the OSIS instrumentation and Control System to perform its intended safety function. The system will be designed for fail safe operation and control equipment, where practical, will assure a failed position consistent with its intended safety function.

7.4.3 Remote Shutdown System

A Remote Shutdown System is provided. It consists of the following provisions:

4) The Standby (on-site) AC Power Supply* consists of three physically separate and electrically independent diesel generators. Two of these diesel generators which supply power to safety-related (Class 1E) Division 1 and 2 loads are redundant to each other. Either one of these three standby diesel generators can provide sufficient power to facilitate and maintain a safe plant shutdown. However, from the consideration of connected loads, Class 1E Divisions 1 and 2 provide power to redundant load groups and as such are referred to as redundant divisions. Class 1E Division 3 provides Class 1E power to Loop 3 of the Heat Transport System (HTS) and to certain plant Non-Class 1E loads. (The Non-Class 1E loads are connected through an isolation subsystem). Since not all the loads powered from Division 3 are identical or similar to those powered by Divisions 1 or 2, this division is not identified as redundant to Division 1 or 2. However, as far as the HTS is concerned, the Divisions 1, 2 and 3 power supplies are fully redundant serving the Loops 1, 2 and 3 Class 1E loads, respectively.

5) The DC Power Supply*, for Division 1, 2 or 3, consists of one independent 125 volt DC battery with its associated active and spare battery chargers and an inverter for 120/208 volt AC uninterruptible power supply (UPS). Each battery is capable of supplying power to DC loads and UPS loads of its associated safety division. Class 1E UPS is also referred to as vital AC power supply.

6) The 120/208 volt vital AC Power Supply*, for each Division 1, 2 or 3, consists of one independent inverter supplied by an independent DC system. Each inverter will supply power to vital AC loads of its associated safety Division. Division 1 and 2 vital AC loads are redundant to each other.

7) The Non-Class 1E DC Power Supply consists of two systems (Divisions A and B) each having one 125 volt DC battery dedicated for plant instrumentation and control. Two separate 125 volt DC batteries are dedicated for switchyard control and instrumentation and two 48 volt DC batteries are provided for the plant communication systems. Division A also has one 250 volt battery to provide power for DC motor loads. Each battery system is equipped with its own active and spare battery chargers, switchgear and distribution panels. 125 volt DC and 250 volt DC battery systems have inverters for 120/208 volt uninterruptible power supply (UPS). Non-Class 1E UPS is also referred to as Non-Class 1E essential power supply.

8) Two Non-Class 1E 125 volt DC Power Supplies (one for Division A and the other for Division B) will be provided complete with associated active and spare battery chargers for security systems, and the associated inverters for 480 volt AC UPS for security and lighting loads.

*This equipment is Class 1E as defined by IEEE Standard 308.

Distribution Systems

The Plant electrical power distribution system can be fed by the Plant, the CRBRP Preferred and the Reserve Power supplies and provides power to all Non-Class 1E and Class 1E loads. The Plant distribution system has been divided into two systems; the normal distribution (Non-Class 1E) system and the safety-related distribution (Class 1E) system. The safety-related distribution system can be fed by the Plant.

The CRBRP Preferred AC Power Supply consists of two 161KV transmission lines in the generating switchyard connected to the main power transformer. In the event of a turbine trip when no electrical fault is present, the generator circuit breaker will open automatically and disconnect the Plant Power Supply. The Plant AC power distribution system will than be provided with power by the CRBRP Preferred AC Power Supply through the main power transformer without interruption.

In the event of non-availability of both the Plant and the CRBRP Preferred AC Power Supplies, the Plant AC distribution system will be transferred to the Reserve AC Power Supply. This transfer is performed within a period of 6 cycles by a fast dead bus transfer scheme as described in Section 8.3.1.1. Both reserve station service transformers are kept energized at all times during plant operation and are available to the Plant AC distribution system within a few cycles. This assures that the specified acceptable design limits are maintained.

Regulatory Guide 1.93, Rev. 0 (12/74)

The available off-site AC power sources consist of the CRBRP Preferred AC Power Supply and the Reserve AC Power Supply. Each of these two supplies provides two connections to the TVA 161KV grid. The two 161KV grid connections to the reserve station service transformers constitute the required independent off-site power sources. In addition, two 161KV grid connections to the generating switchyard provide an added reliability to off-site power, available through the main power and the unit station service transformers.

On-site AC power sources and on-site DC power sources comply with the requirements of CRBRP GDC15 for the availability of electric power sources.

Should an LCO condition be present on these power sources, the plant's continued operation will be restricted in accordance with the Regulatory Guide 1.93 recommendations.

IEEE Standard 308-1974

The Reserve AC Power Supply provides the two independent circuits of the IEEE Std. 308-1974 "preferred power supply." It connects the TVA 161KV grid to each of the two 4.16KV Class 1E switchgear buses through the reserve station service transformers. Hence, the safety-related AC distribution system has two physically separate and electrically independent sources available from the TVA grid.

The CRBRP Preferred and the Reserve AC Power Supplies, each has sufficient capacity to operate the loads applied during a design basis accident. Both the CRBRP Preferred and the Reserve AC Power Supplies are available during normal operation (see Section 16.3.9).

The availability of off-site power supplies to Class 1E buses is monitored on the Electrical Control Panel in the control room. In the event the incoming off-site power source has an undervoltage condition or any one of the protective relays is not reset, the condition will be alarmed on the Electrical Control Panel to alert the operator.

In addition, an amber light on the Electrical Control Panel in the control room will indicate that the off-site power supply line and its breaker are available for transfer of power from the other source if required.

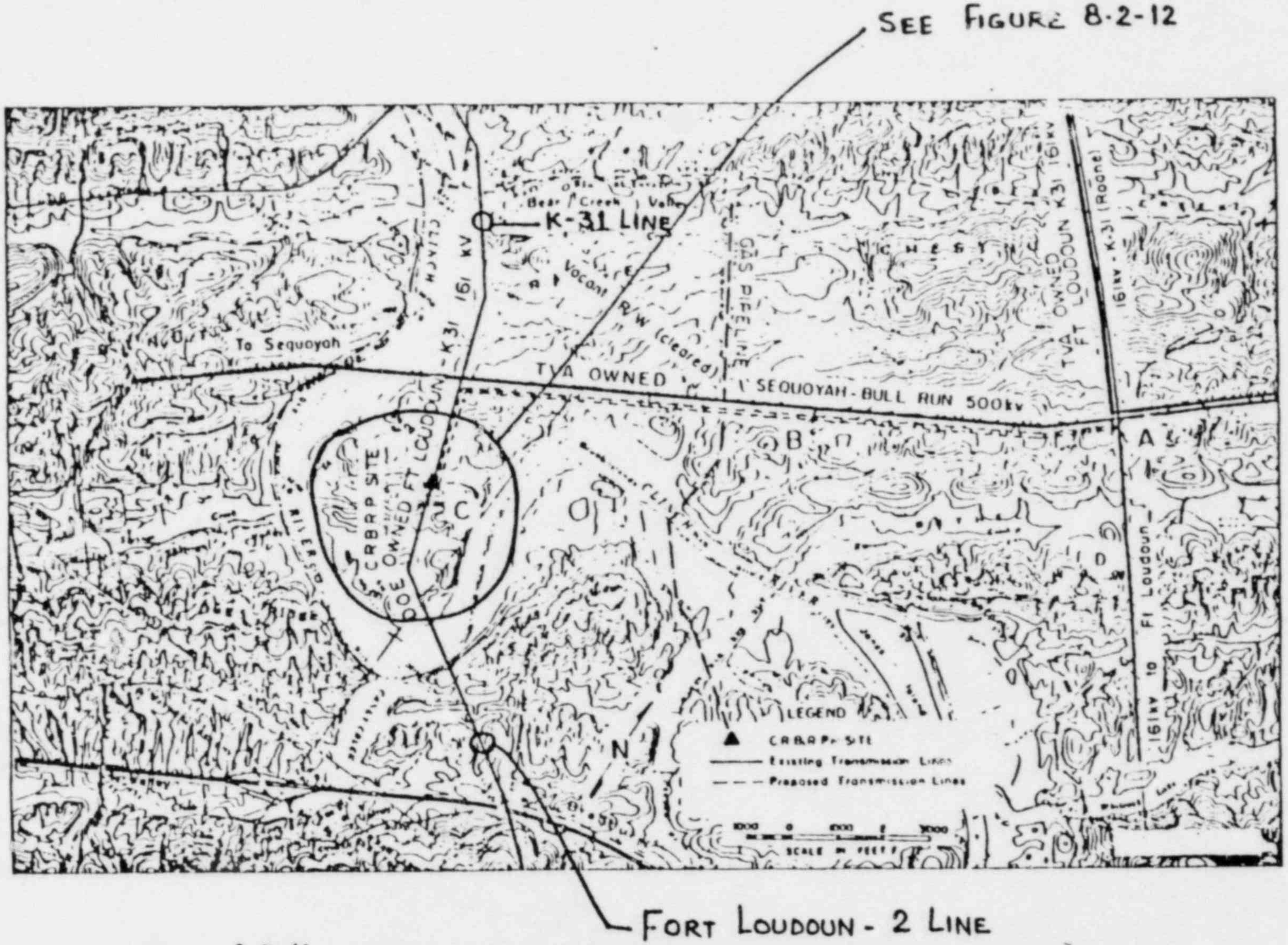
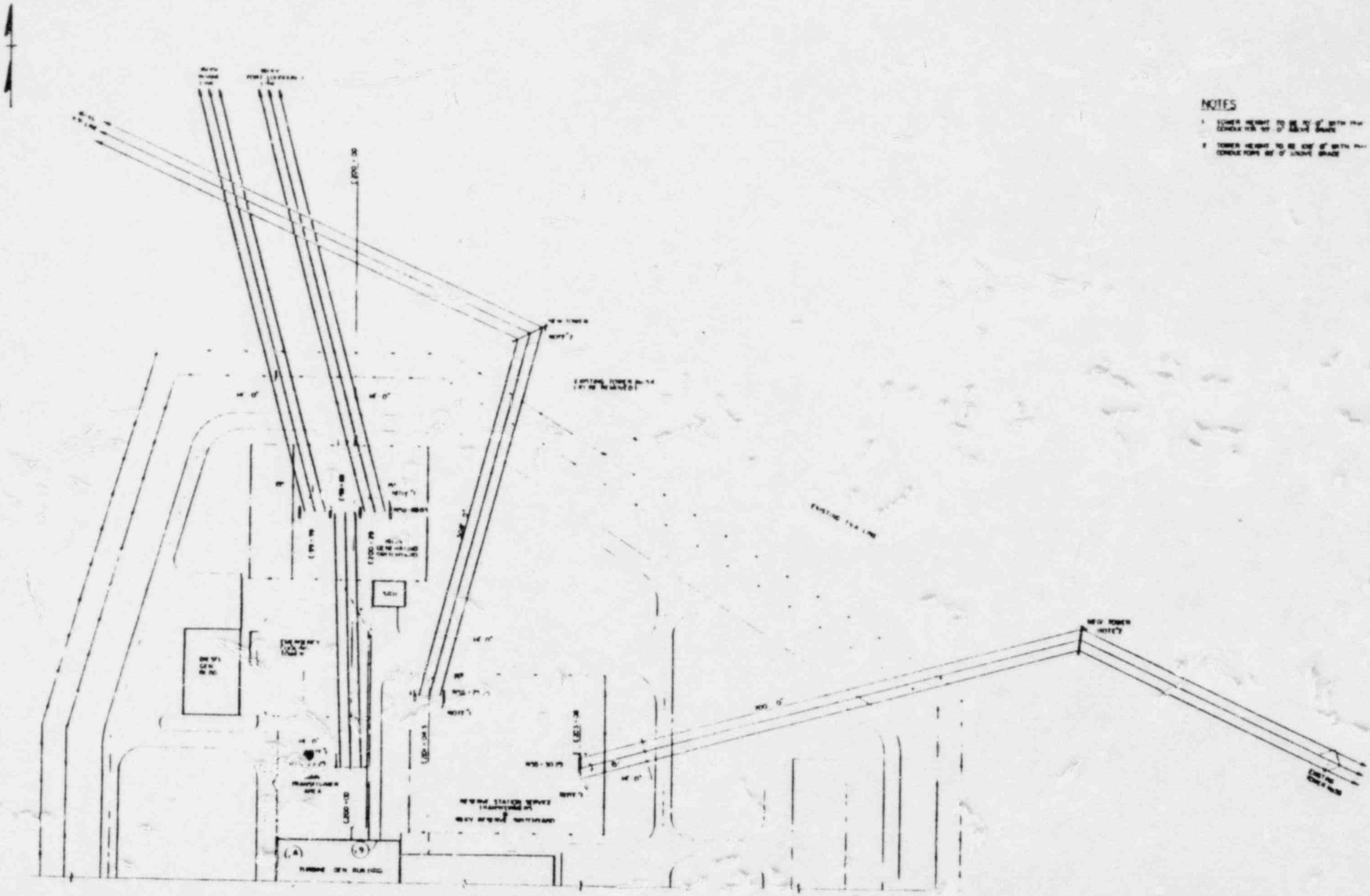
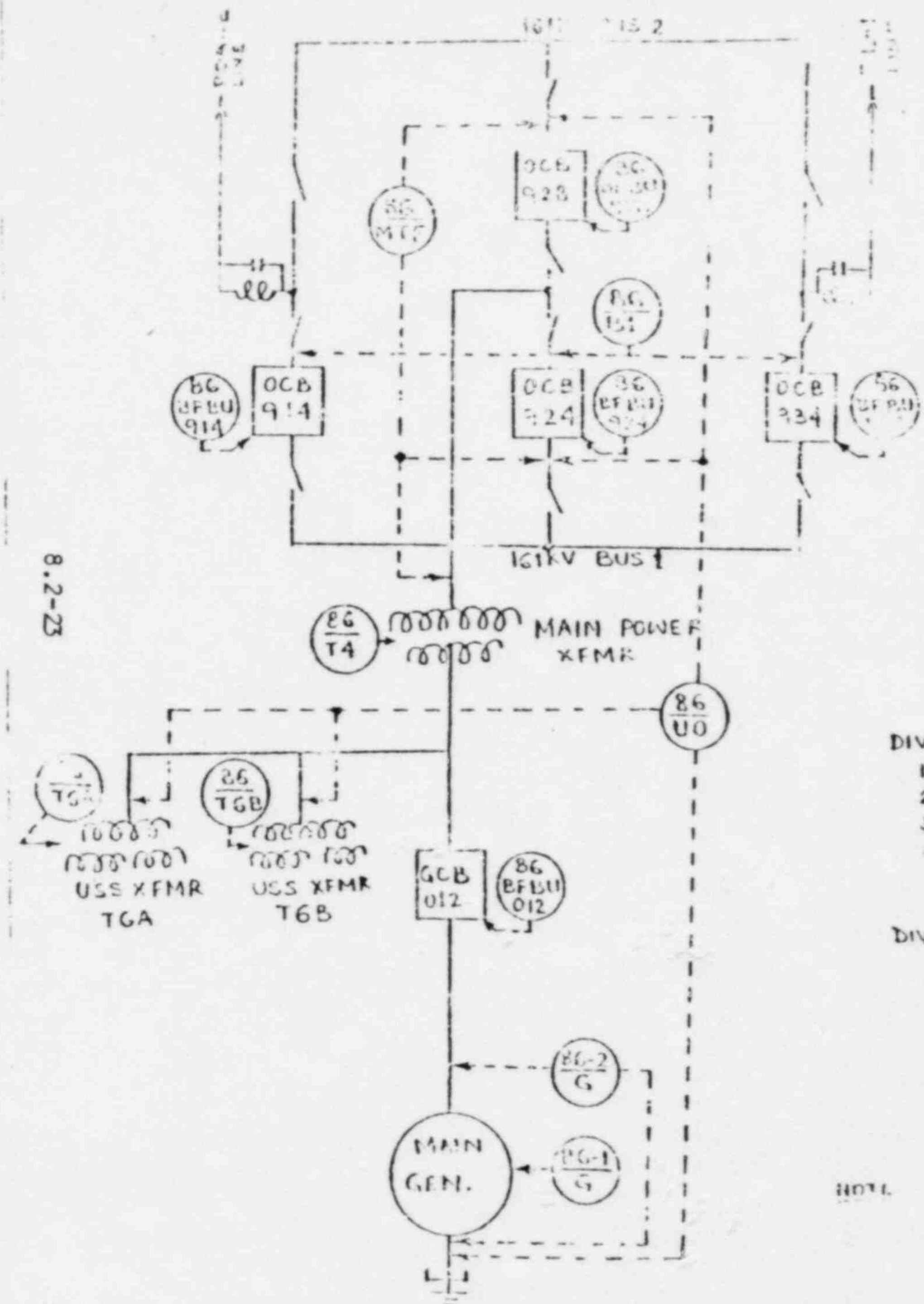


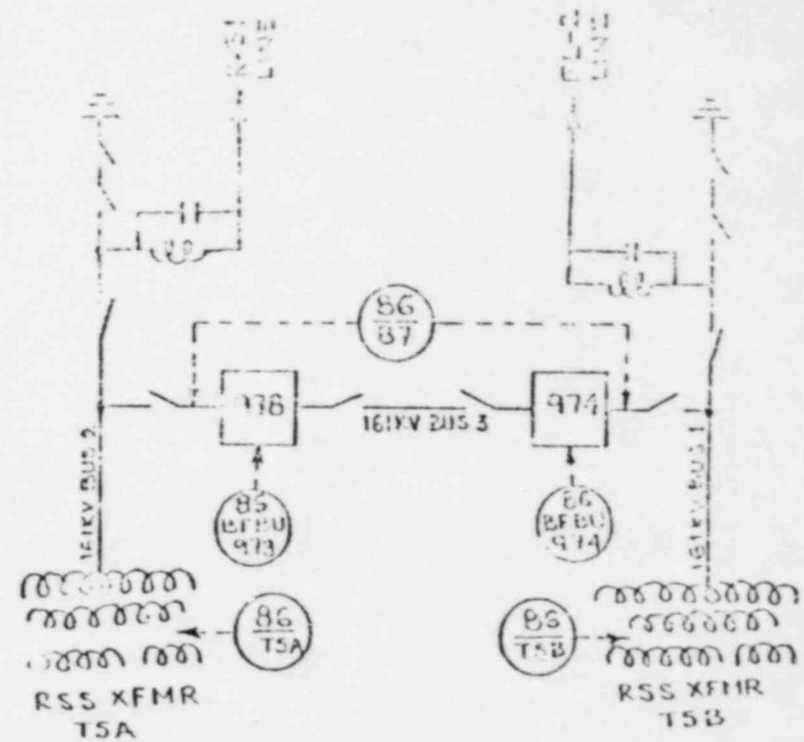
Figure 8-2-11 PROPOSED TRANSMISSION LINE ROUTE OF THE CRBRP SITE AREA



GRAPHIC SCALE

161KV TRANSMISSION
FROM TVA GRID TO
CRBRP
FIGURE 8.2-12





DIVISION A 125V DC DISTRIBUTION SYSTEM SUPPLIES POWER TO:

1. CARRIER, TRANSFER TRIP AND PRIMARY LINE RELAYS OF GSY TRANS. LINE
2. GSY AND MAIN TURBINE GENERATOR LOCKOUT RELAYS & GSY XFMR PROTECTION
3. GSY BREAKERS' AND GEN. CIRCUIT BREAKER'S CLOSING & PRIMARY TRIP COILS
4. GSY SPARE BREAKER LINE RELAYING
5. SECONDARY LINE RELAYING OF RSY TRANS. LINES
6. RSY BREAKERS' SECONDARY TRIP COILS AND BREAKER FAILURE LORS.

DIVISION B 125V DC DISTRIBUTION SYSTEM SUPPLIES POWER TO:

1. CARRIER, TRANSFER TRIP AND PRIMARY LINE RELAYS OF RSY TRANS. LINES
2. RSY XFMR PROTECTION AND RSY LOCKOUT RELAYS
3. RSY BREAKERS' CLOSING AND PRIMARY TRIP COILS
4. SECONDARY LINE RELAYING FOR GSY TRANS. LINES
5. GSY BREAKERS SECONDARY TRIP COILS AND BREAKER FAILURE LORS.

NOTE TRIPPING OF BOTH GSY BREAKERS 924 AND 928 BY ANY RELAY WILL TRANSFER AUXILIARY LOADS TO RSY POWER SUPPLY.

Figure 8.2-13 CRBRP Power Transmission Systems, Protection & Control

8.3 ON-SITE POWER SYSTEMS

8.3.1 AC Power Systems

8.3.1.1 Description

The on-site power system consists of the following:

a) Non-Class 1E power distribution system which consists of two generally independent load groups (Division A and B). Each division is provided with its own:

- power supplies (13.8KV, 4.16KV, 480 volts, 277 volts, 208 volts and 120 volts AC)
- transformers
- cables and raceways
- 125 volts DC control and instrumentation power
- multiplexer system for control, alarm and indication
- 120/208 volts uninterruptible power supplies (UPS) for essential Non-Class 1E loads

b) Class 1E power distribution system which consists of three independent load groups (Division 1, 2 and 3). Class 1E Divisions 1 and 2 provide the two redundant safety related load groups. Each of the three load groups consists of its own:

- power supplies (4.16KV, 480 volts, 277 volts, 208 volts and 120 volts AC)
- standby (on-site) diesel generator
- transformers
- cables and raceways
- 125 volts DC control and instrumentation power
- 120/208 volts uninterruptible power supplies (UPS) for essential Class 1E loads
- solid state programmable logic system for control, diesel generator load sequencing, periodic testing, and alarm indications

Class 1E Division 3 provides power for Loop 3 decay heat removal system.

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Each of these divisions is separated physically and electrically from the other two divisions as described in Section 8.3.1.4, and has the capability to shutdown the plant safely. However, from the consideration of connected loads, Class 1E Divisions 1 and 2 provide power to redundant load groups and as such are referred to as redundant divisions. Class 1E Division 3 provides Class 1E power to Loop 3 of the Heat Transport System (HTS) and to certain plant Non-Class 1E loads. (The Non-Class 1E loads are connected through an isolation subsystem). Since not all loads powered from Division 3 are identical or similar to those powered by Divisons 1 or 2, this division is not identified as redundant to Division 1 or 2. However, as far as the HTS is concerned, the Divisions 1, 2 and 3 power supplies are fully redundant serving the Loops 1, 2 and 3 Class 1E loads, respectively. Each of these three Divisions is capable of shutting down the plant safely.

13.8KV and 4.16KV Distribution System

During normal operation, plant auxiliary power is provided by two (2) 50 percent capacity (50 percent capacity of total plant electrical loads, but 100 percent of loads for one safety division) unit station service transformers (USSTs) fed from the main generator through the 22KV isolated phase bus and the generator circuit breaker.

NRC Regulatory Guidance

The following pages provide discussion of design features which address the guidance of NRC Regulatory Guides 1.6, 1.9, 1.22, 1.32, 1.40, 1.41, 1.47, 1.53, 1.63, 1.68, 1.75, 1.93, 1.100, 1.106, 1.118, 1.128, 1.129, 1.131 and 1.137. Regulatory Guides are further discussed in Appendix I of the PSAR.

8.3.1.1.1 Standby AC Power Supply

The Standby AC Power Supply is a Class 1E system which supplies AC power to the Class 1E and certain essential Non-Class 1E loads when the Plant AC Power Supply, CRBRP Preferred Power Supply, and Reserve AC Power Supply are not available.

The Standby AC Power Supply consists of three Class 1E diesel generators, each supplying power to its own safety group loads. Safety Division 1 and 2 are redundant to each other. The diesel generators are physically and electrically independent of each other. The Divisions 1 and 2 diesel generators supply power to redundant load groups. The diesel generators are sized in accordance with IEEE Standard 387-1977, supplemented by Regulatory Guide 1.9, Rev. 2. The total demand during an emergency condition when off-site AC power supplies are unavailable is within the continuous rating of each diesel generator as indicated in Tables 8.3-1A, 8.3-1B, and 8.3-1C.

Each diesel generator is installed in a separate and independent diesel generator room. These rooms are located in a Seismic Category 1 structure and are capable of withstanding missiles as described in Section 3.8.4.1.4. Auxiliary equipment, local control boards and excitation cubicles associated with each diesel generator are located in the same room with the diesel generator. Except for sensors and other equipment that must be directly mounted on the engine or associated piping, the controls and monitoring instrumentation for the diesel generator unit are installed on two (2) free standing floor mounted panels separate from diesel generator unit skids.

The Diesel Generator sets are installed on their own foundations which are isolated from the main building slab. The control panels are located on the floor area which is considered to be vibration free.

Cables for Standby AC Power Supplies will be installed in their own separate division of the Class 1E raceway system. Cables and raceways of the Standby AC Power Supply will be marked in a distinctive manner as described in Section 8.3.1.4.

The following support systems are those essential auxiliary systems or components required to start and operate the diesel generators.

a. The Safety-Related 125V DC Power System

   Each diesel generator is furnished with an independent DC supply from the Safety-Related 125V DC Power System. (Section 8.3.2 describes the 125V Class 1E DC system).

b. The Diesel Generator Fuel Oil Storage and Transfer System

   Fuel is provided for starting during initial operation using a shaft driven pump taking suction from a day tank. Fuel is provided for continuous operation using AC powered fuel transfer pumps taking suction from the underground storage tanks to replenish the day tank fuel supply. Each diesel generator is furnished with an independent fuel storage and transfer system. For details refer to Section 9.14.1.

c. Diesel Generator Cooling Water System

Each diesel generator is furnished with an independent cooling water support system. For details refer to Section 9.14.2.

Testing and Inspection

The equipment will be tested and inspected at the vendor's facility prior to delivery. The system will also be inspected during installation to confirm that design requirements have been met.

Initial operational system tests will be performed with components installed and connected to demonstrate that the system operates within design limits and meets the performance specification, and to verify the independence between redundant AC power sources and load groups.

After being placed in service, the standby diesel generators and their respective associated supply systems will be inspected and tested periodically to detect any degradation of the system.

The preoperational tests and periodic testing after the diesel generator units are placed in service will be performed in accordance with Regulatory Guide 1.108 (Rev. 1, 8/77). Detailed step-by-step procedures will be provided for each test. The procedures will identify those special arrangements or changes in normal system configuration that must be made to put the diesel generator unit under test. Jumpers and other nonstandard configurations or arrangements will not be used subsequent to initial equipment startup testing. During periodic testing, the diesel generator units will be operated at a load in excess of a minimum of 25% of rated load.

The following tests will be performed as a minimum:

A. Testing of diesel generator units during the plant preoperational test program and at least once every 18 months (during refueling or prolonged plant shutdown) will be performed to:

(1) Demonstrate proper startup operation by simulating loss of all AC voltage and demonstrate that the diesel generator unit can start automatically and attain the rated speed (450RPM) within 10 seconds. Verify that the generator voltage and frequency are at their rated values within 10 seconds after the start signal.

(2) Demonstrate proper operation for design-accident-loading sequence to design-load requirements in Tables 8.3-1A, 8.3-1B, and 8.3-1C. Verify that at no time during the loading sequence will the frequency and voltage decrease to less than 95% of nominal and 75% of nominal, respectively. Verify that the frequency is restored to 98% of nominal and the voltage is restored to 90% of nominal within 4 seconds for each load sequence time interval.

(3) Demonstrate full-load-carrying capability for an interval of not less than 24 hours, of which 22 hours will be at a load equivalent to the continuous rating of the diesel generator unit and 2 hours at a load equivalent to the 2 hour rating of the diesel generator unit. Verify that voltage and frequency are maintained at rated values. The test will also verify that the cooling system functions within design limits.

installation is complete, pre-operational equipment tests and inspections will be performed.

Initial pre-operational tests will be performed with equipment and components installed and connected to demonstrate that the equipment is within the design limits and the system meets performance specifications. This test will also demonstrate that loss of the Plant Power Supply and Offsite (CRBRP Preferred and Reserve Power) AC power supplies can be detected.

Periodic equipment tests will be performed to detect any degradation of the system and to demonstrate the capability of equipment which is normally de-energized.

Periodic tests on the Class 1E 4.16KV switchgear and 480 volt switchgear circuit breakers will be performed by utilizing the following test methods:

a. The operability of circuit breakers carrying current under normal plant operation will be demonstrated by their performance in supplying power. In addition, the circuit breakers will be tested in "Test" position at regular intervals. During this test, the proper operation of the circuit breakers and the control circuits will be verified.

b. Testing of circuit breakers of the standby equipment will be performed by racking the circuit breakers in the "Test" position. In the "Test" position, the main contact of the circuit breaker are disconnected, but the auxiliary and the control circuits are maintained. This facilitates functional tests of the circuit breaker and its control circuit.

c. The operability of safety-related circuit breakers will be demonstrated by their performance in supplying power to safety-related loads during scheduled load performance tests. In addition, functional tests of the circuit breaker and its control circuit will be performed during plant refueling or prolonged plant shutdown.

Periodic tests of the transfer of power between the CRBRP Preferred Power Supply and Reserve AC Power Supplies will be performed during prolonged plant shutdown or during refueling to demonstrate that:

a. Sensors can properly detect loss of the CRBRP Preferred Power Supply and the Reserve AC Power Supplies.

b. Components required to accomplish the transfer from the CRBRP Preferred Power Supply to the Reserve AC Power Supply are operable.

and provide uninterrupted power to the Plant AC Distribution System through the main power transformer and the unit station service transformers. An electrical fault downstream of the generator circuit breaker will cause tripping of the 161KV circuit breakers in the generating switchyard. This will result in the loss of the power supply from the unit station service transformers. Similarly, an event which trips the turbine or reactor concurrent with the loss of CRBRP Preferred Offsite Power from the generating switchyard will also result in the loss of the power supply from the unit station service transformers.

Fault sensing relays provided in the normal power supply and undervoltage sensors at each 13.8KV and 4.16KV switchgear bus will initiate the following upon detecting a fault or loss of bus voltage:

A. Trip the supply circuit breakers from the unit station service transformers.

B. Close the Reserve AC Power Supply circuit breakers from the two 50 percent capacity reserve station service transformers by means of a fast dead bus transfer scheme.

Primary and backup fault sensing relays have been provided in the normal power supply (Generator, generating switchyard, main step-up transformer and the Unit Station Service Transformers) and the reserve switchyard to perform the required protection of the electrical distribution system.

Each fault sensing relay provided in the normal power supply will actuate its respective lockout relay on sensing a fault in the normal power supply. The lockout relay will trip the normal generating switchyard (or CRBRP generator) power supply incoming circuit breakers on the medium voltage switchgear, including the 4.16KV Class 1E switchgear. The tripping of these circuit breakers will automatically initiate closing of the reserve offsite power supply (preferred power) incoming circuit breakers on the medium voltage switchgear using the early "b" contact of the normal power supply incoming circuit breakers.

The medium voltage switchgear busses are also provided with undervoltage sensors, which will also initiate tripping of the normal power supply circuit breaker and close the reserve power supply circuit breakers on sensing an undervoltage condition on the bus. In the case of Class 1E, 4.16KV medium voltage switchgear busses, the detection of an undervoltage condition will also result in an automatic start signal to the emergency diesel generator. However, if the automatic bus transfer to the reserve power supply restores the voltage to the medium voltage Class 1E switchgear busses, the circuit breaker connecting the diesel generator to the MV switchgear bus will remain open and the safety related loads will be powered from the reserve power supply.

A back-up breaker failure protection scheme is also provided in the event of the failure of the above protection scheme. On failure of the fault sensing relay(s), the fault sensing relay in the generating switchyard relaying scheme will actuate another lockout relay which will trip the 161KV circuit breakers in the generating switchyard, thereby isolating the medium voltage switchgear from the normal power supply and will initiate the closing of reserve offsite power supply incoming circuit breakers as described above. Additionally, in the event that a fast bus transfer is unsuccessful, a time delayed automatic bus transfer will be accomplished.

If this automatic closure of the reserve offsite power supply incoming circuit breaker(s) is not accomplished, the operator can manually close the reserve offsite power supply incoming circuit breaker(s).

The CRBRP design includes capability to test the transfer of power supplies among the plant power supply, the normal AC supply through the generating switchyard, the reserve AC supply through the reserve switchyard and the onsite standby diesel generator power supplies.

The sensors that detect the loss of power will be tested during plant operation or plant shutdown.

8.3.1.1.5 <u>120/208 Volt Vital (Uninterruptible) AC Power System</u>

The 120/208 volt Vital (Uninterruptible) AC Power system is a Class 1E system which is required to supply AC power to the Plant Protection System (PPS) controls, alarm and indication and other Class 1E loads for safe shutdown of the plant. The Plant Protection System (PPS), described in Chapter 7., generates signals to actuate reactor trip, and performs other supporting functions in the event of an emergency condition.

The system is divided into three separate and independent load groups (Divisions 1, 2 and 3), each receiving AC power from a separate inverter through a static transfer switch. Connections for the 120/208 volt Vital AC Power System are shown in Figure 8.3-2.

The normal source of power for the Vital AC Power Distribution buses are the inverters which are supplied from their associated division DC power supplies described in Section 8.3.2.

Each 120/208 volt Vital AC Power System Distribution bus can also recieve power from a Class 1E 480 volt motor control center which serves as a backup power source. Each of the distribution buses is connected to this motor control center through a static transfer switch and 480-120/208V AC regulating transformer. Failure of an inverter or its DC power source is sensed and the associated distribution bus is transferred automatically by the static transfer switch to the backup transformer supplied by the Class 1E 480 volt motor control center. The transfer is accomplished at high speed and does not degrade the performance of control and instrumentation loads.

8.3.1.2.1 NRC Regulatory Guide 1.6, Rev. 0 (3/71)

The Class 1E safety-related loads are physically and electrically separated into three functionally redundant shutdown load groups (Divisions 1,2 and 3) such that loss of any two groups, including a single failure condition, will not prevent safe shutdown of the plant. Only one load group is required to shut down the plant safely.

Each AC load group will have connections to the CRBRP Preferred Power Supply, Reserve Power Supply and a Standby On-site AC Power Source. The Standby On-site AC Power source will have no automatic connection to any other redundant load group.

When operating from the Standby On-site sources, redundant load groups and the redundant Standby On-site sources will be independent of each other as follows:

a. The Standby On-site source of one Class 1E load group will not be automatically paralled with the Standby On-site source of another Class 1E load group under normal or emergency conditions.

b. No provisions exist for automatically connecting one Class 1E load group to another Class 1E load group.

c. No provisions exist for automatically transferring loads between redundant Class 1E power sources.

d. Manually connecting redundant load groups together will require at least one interlock to prevent an operator error that would parallel such Standby On-site power sources.

Each Diesel Generator unit consists of one diesel engine, one generator and required accessories.

The Standby On-Site Power Supply network has a provision to manually cross-connect the 4.16KV buses of the Division 1 and 2 power supplies in case of an extreme emergency. This connection will be put into service through strict administrative controls and must satisfy the following prerequisites:

a) There shall be a total loss of off-site power.

b) One of the two redundant diesel generators failed to start and it is determined to be inoperable.

c) Critical safety-related loads associated with the operative diesel generator have failed and become unavailable.

If the above prerequisites are met, loads of either redundant Division 1 or 2 can be connected to the diesel generator of the other division for safe shutdown of the plant and to maintain the plant in a safe shutdown condition.

Key and electrical interlocks and administrative controls will be provided to ensure:

8.3.1.2.4 NRC Regulatory Guide 1.29, Rev. 3 (9/78)

The Class 1E Electric Systems, including the auxiliary systems for the Onsite Electric Power Supplies, that provide the Class 1E electric power needed for functioning of nuclear safety related equipment are designated as Seismic Category I.

All electric devices and circuitry involved in generating signals that initiate protective action are designed as Class 1E.

All Class 1E equipment including the diesel generators, 4.16KV Switchgear, Unit Substations, Motor Control Centers, Control Room Panels, etc. are located inside Seismic Category I buildings and are designed as Seismic Category I.

All non-safety-related equipment located in Seismic Category I buildings are designed to maintain structural integrity under a Seismic event and will not become missiles.

Those portions of structures, systems or components whose continued function is not required but whose failure could reduce the functioning of any nuclear safety related equipment to an unacceptable safety level will be designed and constructed so that the SSE would not cause such a failure.

Seismic Category I design requirements will extend to the first seismic restraint beyond the defined boundaries. Those portions of structures, systems, or components which form interfaces between Seismic Category I and non-Seismic Category I features will be designed to Seismic Category I requirements.

For seismic design classifications, refer to Section 3.2.1.

8.3.1.2.5 NRC Regulatory Guide 1.30, Rev. 0 (8/72)

The Quality Assurance requirements for the installation, inspection and testing of instrumentation and electrical equipment during the plant construction, are those included in ANSI N45.2.4 supplemented by Regulatory Guide 1.30 as follows:

ANSI N45.2.4 will be used in conjunction with ANSI N45.2-1977.

ANSI N45.2.4 requirements will be considered applicable for the installation, inspection and testing of instrumentation and electric equipment during the plant operation.

8.3.1.2.6 NRC Regulatory Guide 1.32, Rev. 2 (2/77)

The electrical separation and independence of redundant (Divisions 1 and 2) and Division 3 Standby AC Power Supplies conform to IEEE Standard 308-1974 supplemented by Regulatory Guide 1.32 as follows:

Electrical independence between redundant Standby AC Power Supplies will be in accordance with Regulatory Guide 1.6 as described in Section 8.3.1.2.1.

Physical independence between redundant Standby AC Power Supplies will be in accordance with IEEE Standard 384-1974 supplemented by Regulatory Guide 1.75 as described in Section 8.3.1.2.14.

c. Sections 6.3 and 6.4 of IEEE Std. 379-1972 are interpreted as not permitting separate failure mode analyses for the protection system logic and the actuator system. The collective protection system logic-actuator system as applicable for the Class 1E electrical power systems is analyzed for single-failure modes which, though not negating the functional capability of either portion, act to disable the complete protective function.

8.3.1.2.11 NRC Regulatory Guide 1.63, Rev. 2 (7/78)

The electrical penetration assemblies in the containment vessel will be designed, constructed, qualified, installed and tested in accordance with IEEE Std. 317-1976, supplemented by Regulatory guide 1.63 positions as discussed herein.

The conductors and the electrical penetration assembly will be designed to withstand the maximum short-circuit currents versus time conditions that could occur given single random failures of circuit overload protective devices. The duration of rated short circuit current is based on the operating time of the secondary (backup) protective device or apparatus. The electrical penetration assemblies will be designed to maintain their mechanical and electrical integrity in accordance with IEEE Std. 317-1976, IEEE Std. 279-1971 and Regulatory Guide 1.63.

The dielectric-strength test qualification for medium voltage power conductors is in accordance with IEEE Std. 317-1976 supplemented by the impulse voltage test as described in Regulatory Guide 1.63.

Regulatory positions, C1, C2, C3, and C4 place additional restrictions on maximum short-circuit current, x/r ratios, maximum short-circuit current duration and impulse voltage qualification testing on the electrical penetration assemblies in addition to the requirements of IEEE Std. 317-1976. The project will comply fully with the requirements as set forth in IEEE Std. 317-1976 and as modified by Regulatory Guide 1.63.

8.3.1.2.12 NRC Regulatory guide 1.68, Rev. 2 (8/78)

Written procedures for preoperational and startup testing for the Plant AC Power Distribution System, Class 1E AC Power Distribution System, Standby AC Power Supplies and DC System will be developed. Format and content of these procedures will conform to the guidance given in Regulatory Guide 1.68. For test program description, see Chapter 14.

8.3.1.2.13 NRC Regulatory Guide 1.73, Rev. 0 (1/74)

All Class 1E electric valve operator assemblies, for installation inside the containment vessel, will be designed, constructed, qualified, installed and tested in accordance with IEEE Std. 382-1972 supplemented by Regulatory guide 1.73 requirements.

Each electric valve operator assembly will be designed and constructed to withstand the worst local environmental requirements (during normal or accident conditions) such as temperature, humidity, radiation, and sodium aerosol condition.

8.3.1.2.14 NRC Regulatory Guide 1.75, Rev. 2 (9/78)

The electrical equipment and circuits comprising or associated with the Class 1E power system, Class 1E protection systems and Class 1E equipment will be designed, qualified and tested in accordance with IEEE Std. 384-1975, supplemented by Regulatory Guide 1.75, "Physical Independence of Electric Systems," positions as discussed herein.

The system will be designed so that the redundant equipment and circuits are separated in accordance with the criteria set forth in paragraph 8.3.1.4.

The AC loads which are not Class 1E but are required for plant availability will not be connected to the redundant Class 1E, Divisions 1 and 2 4.16KV buses, but will be connected to Division 3 switchgear through an isolation device, which is designed as follows:

a. The isolation system will consist of a 4.16KV cirult breaker, a 4.16KV/480V high impedance transformer and a 480V circuit breaker as shown in Figure 8.3-3. The isolation system will be qualified as Class 1E up to the load terminals of 480V circuit breaker.

b. The impedance of the isolation system will be high enough so that for the worst possible fault (three phase bolted fault) on the Non-Class 1E 480V bus, the following conditions will be met:

   (1) The pick-up value of the overcurrent relays protecting the Class 1E 4.16KV main supply circuit breaker will exceed the maximum current (combined maximum load current and maximum fault current contribution) flowing through the supply circuit breaker by a 2:1 margin.

   (2) When the 4.16 KV Class 1E bus is being supplied from offsite power, the voltage at the bus will not drop below 80% of nominal. When the Class 1E bus is being supplied from on-site (standby) power supply, the voltage at the bus will not drop below 75% of nominal. The voltage levels of 80 and 75 percent of nominal are chosen to be the same as the allowable minimum voltage levels during the sequential loading of the 4.16kV Class 1E bus or during starting of the largest motor after the bus has been fully loaded.

c. The isolation system 480 volt and 4.16KV circuit breakers will perform redundant isolation functions. They will be stored energy devices and will be physically separated.

d. Diverse means (electro-mechanical and solid state) will be used for fault sensing and tripping of the isolation system.

e. The isolation system will be able to accept any single component failure concurrent with the worst fault on the Non-Class 1E 480V bus without unacceptable consequences. (This does not include short circuits on the 4.16KV portion of the isolation system since this is considered an extension of the Class 1E bus).

f. Protective devices have been provided in the design to clear any fault on the Non-Class 1E system such as phase to ground, phase to phase and three phase faults within a reasonable time such that there is no degradation to the Class 1E system.

   1) A phase to ground fault (which is the most likely mode of failure) on a Non-Class 1E circuit will have no effect on the Class 1E system since the isolation system includes a 4.16kV/480V delta-wye connected transformer with the high resistance grounded neutral. The neutral is grounded through a 55.4 ohm resistor which will limit the line to ground current to approximately 5 amperes. The Class 1E 480 volt and 4.16kV circuit breakers will be tripped to clear a ground fault in the case that the affected Non-Class 1E feeder circuit breaker fails to trip.

   2) Any phase to phase or three phase fault on the Non-Class 1E circuits will be isolated by instantaneous operation of the affected branch feeder circuit breaker. Back-up protection is provided by fast operation of the Class 1E 480 Volt circuit breaker (0.2-0.3 sec clearing time) or by the 4.16kV circuit breaker (0.6-0.7 sec clearing time). In addition undervoltage sensors are provided at the input terminals of the Class 1E 480 Volt circuit breaker. These undervoltage sensors will initiate tripping of the Class 1E 480 Volt and 4.16kV circuit breakers within five (5) seconds upon sensing the undervoltage caused by loss of power or failure of the circuit breakers to clear a fault.

   3) After the fault has been cleared the voltage at the 4.16kV bus will be restored to a minimum of 90 percent of nominal within (2) seconds, which will allow all connected loads to operate continuously.

g. The high impedance transformer used as an isolation device will be subjected to a short-circuit withstand test as part of the shop testing program at the manufacturer's facility. After the transformer has been energized a three phase fault will be applied at the secondary windings for the maximum duration of the fault. The purpose of this test is to demonstrate the mechanical and thermal capability of the transformer to withstand short-circuit stresses which the transformer could experience and to verify the transformer current limiting capability.

The system is designed to keep the number of associated circuits to a bare minimum. Associated circuits will comply with one of the following paragraphs of IEEE Std. 384-1974: 4.5(1), 4.5(2) or 4.5(3), and positions C.4 and C.6 of Regulatory Guides 1.75-1975.

The cable installation design prohibits the use of cable spicing inside the cable tray or conduit raceway system.

The physical identification of Class 1E equipment, cables and raceway systems are described in Section 8.3.1.5.

The design provides two separate cable spreading rooms, one above the Control Room and one below it. The design does not permit location of any high energy equipment in the cable spreading rooms as required by IEEE Std. 384-1974. The criteria for routing of circuits in the cable spreading rooms is given in Section 8.3.1.4 to assure physical separation.

The Divisions 1, 2 and 3 Class 1E Standby Diesel Generator units are described in Section 8.3.1.1.1. The diesel generator units and associated auxiliaries and control equipment are located in separate Seismic Category I structures having independent ventilating systems. The circuits related to redundant Standby Diesel Generators are routed in accordance with the criteria specified in Section 8.3.1.4, to assure physical separation.

The Non-Class 1E and Class 1E DC batteries and related uninterruptible power supply (UPS) equipment are described in Section 8.3.2. DC battery and associated UPS equipment of each safety division is separated from equipment of the other safety division by reinforced concrete walls. The Class 1E batteries and UPS equipment are located in Seismic Category I structures. The physical separation of circuits related to each separate division of batteries and UPS system is in accordance with the criteria described in Section 8.3.1.4.

8.3.1.2.20 NRC Regulatory Guide 1.118, Rev. 1 (6/78)

CRBRP Design Criterion 16 (GDC 18) has been established to satisfy the requirements of IEEE Std. 279-1971 and 338-1977 and Regulatory Guide 1.118. This requires the design to provide for appropriate periodic inspection and testing of important areas and features, such as wiring, insulation, connections and switchboards, to assess the continuity of the systems and the condition of their components to check the operability and functional performance of the system components such as on-site power sources, relays, switches, buses and the system as a whole under conditions as close to design as practical.

CRBRP design will comply with the above criteria and as a result, it will comply with IEEE Std. 279-1971, 338-1977 and Regulatory Guide 1.118. For details of compliance refer to Sections 8.3.1.1, 8.3.1.2, 8.3.1.2.1 and 8.3.1.3.

8.3.1.2.21 NRC Regulatory Guide 1.131, Rev. 0 (8/77)

The electric cables, field splices and connections will be designed, qualified and tested in accordance with IEEE Std. 383-1974, supplemented by Regulatory Guide 1.131, positions as discussed herein.

The medium voltage cables, low voltage power and control cables, and instrumentation cables are specified to be type tested and qualified to the requirements of IEEE Std. 383-1974 and IEEE Std. 323-1974 supplemented by Regulatory Guide 1.131 and to the design basis events described in Table 8.3-3. The field splicing of cables inside the cable tray or conduit raceway system is prohibited in accordance with the requirements of IEEE Std. 384-1974 supplemented by Regulatory Guide 1.75. The environmental conditions for all cables include the maximum sodium aerosol concentration, along with the values of pressure, temperature, radiation, chemical concentrations, humidity and time, and are specified as applicable to the design of the power plant.

8.3.1.2.22 IEEE Standard 308 - 1974

Class 1E AC and DC Power Supplies and distribution systems will be designed to conform to the requirements of Class 1E electrical systems as discussed below.

All Class 1E electrical equipment will be specified and qualified for the environmental conditions such that no design basis event will cause loss of electric power to any loads related to safety, surveillance or protection, thereby maintaining the safety of the plant at all times.

Loss of electric power to any single Class 1E equipment or to any Class 1E division will not cause damage to the fuel or to the reactor coolant system.

The Class 1E system is capable of performing its function when subjected to the effects of a design basis event at its location. (See Table 8.3-3) No significant radiation hazard to Class 1E loads has been identified for either normal or emergency conditions.

Class 1E loads are designed to perform their intended functions adequately for the variation of voltage or frequency in the Class 1E electric system.

8.3.1.2.28 IEEE Standard 387 - 1977

The Standby AC Power Supply conforms to IEEE Standard 387-1977 which includes requirements for capability rating, independence, redundancy, testing, analyses, quality assurance, and identification.

8.3.1.3 Conformance with Appropriate Quality Assurance Standards

Assurance that equipment and workmanship quality is maintained throughout the construction process is provided by conformance to IEEE Standard 336 - 1971, "Installation, Inspection, and Testing Requirements for Instrumentation and Electric Equipment during the Construction of Nuclear Power Generating Stations". The methods used to accomplish cnformance are described by construction procedures and instructions and in Chapter 17.0 of this PSAR.

8.3.1.4 Indepencance of Class 1E Systems

The following criteria is used to preserve the independence of Class 1E system.

A. General Separation of Cables by Voltage Class

A raceway contains cables of only one class. Classes are based on the nominal utilization voltage of the cable and/or vulnerability to spurious signals.

Voltage Classes are:

15KV Class - 13.8KV AC nominal power
5KV Class - 4.16KV AC nominal power
600V Class - 480-277 volt AC and 250 volt DC nominal power
Control - 120V/208V AC, 125V DC, 120V AC nominal power and control
Low level instrumentation including digital and analog signals

When cable trays are arranged in a vertical stack, the preferable arrangement is in order of voltage class, with the highest voltage at the top.

B. Cable Derating

Ampacity rating and group derating factors of cables are in accordance with the Insulated Power Cable Engineers Association Publication IPCEA-P54-440 and IPCEA-P46-426. Cables are selected to minimize deterioriation due to temperature, humidity, and radiation during design life of the plant. Environmental type tests for the expected environments will be performed on all cables and terminations. The tests will include radiation exposure, heat aging, and electrical measurements to assure that the cable will function in the design environment for the required time. Cable derating as a result of fire stops/seals are included in the design.

C. Raceway Fill

Cable tray fill will be limited such that the summation of the cross-sectional areas of cables in a tray section will in general be not more than 40% of the usable cross-sectional srea of that tray section.

Conduits will be sized for a maximum percent fill of the inside area of the conduit in accordance with NFPA 70 "National Electrical Code" Art. 346.

D. Sealing Raceway Blockouts and Wall and Floor Penetrations

Fire stops will be installed for cable trays wherever the cables pass through fire walls and floors other than the Reactor Containment vessel. Cable and cable tray penetrations of fire baarriers are sealed to provide protection at least equivalent to that required of the fire barrier. Penetrations are qualified to meet the requirements of ASTM E-119, and IEEE Std. 634-1978. The actual fire ratings of stops and penetrations are determined by fire hazards analysis.

Fire stops, fire barriers, and air seals will be constructed of mastic type materials or elastomer modular construction materials qualified in accordance with IEEE Std. 623 and ASTM E-119. Fire stop/seal material will be compatible with insulation and conductor materials and will be shock, vibration, seismic, and radiation resistant in accordance with the area(s) penetrated.

E. Physical Separation of Class 1E Cables

The separation design description for raceways, Class 1E circuitry and associated cabling given below incorporates the requirements of IEEE Std. 384-1974, Regulatory Guide 1.6 and NRC Regulatory Guide 1.75.

Load groups, cables and raceways of a safety-related system will be separated from load groups, cables, or raceways of other safety-related groups in accordance with the separation criteria described herein. This separation criteria will preclude a single failure within the safety-related system from preventing proper protective action at the system level when required. Raceways and cables will be classified by separation groups, namely Class 1E Division 1, Class 1E Division 2, Class 1E Division 3, and Plant Protection System. For the purpose of physical separation criteria Class 1E Division 1, 2, and 3 are treated as redundant divisions.

Cables designated in each division will be run in raceways separated from cables designated in other divisions and from Non-Class 1E cables. Associated cables will be separated as if they were Class 1E pursuant to the Class 1E division associated with these cables.

Each division of Class 1E equipment of Divisions 1, 2 and 3 are located in separate rooms which are separated by a minimum of 3 hours rated fire barriers.

F. <u>Separation Criteria between Class 1E and Non-Class 1E and Associated Circuits</u>

1. <u>Separation of Cables Within Safety-Related Panels</u>

Within safety-related control boards and panels the separation between wiring of redundant divisions or of non-Class 1E wiring from Class 1E and associated Class 1E wiring will comply with at least one of the following:

I) A minimum separation distance of 6 inches vertical and horizontal will be maintained where the control board or panel materials are flame retardant.

II) An analysis will be performed to determine the minimum separation distance. The analysis will be based on tests performed to determine the flame retardant characteristics of the wiring, wiring materials, equipment and other material internal to the control board or panel.

III) Barriers will be installed in the event the above separation distances are not maintained.

Within safety-related control boards and panels, non-Class 1E wiring is not harnessed with Class 1E or associated Class 1E wiring. Associated Class 1E wiring is harnessed with Class 1E wiring of the same division.

2. <u>Separation of Class 1E and Non-Class 1E Cables</u>

All Class 1E and non-Class 1E cables will be routed in raceways consisting of cable trays and conduits. Each raceway will contain cable(s) of one Class 1E safety division or a non-class 1E system only. For the purpose of cable and raceway, the plant areas have been divided into six (6) separation zones as described in Section 8.3.1.4.

3. <u>Separation Between Cable Trays and Conduits of Another Division</u>

A Class 1E conduit will contain circuits of only one load division. In non-hazard zones exposed Class 1E conduits are separated from trays of another division as described in Section 8.3.1.4E. In all other separation zones the Class 1E conduits are not routed with trays of another division.

4. <u>Criteria for the Separation of Third Division</u>

The Class 1E electrical distribution system consists of three Class 1E divisions (Division 1, 2 and 3). Each of these divisions is designed to have physical and electrical independence from the other two divisions as described elsewhere in this secrion. Each of these divisions is provided with an onsite (standby) diesel generator and has the capability to shutdown the plant safely. However, from the consideration of connected loads, Class 1E

Divisions 1 and 2 provide power to redundant load groups and as such are described as redundant divisions in Sections 8.1.2 and 8.3.1.1. Class 1E Division 3 provides power to heat removal system of Loop 3 and to important non-Class 1E loads through an isolation subsystem. Class 1E Division 3 as stated above has the capability to shutdown the plant safely; however, since all the loads powered from this division are not similar or identical to those powered by Division 1 or 2, this division has not been identified as redundant to Division 1 or 2.

5. Criteria for Separation Between Associated Cables and Non-Class 1E Cables

The associated circuits as defined in paragraph 4.5 of IEEE Standard 384-1974 will be considered as Class 1E cables for the purpose of their routing and installation. The separation criteria between associated cables and non-Class 1E cables is the same as described in item 2 above for the separation between Class 1E and non-Class 1E cables. These cables, once identified as associated with a safety division, will be routed and installed in a raceway of that division. Each associated cable will be uniquely identified as described in Section 8.3.1.5.

6. Separation Criteria Before and After an Isolation Device

The cables before an isolation device are Class 1E circuits and are routed in Class 1E circuits and are routed in Class 1E raceway system in accordance with criteria described in item 2 above for physical separation of Class 1E cables. The cables after the isolation device are considered non-Class 1E cables and are routed in non-Class 1E raceway system.

The minimum separation maintained between cables of each division varies according to cable location with respect to potential hazards. The design intent is to provide separation greater than the minimum listed where consistent with a practical plant layout. Six general classifications of hazard zones or areas are defined for electrical separation consideration:

I. Non-Hazard Zones

Areas in which the only potential hazard is a fire of an electrical nature.

II. Fire Hazard Zones

Areas in which a potential fire hazard could exist as a consequence of the credible accumulation of a significant quantity of fixed or transient combustible materials as defined in PSAR Section 9.13.1.

III. Equipment Hazard Zone (Pipe Break Hazard Zone)

Areas in which a potential hazard could exist as a consequence of postulated pipe break events in high energy lines.

IV. Cable Spreading Rooms

Areas just above and below the main control room where control and instrumentation cables converge prior to entering the control room.

V. Containment Electrical Penetration Areas

The areas and assemblies that allow cable passage through the Containment Building pressure boundary.

VI. Control Room

Continuously manned utilized by plant operators to monitor and control the plant.

Non-Hazard Zones

Redundant cables entering panels, cabinets or other equipment enter through separate openings.

In Non-Hazard Zones, no minimum vertical or horizontal physical separation is provided between conduits of the same division beyond that required for construction, installation or access clearances between conduits and/or metal enclosed ducts.

In Non-Hazard Zones, exposed conduits of different Class 1E divisions are routed as far apart as possible, preferably on opposite sides of the walls. Parallel routing of conduits of different divisions is avoided. If the design makes it unavoidable a minimum of one (1) inch spatial separation is provided between conduits of different Class 1E divisions as shown in Figure 8.3-6. When the safety related conduit cross or run parallel to another safety related tray the minimum horizontal and vertical clearance is the same as provided for cable trays of different Class 1E divisions. If this clearance is unobtainable, a barrier is provided between the safety-related conduits and cable trays of other Class 1E divisions as shown in Figure 8.3-6.

In Non-Hazard Zones, a minimum horizontal clear space of three feet is maintained between cable trays of different divisions as shown in Figure 8.3-6. If a horizontal clearance of less than three feet is unavoidable, a fire barrier is provided between the divisions as shown in Figure 8.3-6.

Vertical stacking of cable trays of different divisions is avoided wherever possible. Where cable trays of different divisions are stacked vertically, a minimum clear space of five feet is provided between the divisions as shown in Figure 8.3-6. If a vertical clearance of less than five feet is unavoidable, a fire barrier is provided between the divisions as shown in Figure 8.3-6.

Fire Hazard Zones

In fire hazard zones, Class 1E conduits, trays, wireways or raceways of only one safety division are routed. This division is suitably protected by fire barriers and fire protections systems to mitigate the effects of fire in this zone on the safety function of the other safety groups.

Equipment Hazard Zone (Pipe Break Hazard Zone)

To the extent practical, Class 1E cables are routed in areas remote from high energy piping or areas of potential sodium fires; if unavoidable, the following precautions are taken:

a) CRBRP has three (3) Class 1E Divisions with complete physical separation between divisions. Any damage to cable trays caused by pipe whip missles, jet impingement, or environmental effect will be limited to the same safety division to which the pipe belongs, and the two other divisions capable of safety shutting down the plant will remain unaffected.

   Additional protection will be provided against any single Class 1E Division cable tray damage due to high energy pipe whip missiles by restraint of high energy pipe lines in the vicinity of Class 1E raceways. The design of restraints and/or barriers will be determined by analysis to meet BTP APCSB 3-1.

b) Redundant Class 1E circuits are routed or protected such that a postulated event in one system and division cannot preclude the operation of the other redundant system or division.

c) In all areas of the plant, the separation between redundant Class 1E cable raceways takes into consideration the presence of rotating equipment, monorails, equipment removal paths and dropped equipment such that failure of rotating equipment will not cause failure of more than one safety division and any dropped equipment will not cause failure of any safety-related raceways.

d) In general, Class 1E electrical distribution equipment (e.g., switchgear, motor control centers, etc.) is not located in areas where high energy piping or other similar hazards are located.

action. Separation of Class 1E circuits is maintained through penetrations. No Class 1E cables share penetrations with Non-Class 1E systems, other than associated Class 1E cable systems.

Control Room

Cables in the Control Room are kept to the minimum necessary for operation of the Control Room. All cables entering the Control Room terminate there. Cables are not installed in culverts or floor trenches.

Cables are not routed in a concealed ceiling or under floor spaces unless installed in a solid enclosed steel raceway.

Separation of Non-Class 1E Cables (Non-Safety-Related)

The separation design description for Non-Class 1E circuitry from Class 1E and associated circuits given below incorporates the requirements of IEEE Standard 384-1974 and NRC Regulatory Guide 1.75.

The trays carrying Non-Class 1E circuits are separated form the trays carrying Class 1E and associated circuits by a minimum horizontal clear space of three (3) feet and a minimum vertical clear space of five (5) feet between the trays. If a horizontal clearance of less than three (3) feet is unavoidable, a fire barrier is provided between the safety and non-safety related trays.

Vertical stacking of safety and non-safety related trays is avoided wherever possible. Where safety and non-safety related cable trays are stacked vertically and a vertical clearance of less than five (5) feet is unavoidable, a fire barrier is provided between non-safety and safety related trays.

In Cable Spreading Rooms a minimum clear separtion on one (1) foot horizontal and three (3) feet vertical is maintained between trays carrying Non-class 1E cables and trays carrying Class 1E and associated cables. If the minimum horizontal or vertical separation does not exist, a fire barrier is provided.

Non-Class 1E and Class 1E exposed conduits are routed as far as possible, preferably on opposite sides of the walls. Parallel routing of safety related and non-safety related conduits is avoided. If the design makes it unavoidable a minimum of one (1) inch spatial separation is provided between non-safety related and safety related conduits.

Separation Between Associated Cables and Non-Class 1E Cables

The associated circuits, as defined in paragraph 4.5 of the IEEE Std. 384-1974, which become associated with Class 1E cabling remain with the Class 1E cables of the same division, or are separated in accordance with the above given requirements for physical separation of Class 1E cables. The associated cables are uniquely identified in accordance with Section 8.3.1.5.

Separation Criteria Before and After an Isolation Device

The cables before an isolation device are Class 1E circuits and are routed in Class 1E raceway system in accordance with criteria given above for physical separation of Class 1E cables. The cables after the isolation device are non-Class 1E cables and are routed in non-Class 1E raceway system in accordance with criteria given above for separation of Class 1E and non-Class 1E cables.

Plant Protection System (PPS) Separation

The PPS will meet the separation requirements of IEEE Std. 384-1974 and Regulatory Guide 1.75 and the following:

a) All PPS wiring external to control panels is run in conduit, with wiring for redundant channels run in spearate conduits. Only PPS wiring is included in these conduits. Primary shutdown system wiring is not run in the same conduit as the secondary shutdown system wiring.

b) Wiring for each Primary PPS instrument channel (R1A, R1B, R1C) is routed in separate conduits.

c) Wiring for each Secondary PPS instrument channel (S2A, S2B, S2C) is routed in separate conduits.

d) There are dedicated containment penetrations for each of the three Primary PPS instrument channels and each of the three Secondary PPS instrument channels which pass through containment. All requirements for separation of PPS wiring in raceways are utilized for separation of PPS wiring through containment penetrations.

e) All wiring for the three Containment Isolation System instrument channels is routed exclusively with the three Primary PPS instrument channels, or exclusively with the Secondary PPS instrument channels or through three independent conduits.

f) The Primary PPS Logic Train Actuation wiring is routed through at least three separate conduits from three separate Primary PPS Logic Train Panels to the Primary PPS Scram Breakers. One conduit contains wiring from only one Primary PPS logic train.

g) The Secondary PPS Logic Train Actuation wiring is routed through at least three separate conduits from the Secondary PPS Logic Panels to the Secondary Control Rod Solenoid Valve Actuation wiring in the Head Access Area.

h) Containment Isolation System (CIS Logic Train Actuation wiring is routed through two independent conduits. One conduit contains wiring from only one CIS Logic Train. No intermixing of CIS Logic trains within a conduit is permitted. CIS Logic Train 1 wiring is routed from CIS Logic Panel 1 to CIS Breaker 1 in the Intermediate Building. CIS Logic Trian 2 is routed from CIS Logic Panel 2 to CIS Breaker 2 in the Intermediate Building.

i) The wiring from a PPS buffered output which is used for a non-PPS purpose may be included in a PPS rack. The PPS wiring is separated from the non-PPS wiring. The amount of separation is defined on an individual case basis; however, it is designed to meet the requirements of IEEE Std. 384-1974 and Regulatory Guide 1.75.

j) Containment isolation valve actuation wiring (for either manually or automatically initiated actuation) to the inside containment and the outside containment isolation valves are separated as Division 1 and Division 2 cabling, respectively.

k) Rigid, metallic, completely enclosed and unvented raceways are considered acceptable for any of the above applications as they are equivalent to rigid metal conduit, as defined in IEEE Std. 100 and NFPA 70.

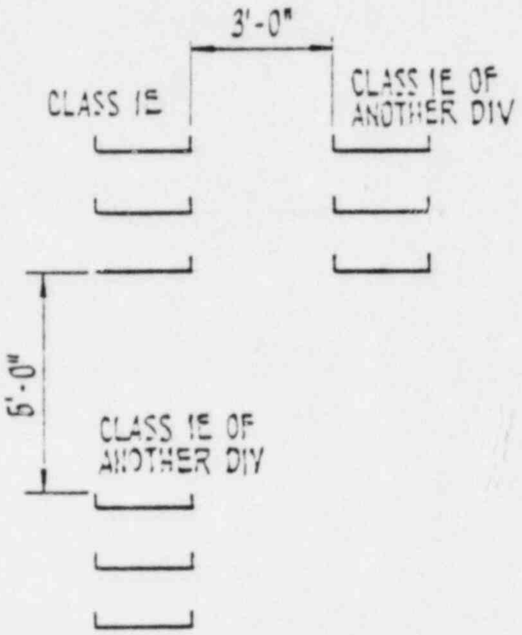
l) The physical separation between PPS conduits, containment penetrations, or panels is in accordance with IEEE Std. 384-1974 and Regulatory Guide 1.75 to provide assurance that a credible single event cannot simultaneously degrade redundant protection channels or shutdown systems.

m) The Primary Steam Generator Auxiliary Heat Removal System (SGAHRS) channels and logic outputs are treated and separated as Primary PPS signals. The primary SGAHRS logic output is kept separated from the Secondary SGAHRS logic output channels. The Secondary SGAHRS channels and logic outputs are treated and separated as Secondary PPS signals. The Secondary SGAHRS logic output is kept separated from Primary PPS, CIS and non-PPS outputs. Redundant SGAHRS logic train outputs are separated form each other. The manual trip and reset inputs to each SGAHRS divisional latch logic are routed and separated as redundant PPS signals separated form the automatic SGAHRS logic outputs and all other PPS and non-PPS channels.

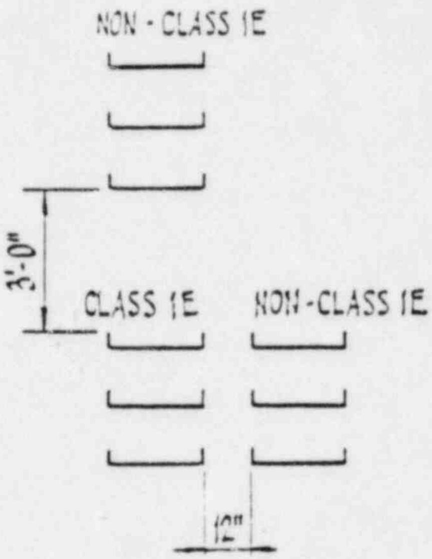
TABLE 8.3-2c

CLASS 1E DIVISION 3 125V DC LOAD LIST

LOAD DESCRIPTION	NORMAL (1) MAX. CONT. LOAD-AMPS	EMERGENCY (2) AMPS	EMERGENCY (2) DURATION	REMARKS
SGAHRS - STEAM TURBINE GOVERNOR CONTROL (1 KW)	4	4	0-120 MIN.	
120 VAC BUS 12NIE008C AS INVERTER LOAD	208	227 182 165	FIRST 1 MIN. NEXT 14 MIN. NEXT 105 MIN.	(NOTE 3)
D.G. CONTROL PANELS LOCAL AND MCR (0.7KW)	11.2	11.2	0-120 MIN.	
D.G. FIELD FLASHING (7.5KW)	-	60	FIRST 1 MIN.	
4.16kV SWITCHGEAR AND 480V USS BREAKER LOAD	4	38 4	FIRST 1 MIN. NEXT 119 MIN.	
TOTAL IN AMPS	227	340 204 184	FIRST 1 MIN. NEXT 14 MIN. NEXT 105 MIN.	



NON-HAZARD ZONES



CABLE SPREADING RM

NOTE
THIS SEPARATION APPLIES FOR ALL DIVISIONS CLASS 1E CABLE TRAYS FROM EACH OTHER AND FROM NON-CLASS 1E CABLE TRAYS.

FIGURE 8.3-6 CABLE TRAY SEPARATION

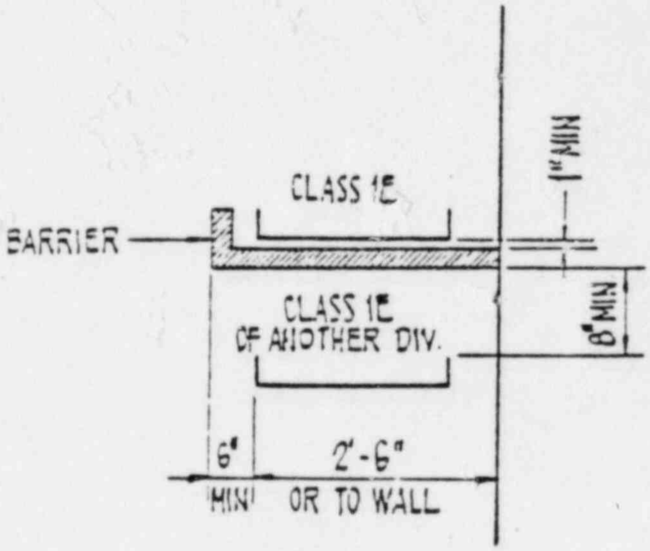


FIGURE 8.3-6 ARRANGEMENT WHEN VERTICAL SPATIAL SEPARATION IS NOT MAINTAINED NON-HAZARD ZONES.

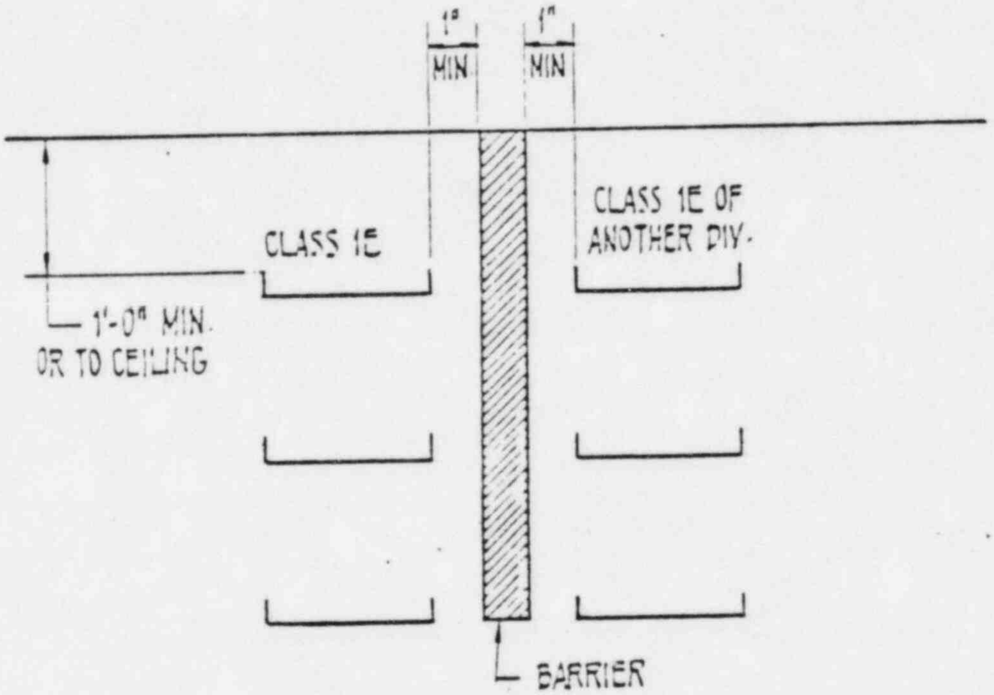
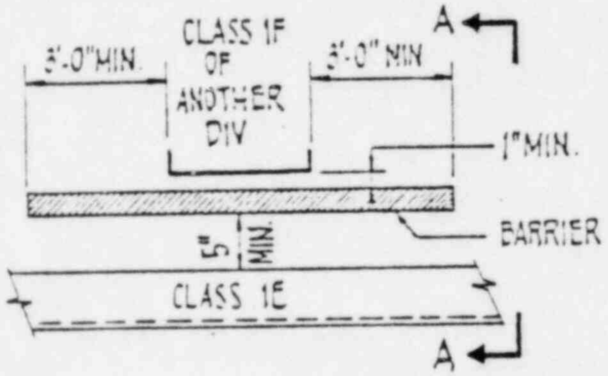


FIGURE 8.3-6 ARRANGEMENT WHEN HORIZONTAL SPATIAL SEPARATION IS NOT MAINTAINED NON-HAZARD ZONES.



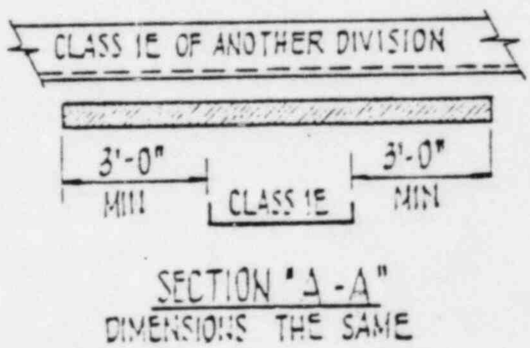


FIGURE 8.3-6 ARRANGEMENT FOR CLASS 1E CABLE TRAY CROSSINGS
WHERE VERTICAL SEPARATION IS NOT MAINTAINED
NON-HAZARD ZONES.

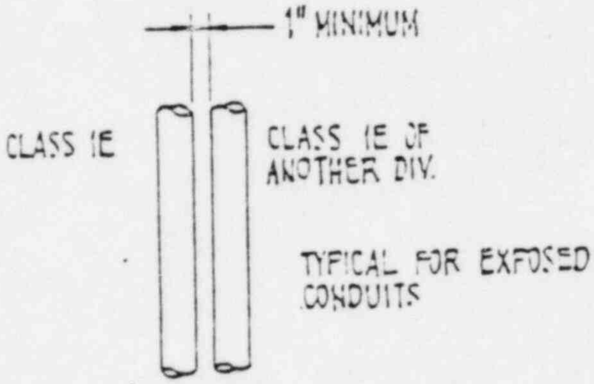
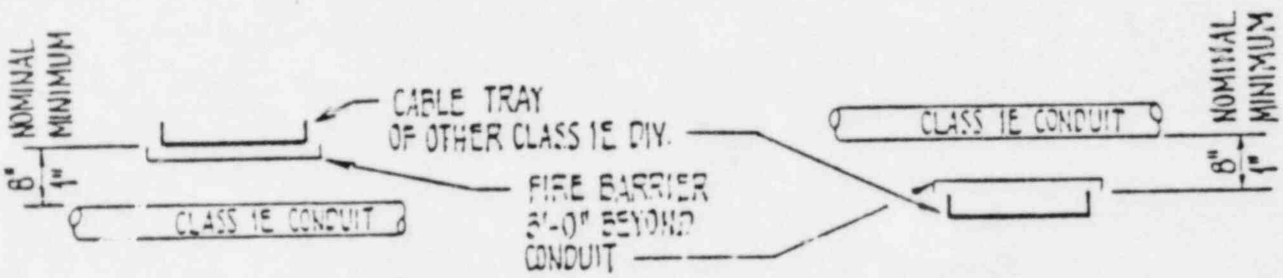


FIGURE 8.3-6 CONDUIT SPATIAL SEPARATION NON - HAZARD ZONES



SAFETY CONDUITS CROSSING
OTHER CLASS 1E DIVISION
CABLE TRAYS FROM BELOW
NON-HAZARD ZONES

SAFETY CONDUITS CROSSING
OTHER CLASS 1E DIVISION
CABLE TRAYS FROM ABOVE.
NON-HAZARD ZONES

FIGURE 8.3-6

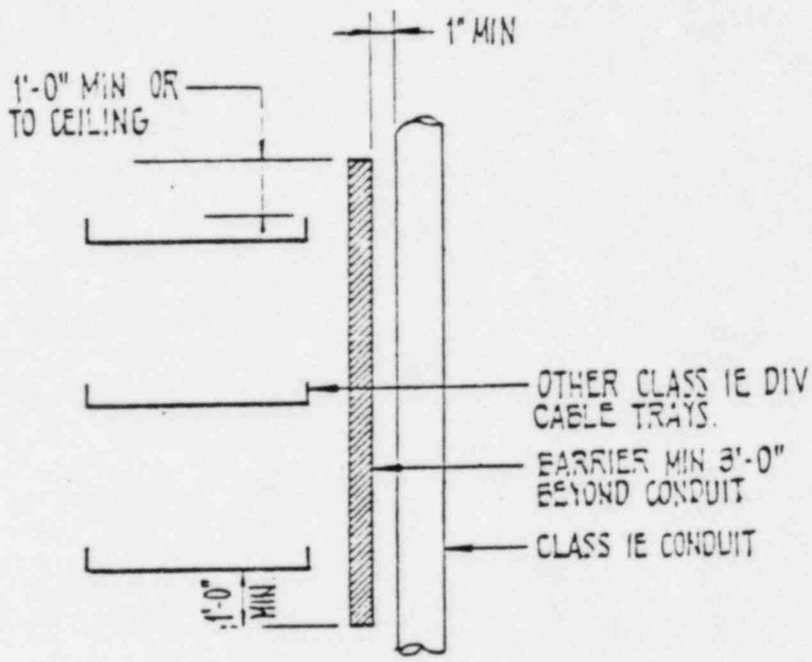


FIGURE 8.3-6 ARRANGEMENT FOR VERTICAL SAFETY CONDUITS CROSSING OTHER CLASS 1E DIVISION CABLE TRAYS NON-HAZARD ZONES.

As discussed in Section 15.5.2.4, an unlikely accident releasing radioactive cover gas from the reactor leads to a site boundary dose well below the guideline value of 10CFR20.

9.1.4.7 Safety Aspects of the Reactor Fuel Transfer Port Adaptor and Fuel Transport Port Cooling Inserts

The reactor fuel transfer port adaptor (see Figure 9.1-19) is positioned on top of the reactor fuel transfer port and extends from the reactor head to the bottom of the floor valve which is located at the elevation of the RCB operating floor. It serves as an extension of the reactor cover gas containment and provides shielding when irradiated core assemblies are removed from the reactor. The adaptor also guides cooling air from an air blower to a cooling insert inside and below the adaptor.

The function of the cooling inserts, located around the EVST and FHC fuel transfer ports as well as the reactor port (see Figure 9.1-19), is to remove decay heat should an irradiated core assembly in a sodium-filled CCP become immobilized in a fuel transfer port during transfer between the reactor vessel, EVST or FHC and the EVTM.

9.1.4.7.1 Design Basis

The design bases for shielding and radioactive release of the fuel transfer port adaptor are the same as for the EVTM (see 9.1.4.3.1). The reactor, EVST, and FHC fuel transfer port cooling inserts have the capacity to remove decay heat from 20 KW irradiated core assemblies in sodium-filled CCP's to prevent exceeding the 1500°F spent fuel cladding temperature limit specified for unlikely or extremely unlikely events (Table 9.1-2).

9.1.4.7.2 Design Description

The reactor fuel transfer port adaptor extends from the upper surface of the fuel transfer port in the reactor head to the operating floor, see Figure 9.1-19. The upper surface of the reactor fuel transfer port adaptor consists of a flange which is bolted to the floor valve and provides the sealing surface for the double seals on the lower surface of the floor valve. Shielding is provided by a thick, annular lead cylinder surrounding the adaptor cover gas containment tube over its entire length to limit the dose rate at the shield surface to less than the limits given in Sections 12.1.1 and 12.1.2. The lower part of the adaptor is bolted to the reactor head during refueling only.

The reactor fuel transfer port cooling insert extends from the top flange of the adaptor to the fuel transfer port nozzle. The cooling insert uses a cold wall cooling concept, similar to the EVTM. The CCP containing a spent fuel assembly is cooled by thermal radiation and conduction across the argon gas gap to the cold wall which forms the confinement barrier for the reactor cover gas. Ambient air is blown down the outside annulus of the cooling insert, and discharges into the reactor head access area. Air flow from the blower is adequate to limit the cladding temperature of a 20 KW fuel assembly to less than 1500°F.

This system is an alternate means of data and voice communications between CRBRP and other TVA generation and transmission facilities and TVA Control Centers.

9.11.2.5 Maintenance Communications Jacking System (MCJ)

The system consists of sound powered headset/microphones and jack stations. Each headset/microphone contains a transmitter/receiver and need be only plugged into a jack station for operation.

The purpose of this system is to facilitate the testing and calibration of equipment instrumentation and to provide for a fixed communications system for effective response to an emergency. The MCJ system may also be used for the support of remote plant shutdown. Jack stations are arranged and located where required throughout the plant. The CRBRP MCJ System consists of six loops distributed throughout the plant. The Reactor Containment Building, the Steam Generator Building, Diesel Generator Building, Control Building, and Reactor Service Building have one loop each. The BOP buildings and areas will be covered by one additional loop. Each of the loops consists of three circuits and can accommodate three concurrent conversations. All jack station loops are connected to the Control Room patch panel where connections can be made to permit the six building loops to communicate with one another. All Nuclear Island jack station loops are also connected to a patch panel located on the remote plant shutdown panel. The user wears a headset/microphone assembly, plugs the cable into either a jack station or a panel rock mounted jack and thereby has hands-free communications.

9.11.2.6 VHF Radio Station

The VHF Radio Station is provided to transmit emergency voice communications between the CRBRP Control Room and the TVA Power Production Emergency staff operations office. The CRBRP VHF Radio station transmits at 163.175 megahertz and receives at 170.075 megahertz. The radio will be frequency checked in accordance with FCC regulations and be given frequent operating checks.

9.11.2.7 Portable Radio System

This system consists of a number of selective all portable radios (walkie-talkies) with paper and voice actuated microphone that transmit a low power signal to the base station and its comparator. The comparator selects the strongest signal received from a satellite receiver (voting system) and then wire transmits the amplified signal to the base station which in turn retransmits the amplified signal.

The portable units have the capability to communicate among themselves on an alternate frequency.

Fixed repeaters which permit use of portable radio communication untis are protected from exposure to fire damage by fire rated cabinets.

9.12 LIGHTING SYSTEMS

The Clinch River Breeder Reactor Plant is provided with normal standby and emergency lighting systems using fluorescent, high intensity discharge (HID), and incandescent luminaires. The Normal Lighting System provides illumination under all normal plant operating conditions with power available from the Plant, Preferred, or Reserve power supply systems. The Standby Lighting System provides adequate illumination under all normal and emergency plant operating conditions with power available from the Plant, Preferred, Reserve or Class 1E Onsite AC Power System. Under an emergency condition, resulting in loss of all offsite power sources, the Standby Lighting System will be powered from the Class 1E onsite AC power system (Emergency Diesel Generators). Both Normal and Standby Lighting Systems utilize high pressure sodium and fluorescent light fixtures. The Emergency Lighting System provides adequate illumination at points of egress, in the Control Room, at remote shutdown locations and at all locations required for access to safety-related equipment. The Emergency Lighting System utilizes self-contained individual eight(8) hour rated battery powered units with sealed beam lamps and self contained eight(8) hour rated battery powered exit signs.

All lighting fixtures in Nuclear Island buildings are seismically qualified to maintain structural integrity in accordance with IEEE Std. 344-1974. The lighting fixtures and raceways are supported to meet Seismic Category I requirements as described in Sections 3.7.2 and 3.7.3 of the PSAR.

The Standby Lighting System is classified as 1E up to and including the lighting panel. The circuits to Standby Lighting System light fixtures are also 1E and are routed to maintain required separation from Non-Class 1E or Class 1E cables of other divisions as described in Section 8.3.1.2. However, the lighting fixtures are Non-Class 1E, and as such, the circuits from the lighting panels to the lighting fixtures of the standby lighting system are considered associated 1E.

9.12.1 Normal Lighting System

This system provides plant lighting under all normal plant operating conditions with power available from the Plant, Preferred, or Reserve Power Supply Systems by connection to the non-Class 1E AC Power Distribution System. The Normal Lighting System is AC powered at 120/208VAC or 277/480VAC, 3-phase, 4-wire.

In general, high pressure sodium luminaries are used in high ceiling areas and the fluorescent luminaries in all other areas including the main control room.

The normal lighting system will be designed for a high degree of availability. A given area or cell of the plant will be illuminated by luminaries connected to at least two different power circuits, where practical, thus preventing darkness due to the outage of one power circuit. In inaccessible cells, where remote viewing devices are used, spare luminaries, normally off, will be provided to allow for lamp blowouts throughout the design life of the plant. Accessible luminaries will be located to facilitate ease of maintenance and relamping operations.

In general, wiring of all plant lighting systems will be designed and installed in accordance with the applicable sections of the National Electric Code.

9.12.1.1 Design Bases

The plant lighting systems shall be designed to provide illumination of plant facilities to meet the following design objectives:

a. Provide illumination of plant components, facilities, and control locations to the level recommended by the IES Handbook.

b. Provide illumination of access ways and means of egress for the safety of plant personnel in accordance with "Life Safety Code" NFPA 101, Sections 5-8 thru 5-10, and the Standard Building Code, Sections 1123 and 1124.

c. Provide a lighting system which is efficient, reliable, and maintainable, within practical limits.

Luminaires for a particular area of the plant shall be selected based on the following criteria:

a. In large, high ceiling areas (i.e., mounting height greater than 10 feet) high intensity discharge (HID) luminaires will be used.

b. Outdoor facilities and general site areas shall be illuminated with HID luminaires.

c. In areas where HID luminaires cannot be used, fluorescent or incandescent luminaires will be used. Choice of incandescent or fluorescent will be based on economic evaluation of capital cost, maintenance cost, reliability, and efficiency.

9.12.2 Standby Lighting System

This system provides adequate illumination under all normal and emergency plant operating conditions with power available from the Plant, Preferred, Reserve, or Standby Onsite AC Power System by connection to the Class 1E AC Power Distribution System. The Standby Lighting System is AC powered at 120/208VAC or 277/480VAC, 3-phase, 4-wire. The Standby Lighting System contributes to the general illumination of the plant.

9.12.2.1 Design Bases

a. The standby lighting system will illuminate those areas of the plant where illumination is required for operation or maintenance of safety-related equipment and provides an illumination of 20 foot candles.

b. The standby lighting system will be supplied by the Class 1E Standby Onsite AC power supplies, Class 1E diesel generators, under loss of all offsite power sources.

c. Luminaires will in general, be interchangeable with luminaires utilized for the normal plant lighting system.

d. The standby lighting system will be designed to be available upon the complete loss of Plant, Preferred and Reserve Power by connection to the Class 1E diesel generator during the first load block.

e. The standby lighting system will be separated into three independent lighting divisions, each division supplied by one of the Class 1E AC power supplies. Each division will provide illumination to the equipment of the same division areas.

9.12.3 Emergency Lighting System

This sytem provides illumination at points of plant egress, Control Room and remote shutdown areas during loss of plant, preferred and reserve AC power. The Emergency Lighting System operates only during loss of normal or standby lighting. The Emergency Lighting System provides one foot candle illumination, per NFPA 101, Section 5-8, and IES recommendation, in all egress routes and where access is required for fire fighting in areas containing safety-related equipment. The emergency lighting system utilizes self-contained individual eight (8) hour rated battery powered units with sealed beam lamps and self-contained eight (8) hour rated battery powered exit signs for a period of 8 hours, per Branch Technical Position CMEB 9.5-1, paragraph 5g. In the Control Room, fluorescent lighting provided at all operator work stations will be powered from the plant Class 1E uninterruptible power supplies (UPS) system and will provide an illumination of minimum 10 foot candles, in accordance with the requirements of Section 6.1.5.4 of NUREG 0700, during loss of all offsite power.

9.12.3.1 Design Bases

a. The emergency lighting system will be designed to meet the requirements of the "Life Safety Code", NFPA 101, and IES Handbook for Illumination and identification of means of egress in all plant areas. The system shall also provide illumination of panels at remote shutdown locations.

b. The emergency lighting system will illuminate the points of egress including the intersections of hallways, stairways, and corridors, to a minimum required level.

c. The emergency lighting system will be capable of illuminating the points of egress and remote shutdown areas for a period of 8 hours to meet the intent of NRC Branch Technical Position APCSB 9.5-1. The equipment utilized to supply emergency lighting will be self-contained, individual eight hour battery units with sealed beam lamps. Areas provided with standby lighting will have the emergency lighting units float charged from the standby lighting panels such that the emergency lighting units only provide illumination during the time necessary for energization of standby lighting (diesel generator start) or complete loss of standby onsite AC or loss of power to the standby lighting panel.

d. The emergency lighting system will provide self contained, battery powered, portable hand lights which will be used in unanticipated emergency situations requiring supplementary lighting. These units shall be fully charged and conveniently available to plant personnel when needed. These portable hand lights will only be used in case of a bonafide plant emergency. Portable hand lights are provided to meet the intent of NRC Branch Technical Position APCSB 9.5, Appendix A, B.5(a). Emergency lighting in the Control Room will utilize fluorescent fixtures powered from the plant Class 1E uninterruptible power supply (UPS).

e. Exit signs identifying points of egress will be completely self contained (battery, charger, and components within exit sign housing) meeting the requirements of NFPA 101, Section 5.

9.12.4 Design Evaluation

The Standby Lighting System provided for the Control Room Drive Mechanism Rooms, Switchgear Rooms and other remote shutdown areas is interrupted for ten seconds if both the preferred and the reserve AC power supplies fail. It is energized automatically upon initial loading of the diesel generator. Where practical, the standby lighting system will be separated into three lighting divisions, each division supplied by one of the Class 1E power supplies. Each division shall provide illumination of the equipment of the same division areas where applicable. During the time interval when the diesel generators are starting after the loss of offsite power or when all AC power is lost, the emergency lighting system provides essential illumination. The emergency lighting provided in the Control Room will be powered from the plant Class 1E uninterruptible power supply (UPS), which will remain operational under all modes of plant operation including emergency conditions. This system will provide an illumination of minimum 10 foot candles during loss of offsite power per NUREG 0700 Section 6.1.5.4.

9.13 PLANT FIRE PROTECTION SYSTEM

9.13.1 Non-Sodium Fire Protection System

The Non-Sodium Fire Protection System (NSFPS) provides the plant with equipment, piping, valves, detectors, instrumentation and controls to prevent or mitigate the consequences of a non-sodium fire. Table 9.13-1 shows the areas covered by the Non-Sodium Fire Protection System. Fire Hazard Zones are areas in which a potential fire hazard could exist as a consequence of the credible accumulation of a significant quantity of fixed or transient combustible material.

9.13.1.1 Design Bases

a. Fires that could indirectly or directly affect Seismic Category I safety-related structures, systems and components are identified in Table 9.13-2. Potential fire hazards which provide the base for the design of the fire protection system in areas containing engineered safety-related structures, systems or components, are self-contained lube oil systems, diesel generator fuel oil system, electrical cable insulation, and activated carbon filters. The intensities of the maximum fires involving the above combustible materials are listed in Table 9.13-2 and described below.

   These maximum fires, together with lesser intensity design-basis fires, have served, via a preliminary fire hazards analysis, as the bases for the selection of fire protection measures taken will be confirmed in conjunction with a more detailed fire hazards analysis which will be provided in the PSAR.

   Lubricating Oil

   The maximum fire involving lubricating oil would develop in the turbine lubricating oil equipment located in the Turbine Generator Building and would have an intensity of 20,000 BTU/lb. Fire from this source does not involve safety-related areas and safe shutdown of the plant will not be jeopardized.

   Diesel Generator Fuel Oil

   The largest potential source of fire from fuel oil is in the vicinity of the standby diesel generator fuel oil storage tanks, located below grade adjacent to the Diesel Generator Building. As these tanks are located below grade, the chance of an accident is reduced. Physical separation provided between the two tanks limits

9.14 DIESEL GENERATOR AUXILIARY SYSTEM

9.14.1 Diesel Generator Fuel Oil Storage and Transfer System

9.14.1.1 Design Bases

The emergency diesel engine fuel oil storage and transfer system (EDEFSS) provides fuel oil storage and transfer capability for the operation of the three (3) emergency diesel generator units. The EDEFSS is comprised of the fuel oil storage tanks, the fuel oil transfer pumps, day tanks, the interconnected piping up to the diesel engine interconnection and the instrumentation required for the operation, monitoring and testing of the system.

Each diesel generator shall be provided with a fully independent fuel oil storage and transfer system. Interconnections shall not be provided between the systems. The independence of these systems shall be maintained by the independence of the electrical power supply to the system components. The active components for each fuel oil supply train shall have adequate redundancy to prevent failure of the system due to a single active component failure.

9.14.1.1.1 Seismic and Quality Group Classification

a) The entire EDEFSS including all components and piping shall be designed to Seismic Category I requirements.

b) The Quality Group class for the EDEFSS system shall be Quality Group C, except for the engine and all casted diesel vendor supplied components, including the fuel oil filters and the fuel oil storage tank. The design of the engine and all casted diesel vendor supplied components shall meet the requirements of ANSI N195 and B31.1 and the Diesel Engine Manufacturers Association (DEMA) Standards. (The interfaces between the the engine-mounted components and the external part of the system shall be clearly identified on the design drawings.) In lieu of the Quality Group C (ASME Section III, Class 3) design for the fuel oil storage tanks, concrete tanks with steel liners designed in accordance with the ASME Section VIII requirements is acceptable.

c) The design, construction and maintenance of the EDEFSS shall be in accordance with the requirements of Regulatory Guide 1.28 and ANSI N45.2-1977.

9.14.1.1.2 General Arrangements

a) The location of the Diesel Generator Building and the part of the fuel oil supply system located outside of the Diesel Generator Building shall assure the independence of the three (3) EDEFSS supply trains. The fire separation between the EDEFSS trains shall be maintained in accordance with BTP CMEB 9.5-1. The Diesel Generator Building and the associated equipment located outside of the building shall be placed outside of the turbine missile trajectory range.

b) The components of the EDEFSS shall be located to provide adequate space for inspection, cleaning, maintenance and repair of the system.

c) The day tanks to the emergency diesel generator shall be located in the Diesel Generator Building and separated from sources of fires or ignition in accordance with the requirements of BTP CMEB 9.5-1. The location of the day tanks shall be in accordance with the requirements of diesel engine manufacturers and it shall take into account the net positive suction head requirements of the fuel pumps to assure the automatic start of the diesel generator unit. If a booster pump is required for starting the diesel engine, a reliable power supply shall be provided to assure the oil supply during the engine start cycle or until the fuel oil pressure is established by the engine drive pump. A day tank overflow line shall be provided to the fuel oil storage tank for the return of the excess fuel oil delivered by the transfer pump. The piping from the fuel oil day tank to the diesel engine shall be protected from heat sources and ignition sources. The vent line from the fuel oil day tank shall be provided with flame arrestors.

9.14.1.1.3 Fuel Oil Supply

a) The capacity of the fuel oil storage tanks shall be established on the basis of the continuous seven (7) day operation of the diesel generators at their full loaded capacity. The method of calculation shall be in accordance with ANSI N195, Paragraph 5.4.

b) Procedures shall be established to assure fuel oil delivery to the site within 24 hours during emergency conditions and extremely unfavorable environmental conditions. These procedures shall consider the potential fuel oil suppliers within a 100 mile radius and shall take into consideration the expected delivery distances and road conditions for the establishment of the delivery time.

c) The design of the EDEFSS shall assure the maintenance of fuel oil quality and the prevention of the failure of the diesel engine due to oil degradation or contamination. Procedures shall be established (1) for the sampling and analysis of the newly delivered fuel oil, (2) for the periodic sampling of the onsite stored fuel oil, (3) for the monitoring and removal of the potential accumulated water from the storage tank, and (4) for the detection and prevention of organic material growth, i.e. algae, in the fuel oil storage tank. These procedures shall be developed in accordance with the requirements of Regulatory Guide 1.137 and ANSI N195.

The diesel fuel oil storage tank shall be equipped with flow distributors on the fill lines to minimize the turbulence of the sediment in the bottom of the storage tanks. The fill box for the diesel fuel oil storage tank shall be provided with water-tight seals to prevent entrance of water and other contaminants including micro-biological organisms. Additionally, procedures shall be established for the filling of the storage tanks to prevent entrance of any deleterious material as a consequence of adverse environmental conditions. This procedure shall specify the use of an inlet filter during fuel delivery.

d) The EDEFSS buried components shall be protected against internal and external corrosion. The coating system and cathodic system for the buried portion of the system shall be in accordance with ANSI N195 and Regulatory Guide 1.137 requirements.

9.14.1.1.4 <u>Protection from Natural Phenomena & Missiles</u>

a) The design of the EDEFSS system shall be Seismic Category I and the building housing the system shall also be Seismic Category I design. The location of the Diesel Generator Building and externally placed auxiliaries shall prevent failure of the system due to a potential failure of a non-Seismic Category I structure. The Diesel Generator Building and the storage tank and other external equipment shall be protected from tornados, tornado missiles and floods. The fill and vent point for the storage tanks shall be located higher than the potential maximum flood level. The tornado missile protection for the fuel oil storage tank and associated buried piping shall utilize either appropriate thickness of earth cover or concrete missile shielding or the combination of both.

b) The EDEFSS shall be protected from the consequences of moderate energy pipe line failures. High energy pipe lines, except the diesel engine exhaust pipe, shall be excluded from the Diesel Generator Building. Postulated piping failures shall be evaluated in accordance with BTP ASB 3-1 and the location shall be established in accordance with BTP MEB 3-1. The design of the piping systems shall utilize supports, restraints, spray shields and adequate floor drain system to prevent direct impingement of water on the diesel engine or electrical components and to prevent flooding of the Diesel Generator Building.

c) The design of the Diesel Generator Building and the EDEFSS system shall be in accordance with BTP CMEB 9.5-1 to minimize the potential and consequences of fires.

9.14.1.1.5 Testing, Surveillance and Qualification

a) The design of the EDEFSS shall include provisions for testing of the system to verify the parameters of operation. The design shall consider and select the location of instrumentation sensors and shall include status indication and alarm features. The sensors shall be accessible and designed to permit inspection and calibration in-place.

b) The EDEFSS shall be provided with surveillance, instrumentation to provide status indication and facilitate trouble identification and diagnosis.

c) The EDEFSS design shall provide for inservice inspection and testing in accordance with ASME Section XI requirements. The acceptable method of the inservice inspection requirements shall be in accordance with Regulatory Guide 1.137, Paragraph C.1.e and ANSI N195.

d) The minimum instrumentation for the EDEFSS shall include level indication and alarms for the fuel oil storage tanks and fuel oil day tanks, differential pressure indication for the fuel oil transfer pump, inlet filters, and temperature indication to assure that the "cloud point" requirements for the fuel oil are not violated.

9.14.1.1.6 Applicable Codes and Standards

1. Regulatory Guide 1.9, "Selection, Design and Qualification of Diesel-Generator Units As Standby (Onsite) Electric Power Systems At Nuclear Power Plants"

2. Regulatory Guide 1.115, "Protection Against Low-Trajectory Turbine Missiles"

3. Regulatory Guide 1.117, "Tornado Design Classification"

4. Regulatory Guide 1.137, "Diesel Generator Fuel Oil Systems"

5. ANSI Standard N195, "Fuel Oil Systems for Standby Diesel Generators", American National Standards Institute

6. Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment" (attached to SRP Section 3.6.1)

7. Branch Technical Position MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment" (attached to SRP Section 3.6.2)

8. Branch Technical Position CMEB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants" (attached to SRP Section 9.5.1)

9. Branch Technical Position ICSB-17 (PSB), "Diesel Generator Protective Trip Circuit Bypasses" (attached to SRP 8.3.2, Appendix 8A)

10. IEEE Standard 387 "IEEE Standard Criteria for Diesel Generator Units Applied As Standby Power Supplies for Nuclear Power Generating Stations"

11. Diesel Engine Manufacturers Association (DEMA) Standard

12. NUREG/CR-0660, "Enhancement of Onsite Emergency Diesel Generator Reliability"

9.14.1.2 System Description

The Diesel Generator Fuel Oil Storage and Transfer System for the three (3) diesel generator units is designed to provide independent storage and transfer capacity to supply No. 2 diesel fuel oil to each diesel generator unit operating at full load for a period of at least seven (7) days.

The fuel oil storage tanks are embedded in concrete in the yard adjacent to the Diesel Generator Building to provide adequate missile protection. The fuel oil day tank for each diesel engine has a capacity of 1,100 gallons. The Diesel Generator Building, diesel fuel lines, pumping systems, and tanks are designed to Seismic Category I requirements, and are designed to withstand the environmental conditions defined in Chapter 3.

The fuel oil system for each diesel unit is completely separate from other diesel units thus assuring that a failure in one (1) diesel unit will not affect other diesel units. To make the system more reliable, redundant transfer pumps for pumping diesel fuel from the storage tanks to the day tanks have been provided. Also, two (2) pumps are provided to pump from the day tank to the diesel engine, one (1) shaft driven and one (1) motor driven.

The design code requirements for the system are as follows:

a) Diesel Generator Fuel Oil Seven (7) Day Storage Tanks - Code for Unfired Pressure Vessels, ASME Section VIII, Division 1. These tanks are embedded in Seismic Category I concrete structures and serve essentially as liners.

b) Piping and Components from Fuel Oil Seven (7) Day Storage Tanks to Diesel Generator Units - Boiler and Pressure Vessel Code, ASME Section III, Class 3.

c) Diesel Generator Fuel Oil Day Tanks - Boiler and Pressure Vessel Code, ASME Section III, Class 3.

d) Diesel Engine and all casted diesel vendor supplied components including the fuel oil filters - ANSI N195, B31.1 and DEMA Standard.

The Division 1 and Division 2 Fuel Oil Systems each consist of two (2) fuel oil storage tanks, two (2) redundant transfer pumps, a day tank, two (2) fuel pumps and associated piping and controls. The Division 3 Fuel Oil System consists of one fuel oil storage tank, two (2) redundant transfer pumps, a day tank, two (2) fuel pumps and associated piping and controls.

For the Division 1 and 2 Fuel Oil System, each of the two transfer pumps are to be capable of pumping fuel oil from both storage tanks. Each storage tank is provided with independent level indication and an alarm will be provided if the fuel oil level in the tanks becomes unequalized.

A Seismic Category I truck fill connection for the storage tank has a locked fill box with a watertight gasket seal to prevent the entrance of water or other contaminates, including microbiological organisms. Connections and riser piping are provided for testing and for removal of condensate and sediment. The storage tank is lightly sloped toward the test riser. Test samples, water, and sediment will be removed with a portable pump. the pump suction will be inserted into the tank through the test riser. All fill and test connections are located above maximum flood elevation.

All inlet lines to the fuel oil storage tanks are provided with flow distributors to minimize the creation of turbulence in any sediment at the bottom of the tank.

Each fuel oil storage tank size is 35,000 gallons and the storage capacity for each diesel generator exceeds the requirements of ANS N195.

Level transmitters are provided on each fuel storage tank to furnish signals for the following functions:

a) Provide local fuel level indication.

b) Annunciate an alarm in the Main Control Room when the fuel level drops below a seven (7) day supply.

c) Annunciate an alarm in the Main Control Room on high level.

d) Permissive interlock for each of the two (2) transfer pumps to lock the pumps out if fuel level is below five (5) percent of tank gross volume (sedimentation space).

A 1/16 inch corrosion allowance is provided in the design wall thickness for the embedded fuel oil storage tanks. The interiors of the tanks are coated with Humble Oil Company's Rustban No. 357 or equal for added corrosion protection. The fuel oil piping and fittings within the Diesel Generator Building have more than ample corrosion allowance and have been designed per the codes noted above.

Two (2) electric motor driven fuel oil transfer pumps are provided for each engine to transfer fuel from the fuel storage tank to the day tank. Each of these pumps is independently capable of supplying adequate fuel to the day tank. Each pump is powered from a Class 1E power source. Its capacity is approximately four (4) times the engine full load consumption rate at adequate head to offset system friction loss. Motor horsepower is sufficient to drive the pump without overloading. The pumps are high lift, self-priming (with a foot valve on the tank suction riser), and the NPSH required will not exceed the NPSH available. Each transfer pump is provided with a separate duplex strainer equipped with high differential pressure indicating alarm switch. Each transfer pump is also provided with a discharge pressure gauge. The common discharge header is provided with local flow and temperature indicators.

Each day tank is located in the Seismic Category I Diesel Generator Building in a cell separate from the engine it serves. No ignition source exists in the day tank room. In accordance with the requirements of diesel engine manufac-turers, the tank elevation provides flooded suction at both fuel pumps, but is not located over 20 feet above the crankshaft centerline.

Two (2) sets of level switches are provided for each day tank. The level switches are arranged so that one(1) transfer pump will be the primary pump and the other a backup. A selector switch is provided on the engine control cabinet which will allow the operator to administratively select the primary transfer pump. In addition, these level switches provide both local and Main Control Room alarms to indicate high and low fuel oil level in the day tank.

From the day tank, fuel is supplied to the diesel injectors by a shaft driven pump. An electric motor-driven fuel pump, powered from a Class 1E power source, is provided as a backup for the engine driven fuel pump. Separate suction and discharge lines serve each pump. Each pump has a suction duplex strainer with differential pressure and outlet pressure indicators and discharges through a duplex filter located downstream from the discharge junction. Each filter is provided with differential pressure indication, outlet low pressure switches, and inlet and outlet pressure gauges. Fuel oil pressure is monitored just upstream of engine injectors. Low fuel oil pressure is indicated on the Diesel Engine Control Panel.

Fuel delivery data, sources, and the distances to be traveled to the site will be provided in the FSAR.

High quality and reliable diesel fuel will be assured by purchasing only No. 2 diesel fuel oil which complies with Federal Specification VV-F-800C or equivalent.

The diesel generator has a minimum design temperature of 40°F (for all postulated environmental conditions) thus assuring that fuel oil temperature remains well above cloud point. No direct method of indicating, controlling, or monitoring fuel oil temperature is provided, other than temprature indication for flow measurement purposes.

Fuel oil outline specifications are as follows:

	Maximum	Minimum
Viscosity, S.S.U. at 100°F	45	32
*Gravity, Deg. A.P.I.	38	26
Sulphur, %	1.05	-
Sulphur, Corrosion Test	Pass	Pass
(Copper Strip, 3 Hrs. at 212°F)	0.20	-
Conradson Carbon, %	0.10	-
Ash, %	0.50	
Water & Sediment, %		
Flash Point, F (P.M.C.C.)		150 or legal
Pour Point, at least 10 F below coldest fuel oil temperature		
Cloud Point, less or equal to coldest fuel oil temperature		
DISTILLATION, °F		
90% Point	675	
IGNITION QUALITY		
Cetane Number		45

*Heat Value - determine from A.P.I. gravity limits shown to determine total or net Btu/lb or gallon.

The diesel generator units, including all engine mounted components, are qualified to the normal and accident environmental conditions. This qualification is done by testing the particular equipment or by inference from tests done on similar equipment. The environmental design and qualification is in accordance with the criteria of IEEE Standard 323; "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations".

The Diesel Generator Building, the walls separating the three (3) diesel generator rooms, day tank rooms, and transfer pump rooms, and the systems within the rooms are designed to Seismic Category I requirements.

The failure of one (1) Diesel Generator System therefore will not affect the other two (2) units.

The Seismic Category I walls separating the three (3) engine rooms are designed to contain the misiles and shrapnel that might be generated by the rupture of a moderate energy fluid system or by a crankcase explosion. Initial flooding from a cooling system break will be limited and will be handled by the drainage system.

All systems and structures in the Diesel Generator Building or near the fuel oil storage tanks and piping are designed to Seismic Category I requirements, or are qualified to meet the criteria of IEEE Standard 323.

9.14.1.3 Safety Evaluation

The diesel fuel is stored in tank assemblies embedded in a concrete Seismic Category I encasement and separated by a minimum of 12 inches of concrete; therefore, each diesel generator unit is assured of having at least a seven (7) day fuel supply for any emergency condition. The Diesel Generator Fuel Oil Tank Assemblies, piping, and pumps are arranged so that malfunction or failure of either an active or passive component associated with one (1) diesel generator unit will not impair the fuel oil supply to other units.

Each diesel generator is located in a separate bay to prevent a single failure from resulting in loss of more than one (1) Diesel Generator Unit. The system thus, meets the requirements of the single failure criteria.

All fuel connections and vents to the atmosphere are above maximum flood elevation. The vents are flameproofed. Fire sprinkler protection is provided in each Diesel Generator Building.

The fill boxes for direct filling of the fuel oil storage tanks are locked to prevent unauthorized access. The emergency diesel fuel oil system will withstand all postulated natural phenomena without adverse effects on fuel oil quality.

All connections to the fuel supply tanks enter the top of the tanks and are designed and located such that an inadvertent line break for any cause will not siphon the contents of the fuel oil storage tanks. Bottom drains are not provided.

9.14.1.4 Inspection and Testing Requirements

The electric motor and engine-driven fuel oil transfer pumps and day tanks are functionally tested in the vendor's shop in accordance with the Manufacturer's standards to verify the performance of the Diesel Generator Units and accessories. The fuel oil transfer pumps in the Diesel Generator Building are tested in the Manufacturer's factory to verify their performance. The embedded fuel oil storage tanks are hydrostatically tested to 39 psig prior to shipment to the plant site.

The entire Diesel Fuel Oil System is flushed with oil and then functionally tested at the plant site. The diesel fuel oil system will be periodically tested. The diesel generators shall be test operated for a minimum of two (2) hours at least once per 31 days on a staggered test basis. Portions of these surveillance requirements include the following:

a) Verify the proper fuel oil levels in the day tank.

b) Verify the proper fuel oil level in the Diesel Generator Building embedded fuel oil seven (7) day storage tank assemblies.

c) Verify that the fuel oil transfer pumps can be started and that they can transfer fuel from the storage system to the day tank.

Precautionary measures that will be taken to ensure the quality and reliability of the fuel oil supply for emergency Diesel Generator Operations are as follows:

a) Onsite sampling will be conducted as per ASTM D270-65 (Reapproved 1975) and analyzed to comply with Federal Fuel Oil Specification VV-F-800a.

b) Sample analysis prior to receipt of new fuel oil will include specific gravity, flash point, and a visual inspection to detect any sediment or water content. Samples will be collected at this time for future analysis to ensure compliance of the purchase specification.

c) As part of the operability test, samples will be collected and analyzed for viscosity, water, and sediment from the fuel oil storage tanks on a quarterly basis.

Fuel oil which has degenerated will be pumped out, discarded, and replaced.

Other control measures to be taken at a minimum of once a month will be as follows:

a) Sample will be visually checked to detect water accumulation in the fuel storage tanks and the day tanks checked for condensate accumulation.

b) Sample and test the fuel storage tanks for microbiological growth and for residual concentration of microbiocide. The sampling and testing shall be done in accordance with the microbiocide Manufacturer's instructions. Add microbiocide as required to restore the original concentration. The microbiocide shall be a commercial product such as Biobor JF, Nalco 8256 or 2210, or equal.

9.14.2 Diesel Generator Cooling Water System

9.14.2.1 Design Bases

The Emergency Diesel Engine Cooling Water System (EDECWS) provides cooling water to the three(3) emergency diesel engines. The EDECWS comprises of a standpipe or expansion tank, an engine driven jacket water pump, a parallel motor driven pump, a shell and tube jacket water cooler, a jacket water keep warm system, interconnecting piping and instrumentation required for the operation, monitoring and testing of the system.

Each diesel generator shall be provided with a fully independent engine cooling water system. Interconnections shall not be provided between the systems. The independence of these systems shall be maintained by the independence of the electrical power supply and emergency plant service water supply to the system components. The active components to each cooling water train shall have adequate redundancy to prevent failure to the system due to a single active component failure.

9.14.2.1.1 Seismic and Quality Group Classification

a) The entire EDECWS, including all components and piping, shall be designed to Seismic Category I requirements.

b) The Quality Group class for the EDECW system shall be Quality Group C except for the diesel engine and all casted diesel vendor supplied components. The design for these components shall meet the ANSI B31.1 and DEMA standard requirements.

c) The quality assurance for the design and construction of the EDECWS shall be in accordance with the requirements of Regulatory Guide 1.28 and ANSI N45.2-1977.

9.14.2.1.2 General Arrangements

a) The location of the three(3) emergency diesel generators in separate cells of the Diesel Generator Building shall assure the independence of the three(3) EDECWS supply trains. The fire separation between the EDECWS trains shall be maintained in accordance with BTP CMEB 9.5-1. The Diesel Generator Building shall be placed outside of the turbine missile trajectory.

b) The components of the EDECWS shall be located to provide adequate space for inspection, cleaning, maintenance and repair of the system.

c) The highest point of the EDECWS shall be provided with a vent to atmosphere to assure that all spaces are filled with water.

9.14.2.1.3 Cooling Water Supply

a) The EDECWS system shall be provided with chemical additives to preclude long-term corrosion and organic fouling that would degrade system cooling performance. Chemicals used shall be compatible with materials of the system and shall be as recommended by the engine manufacturers.

b) A jacket water keep warm system shall be provided for each EDECWS to enhance the engine "first try" starting reliability while the engine is in the standby mode.

c) A three-way thermostatic valve shall be provided for each EDECWS so that the proper coolant temperature is maintained at the engine inlet by controlling flow through the jacket water cooler.

d) Procedures shall be established to periodically inspect and analyze the EDECWS for system leakage.

9.14.2.1.4 Protection from Natural Phenomena & Missiles

a) The design of the EDECW system shall be Seismic Category I and the building housing the system shall also be Seismic Category I design. The location of the Diesel Generator Building shall prevent failure of the system due to a potential failure of a non-Seismic Category I structure. The Diesel Generator Building shall be protected from tornado, tornado missile and floods.

b) The EDECWS shall be protected from the consequences of moderate energy pipe line failures. Higher energy pipe lines shall be excluded from the Diesel Generator Building. The postulated piping failure shall be evaluated in accordance with BTP ASP 3-1 and the location shall be established in accordance with BTP MEB 3-1. The design of the piping systems shall utilize supports, restraints, spray shields and adequate floor drain system to prevent direct impingement of water on the diesel engine or electrical components and to prevent flooding of the Diesel Generator Building.

c) The design of the Diesel Generator Building and the EDECWS shall be in accordance with BTP CMEB 9.5-1 to minimize the potential and consequences of fires.

9.14.2.1.5 <u>Testing, Surveillance and Qualification</u>

a) The design of the EDECWS shall include provisions for testing of the system to verify the parameters of operation. The design shall consider and select the location of instrumentation sensors and shall include status indication and alarm features. The sensors shall be accessible and designed to permit inspection and calibration in place.

b) The EDECWS shall be provided with surveillance instrumentation to provide status indication and facilitate trouble and diagnosis.

c) The EDECWS design shall provide for inservice inspection and testing in accordance with ASME Section XI requirements.

d) The minimum instrumentation for the EDECWS shall include level indication for standpipe or expansion tank, pressures at the engines and coolers, and temperatures at the engines and coolers to permit operational testing of the system and to monitor operating parameters of the system.

9.14.2.1.6 <u>Applicable Codes and Standards</u>

1) Regulatory Guide 1.9, "Selection, Design, and Qualification of Diesel Generator Units Used As Standby (Onsite) Electric Power Systems at Nuclear Power Plants"

2) Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants"

3) Regulatory Guide 1.29, "Seismic Design Classification"

4) Regulatory Guide 1.68, "Initial Test Programs for Water Cooled Reactor Power Plants"

5) Regulatory Guide 1.115, "Protection Against Low Trajectory Turbine Missiles"

6) Regulatory Guide 1.117, "Tornado Design Classification"

7) Branch Technical Position AEB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment", attached to SRP Section 3.6.1.

8) Branch Technical Position MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment", attached to SRP Section 3.6.2.

9) Branch Technical Position ICSB-17 (PSB), "Diesel-Generator Protective Trip Circuit Bypasses", attached to SRP Section 8.3.2, Appendix 8A.

10) Branch Technical Position ASB 9.5-1, "Guidelines for Fire Protection for Nuclear powre Plants" attached to SRP Section 9.5.1.

11) IEEE Standard 387, "IEEE Standard Criteria for Diesel Generator Units Applied as Standby Power Supplies or Nuclear Power Generating Stations"

12) Diesel Engine Manufacturers Association (DEMA) Standard

13) NUREG/CR-0660, "Enhancement of Onsite Emergency Diesel Generator Reliability"

9.14.2.2 System Description

A Closed Loop Jacket Circulating Water Cooling System is furnished for each of the three (3) diesel generator units. The Diesel Generator Building which houses the three (3) units is designed to Seismic Category I requirements, and is designed to withstand environmental effects as defined in Chapter 3. Each unit, with its dedicated support systems, is located in a separate room. Each jacket water system consists of a standpipe or expansion tank, an engine mounted pump driven from the accessory gear train, a parallel motor driven pump, a shell and tube jacket water cooler, and a jacket water keep warm system.

A shell and tube lube oil cooler rejects heat into the jacket circulating water cooling system.

The shell and tube jacket water cooler rejects heat into the Emergency Plant Service Water System. The coolers for the Divisions 1, 2 and 3 engines reject heat into the Emergency Plant Service Water Systems A, B, and C trains, respectively.

There are no shared auxiliary support systems for the Divisions 1, 2 and 3 diesel generators. Each safety division diesel generator system is supplied with DC power and AC control power from the same safety division. Therefore, the diesel generator is self supporting.

The Divisions 1, 2 and 3 diesel generators, are independent of each other. Division 1 and 2 diesel generators are each redundant to each other. Each engine is capable of operating without emergency plant service water system cooling water flow for the time required to start diesel engines, and bring the emergency plant service water pump up to speed.

Normal makeup water to the diesel generator cooling water system is drawn from the Seismic Category III demineralized water system.

The components other than the diesel engine and all casted diesel vendor supplied components are designed to Seismic Category I and to ASME Code Section III, Class 3 requirements.

The diesel engine and all casted diesel vendor supplied components are designed to the ANSI B31.1 and DEMA standards. The engine and engine mounted components are tested and qualified to the normal and accident environmental conditions. The environmental design and qualification meet the criteria of IEEE Std. 323.

Each cooling water system consists of a standpipe (Division 1 & 2) or an expansion tank (Division 3), a motor driven auxiliary pump to operate in parallel with the engine mounted, accessory gear case driven pump, and connections to make-up water and to Emergency Plant Service Water. The tube side of the lubricating oil cooler is in the circuit to reject heat from the lubricating oil system into the jacket water cooling system.

The jacket water closed loop flow is from the standpipe or expansion tank to the circulating pumps, to the jacket water cooler, to the oil cooler, to the engine, and back to the standpipe or expansion tank.

The standpipe or expansion tank is vented to atmosphere at the high point of the system to assure that all system components are filled with water.

The standpipe or expansion tank has reserve capacity to offset the evaporation through the vent and leakage through the pump shaft seals for seven days at rated load. Also, a low water alarm is provided for each system.

The standpipe or expansion tank also is provided with a nozzle for adding water treatment chemicals to the jacket water. Corrosion protection will be provided by using a commercial preparation in accordance with the diesel engine manufacturers recommendation. This will prevent corrosion in the jacket water passages in the engine, and on the jacket water side of all components and equipment in the system.

An electric heater is installed in the standpipe to maintain jacket water temperature above 125 F when the engine is not running. The keep warm pump circulates water from the heater through the engine and back to the system. The check valves in the main and auxiliary circulating pump discharges prevent the flow from bypassing the engine. The heater and keep warm pump control circuits are interlocked in the engine starting and running control circuits such that they are deenergized when the engine is running and energized when the engine is not running. The electric heater is provided with a control thermostat and a high-high temperature trip and lockout, and manual reset.

The motor driven auxiliary circulating pump operates continuously in parallel with the engine driven pump when the engine is running. The pump is powered from a Class 1E AC source. This pump serves as backup for the engine driven pump.

The jacket water cooler is a shell and tube heat exchanger designed to reject into the emergency plant service water system the heat picked up by the jacket water circulating system at rated engine load.

A three way thermostatic valve maintains jacket water temperature out of the engine between 170 F to 180 F by bypassing hot water around the jacket water cooler. The valve is self-contained with internal thermostatic capsules positioning the plug. There are no penetrations through the body or cover of this valve, therefore, there is no leakage to atmosphere.

The cooling water pressure, temperature, and level gauges are provided on the engine, on equipment, and on the engine control panel for monitoring engine operation. In addition, the following alarms and trips are provided at the engine control panel. Selected alarms are relayed to the main control room. The trips are disabled if the engine is started under emergency conditions.

a. Standpipe or Expansion Tank Level: Low Level Alarm

b. Cooler Pressure: High Alarm

c. Cooler Pressure: Low Alarm

d. Temperature in Engine: Low Alarm

e. Pressure in Engine: Low Alarm

f. Pressure in Engine: Low-Low Trip @ 10 psig

g. Temperature out Engine: High Alarm

h. Temperature out Engine: High-High Trip @ 200 F

Potential leakage points on the engines are the main headers, the cylinder jackets, the governor cooler, the turbocharger air aftercoolers, the turbochargers, and the exhaust jackets. Potential leakage points off the engines are the jacket water cooler and the oil cooler.

The regular surveillance scheduled for the diesel engine will check for the following symptoms:

a) If oil leaks into the jacket water system, the oil will appear in the standpipe or expansion tank overflow, and leakage will be evidenced by an abnormal decrease in oil sump level.

b) If jacket water leaks into the oil system, sump level will increase, water will appear in the sump drain and the oil cooler drain, and the standpipe level will decrease.

c) If jacket water leaks into the emergency plant service water system, the standpipe level will decrease.

d) If emergency plant service water leaks into the jacket water system, the standpipe level will increase to overflow and the concentration of water treatment chemical will decrease.

Leakage to atmosphere will be evidenced by water dripping on the floor. If leakage occurs, the fault will be repaired, the systems will be repaired, the unit will be tested, and it will then be returned to available status.

The water treatment chemicals will prevent corrosion on the jacket water side and minimize the possibility of leakage.

When the engines are first run in, bolts will be retorqued after several hours of operation.

The jacket water keep warm system and the lubricating oil keep warm system will tend to minimize temperature changes in the systems, and thus tend to minimize the effect these changes have in causing leakage.

9.14.2.3 Safety Evaluation

The Diesel Generator Cooling Water System meets single failure criteria in that loss of cooling water to one diesel will not affect the other diesel units. All piping in the engine rooms is designated Seismic Category I.

9.14.2.4 Inspection and Testing Requirements

The Emergency Plant Service Water System within each Diesel Generator Building is hydrostatically and functionally tested at the plant site. All system components are accessible for periodic inspections during operation. The diesel generator jacket water system is periodically tested.

All skid mounted jacket water system components are inspected and serviced under a regularly scheduled preventative maintenance program. This inspection program includes regular checking for system leaks and sampling and analyzing of the jacket water quality.

Engine maintenance will be programmed on the basis of calendar time, engine running time, and a continuous review of engine operating data-with special attention being paid to data value trends. If alarms occur, the engine will be shut down as soon as possible and repaired. If a trip occurs, the engine will be repaired on an expedited schedule, tested and returned to available status.

9.14.3 Diesel Generator Starting System

9.14.3.1 Design Bases

The Emergency Diesel Engine Starting System (EDESS) assures reliable starting of the emergency diesel engine following loss of offsite power. The EDESS is comprised of air compressors, air dryers, air receivers, engine cranking devices, piping and valves, filters and associated ancillary instrumentation and controls.

Each of the three (3) diesel generators shall be provided with an independent starting air system, fully separated from each other by three (3) hour rated walls and provided with independent power supplies from the same power division as the diesel generator for which the air supply system provides service.

The design of the EDESS shall meet the requirements of SRP 9.5.6.

9.14.3.1.1 Seismic and Quality Group Classification

a. The essential portions of the EDESS, except the diesel engine and all casted Diesel vendor supplied components, but including the isolation valves separating the essential and non-essential portions, shall be designed to the Quality Group C, and Seismic Category I requirements.

b. The diesel engine and all casted diesel vendor supplied components, the air compressor, and the aftercooler, shall be designed in accordance with the ANSI B31.1 and DEMA Standard requirements. The engine and engine mounted components shall be tested and qualified for the environmental conditions under normal and accident conditions. The environmental design and qualification shall meet the requirements of IEEE Standard 323.

c. The P&IDs and other system documentation shall indicate points of change in the system and/or components seismic or quality group classification.

9.14.3.1.2 General Arrangements

a) The location of the Diesel Generator Building housing the EDESS shall assure the independence of the three (3) EDESS supply trains. The fire separation between the EDESS trains shall be maintained in accordance with BTP CMEB 9.5-1. The Diesel Generator Building shall be placed outside of the turbine missile trajectory range.

b) The components of the EDESS shall be located to provide adequate space for inspection, cleaning, maintenance and repair of the system.

9.14.3.1.3 System Performance

a) Each diesel generator shall be provided with redundant starting air systems.

b) Each starting air system shall have the capability of cranking the cold diesel engine five times without recharging the receivers. The system capacity shall be in accordance with the requirements of SRP 9.5.6, Paragraph 1.4.g.

c) The dew point of the starting air shall be not more than 50°F when the system is installed in a normally controlled 70°F environment, otherwise the starting air dew point shall be controlled 10°F below the expected lowest ambient temperature.

9.14.3.1.4 Protection from Natural Phenomena & Missiles

a) The design of the EDESS system shall be Seismic Category I and the building housing the system shall also be Seismic Category I design. The location of the Diesel Generator Building shall prevent failure of the system due to a potential failure of a non-Seismic Category I structure. The Diesel Generator Building shall be protected form tornados, tornado missiles and floods.

b) The EDESS shall be protected from the consequences of moderate energy pipe line failures. High energy pipe lines, except the diesel engine exhaust pipe, shall be excluded from the Diesel Generator Building. Postulated piping failures shall be evaluated in accordance with BTP ASP 3-1 and the location shall be established in accordance with BTP MEB 3-1. The design of the piping systems shall utilize supports, restraints, spray shields and adequate floor drain system to preven direct impingement of water on the diesel engine or electrical components and to prevent flooding of the Diesel Generator Building.

c) The design of the Diesel Generator Building and the EDESS system shall be in accordance with BTP CMEB 9.5-1 to minimize the potential and consequences of fires.

9.14.3.1.5 Testing, Surveillance and Qualification

a) The design of the EDESS shall include provisions for testing of the system to verify the parameters of operation. The design shall consider and select the location of instrumentation sensors and shall include status indication and alarm features. The sensors shall be accessible and designed to permit inspection and calibration in-place.

b) The EDESS shall be provided with surveillance instrumentation to provide status indication and facilitate trouble and diagnosis.

c) The EDESS design shall provide for inservice inspection and testing in accordance with ASME Section XI requirements.

9.14.3.1.6 Applicable Codes and Standards

1) Regulatory Guide 1.9, "Selection, Design, and Qualification of Diesel-Generator Units Used as Standby (Onsite) Electric Power Systems at Nuclear Power Plants"

2) Regulatory Guide 1.68, "Initial Test Programs for Water Cooled Reactor Power Plants"

3) Regulatory Guide 1.115, "Protection Against Low-Trajectory Turbine Missiles"

4) Regulatory Guide 1.117, "Tornado Design Classification"

5) Branch Technical Position ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment", attached to SRP Section 3.6.1.

6) Branch Technical Position MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment", attached to SRP Section 3.6.2.

7) Branch Technical Position ICSB-17 (PSB), "Diesel Generator Protective Trip Circuit Bypasses", attached to SRP Section 8.3.2, Appendix 8A.

8) IEEE Standard 387, "IEEE Standard Criteria for Diesel Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations"

9) Diesel Engine Manufacturers Association (DEMA) Standard

10) NUREG/CR-0660, "Enhancement of Onsite Emergency Diesel Generator Reliability"

9.14.3.2 System Description

Each of the three (3) diesel generator units is provided with two (2) redundant and independent pneumatic starting systems. Each system is completed with an air compressor, after cooler, air dryer, air receiver and two (2) redundant air solenoid valves in parallel, each of which is energized by a separate Class 1E 125 volt DC circuit. The engines are started by a local or remote manual control signal, or by an emergency automatic signal. In the emergency mode, the only protective devices that will remain effective will be the engine overspeed and generator differential trips, all other protective devices will be bypassed. In the normal condition or under testing all protective features will remain effective.

The Diesel Generator Building which houses the three (3) units is designed to Seismic Category I requirements, and is designed to withstand environmetal conditions as defined in Chapter 3. Each unit, with its dedicated support systems, is located in a separate room.

The individual room arrangement insures that a malfunction or failure of any system component associated with any single unit will not impair the operation of the other units. The system thus meets the requirements of the single failure criteria.

The air compressors are two (2) stage, air cooled, equipped with dry type air intake filter/silencer, and air cooled intercooler and after cooler.

The air compressors for the Division 1 and 2 diesels are motor driven and for the Division 3 diesel, one motor and one diesel engine driven.

The air dryers are twin tower, desiccant type with automatic regeneration and a moisture indicator, designed to ASME Section VIII and ANSI B31.1 requirements. The air receivers are vertical tank type with skirt and base designed to ASME Section III, Class 3 requirements. The solenoid valves are pilot operated with 125 volt DC coils.

Each air receiver has the capacity for five (5) diesel engine starts without recharging. Each compressor (either motor or engine driven) is sized to recharge the corresponding air receiver in thirty minutes running time and is controlled through a hand-off-automatic switch. In the automatic position, each compressor is under on-off pressure control from its corresponding air receiver. Relevant pressures are as follows:

Relief Valve Setting	270 psig rising
Compressor Off	250 psig rising
Compressor On	235 psig falling
Low Pressure Alarm	210 psig falling

Each of the air dryers is a twin tower desiccant type unit with a timer operated four (4) way valve which alternates each tower from the drying to the regeneration cycle, and conversely. A moisture indicator shows the moisture content of the leaving air.

The diesel engines for the Division 1 and 2 diesels are started by the timed admission of high pressure air to the power cylinders during the equivalent of the power stroke of the respective cylinders, thus causing rotation of the engine comparable to the normal power stroke. As the engine accelerates on starting air, the heat of compression of the combustion air plus that of the starting air develops a sufficiently high temperature to ignite the injected fuel within a few revolutions. The Division 3 diesel engine is started by the introduction of the starting air to the air start motors.

Upon receipt of either a manually or automatically generated start signal, the following steps in starting the diesel generator will occur, provided that the overspeed and generator differential trips are permissive and the DC power is available:

a. When energized by the DC power source, solenoid valves open, admitting starting air from the primary receiver to the engine cylinders or to the air starting motor.

b. Field flash timers are started.

c. Flashing of the generator field will occur when the field flash time delay times out or the (1) set of contacts on the relay tachometer closes thus starting the engine.

d. Starting air is cutoff upon reaching synchronous speed by the closure of a second set of contacts on the relay tachometer. The cylinder head start air valves are closed by combustion pressure for the Division 1 and 2 engines.

e. When voltage approximates normal, ready-to-load signals are generated.

Each diesel generator is provided with an automatic start sequencer. The start sequencer is programmed for five (5) automatic start trial cycles. Following this sequence, the starting will be cut off until the reset of the start sequencer and a new start trial.

9.14.3.3 Safety Evaluation

Since each diesel engine has two (2) independent and redundant starting systems, each starting system with a separate compressor, dryer, accumulator, distributor, and other equipment, the starting system for each diesel generator is designed to satisfy the single active failure criteria.

The air supply to each power cylinder bank is controlled by two (2) solenoid valves in parallel. Each air supply is sufficient for five (5) engine starts; therefore, the failure of one (1) air supply will not prevent an engine start. Since the two (2) solenoid valves in each air supply are in parallel, the failure of one (1) solenoid valve will not prevent an engine start. Each redundant start system has a separate DC power supply. A single failure in the starting system of any diesel generator will not lead to a loss of function of the starting system of any other diesel generator because the starting system of each diesel generator is independent from any other and the diesel generators are physically separated.

In addition to an air compressor, a dryer, an air receiver, and the related piping and valves, each of the starting systems also has two (2) redundant starting air valves, starting air distributor, strainer, relief valve, automatic operated pressure control switch, and other equipment. The following equipment is provided in the starting air system to preclude the fouling of the starting air:

a. A drip trap on the outlet of the compressor aftercooler to entrain excess water and any oil traces from the compressor.

b. A separator, trap, and prefilter on the inlet of the air dryer.

c. An afterfilter on the outlet of the air dryer.

d. An additional drip trap at the air receiver.

e. Drip legs on the outlet of the air receiver.

f. Strainers upstream of the start air admission valves.

g. Filters downstream of the starting air header on the engine.

9.14.3.4 Inspection and Testing

Each receiver is equipped with shutoff valves, a pressure gauge, drain valves, a safety-relief valve, and low-pressure alarm contacts. The alarm contacts alert operating personnel if the pressure of any air receiver falls below the minimum allowable value. Both local and Main Control Room alarms are activated when the starting air pressure in any receiver falls below 210 psig. When this occurs, steps taken to correct the low-pressure condition include:

a. Determining if compressor is operational.

b. Check for pressure switch malfunction.

c. Check for starting air system valve malfunction.

d. Check for system leakage.

e. Verify that the redundant starting air system is operational and available for service.

The operator is notified by the alarms that an abnormal condition exists. The above actions are performed by locally examining the system. By means of the automatic operated pressure control switch and the starting system instrumentation and controls, the receiver pressures are automatically maintained within an allowable operating range. The starting system of a given diesel generator has no shared structures, systems or components with that of another diesel generator. The building layout is such as to permit adequate inspection and repair of the starting system.

9.14.4 Diesel Generator Lubrication System

9.14.4.1 Design Bases

Each of the three (3) diesel generator units is provided with an independent Emergency Diesel Engine Lubrication System (EDELS) to lubricate and cool all bearing and rubbing surfaces, and to cool the power piston heads. Each system contains a makeup storage tank for adding lubricating oil to the circulating system. This tank is for operating convenience only and is not required to replenish the sump tank during prolonged emergency operation.

9.14.4.1.1 Seismic and Quality Group Classification

a) The entire EDELS including all components and piping shall be designed to Seismic Category I requirements.

b) The Quality Group class for the EDELS shall be Quality Group C, except for the diesel engine and all casted diesel vendor supplied components. The design for these components shall meet the requirements of ANSI B31.1 and the Diesel Engine Manufacturers Association (DEMA) Standards. (The interfaces between the engine-mounted components and the external part of the system shall be clearly identified on the design drawings.)

c) The design, construction and maintenance of the EDELS shall be in accordance with the requirements of Regulatory Guide 1.28 and ANSI N45.2-1977.

9.14.4.1.2 General Arrangements

a) The location of the Diesel Generator Building housing the EDELS shall assure the independence of the three (3) EDELS trains. The fire separation between the EDELS trains shall be maintained in accordance with BTP CMEB 9.5-1. The emergency Diesel Generator Building and the associated equipment located outside of the building shall be placed outside of the turbine missile trajectory range.

b) The components of the EDELS shall be located to provide adequate space for inspection, cleaning, maintenance and repair of the system.

9.14.4.1.3 <u>System Requirements</u>

a) The EDELS shall be provided with leak detection capability and capability for isolation in case of excessive leakage.

b) The design of the EDELS shall assure the maintenance of lube oil quality and the prevention of the failure of the diesel engine due to lube oil degradation or contamination. Procedures shall be established (1) for the sampling and analysis of the newly delivered lube oil, and (2) for the periodic sampling of the diesel engine lube oil.

c) The EDELS shall be provided with adequate cooling margin to prevent the degradation of the lube oil and to facilitate heat removal from the system.

d) The operating pressure, temperature differentials, flow rate and heat removal capability shall be in accordance with the engine manufacturer's recommendation.

e) The EDELS shall provide protection to prevent crankcase explosions and to mitigate the consequences of such events.

f) The temperature and pressure in the EDELS shall be maintained in standby condition to enhance the "first-try" starting reliability.

g) The design of the EDELS shall preclude entry of deleterious material due to operator error or other events.

h) The prelube time prior to manual starting shall be limited to 3 to 5 minutes or as recommended by the engine manufacturer.

i) The EDELS shall be provided with features to prevent dry starting during emergency starts. The acceptable methods are as per SRP 9.5.7 - Section III, 1.h.

9.14.4.1.4 <u>Protection from Natural Phenomena and Missiles</u>

a) The design of the EDELS system shall be Seismic Category I and the building housing the system shall also be Seismic Category I design. The location of the Diesel Generator Building shall prevent failure of the system due to a potential failure of a non-Seismic Category I structure. The Diesel Generator Building shall be protected from tornados, tornado missiles and floods. The EDELS shall be located higher than the potential maximum flood level.

b) The EDELS shall be protected from the consequences of moderate energy pipe line failures. High energy pipe lines except the diesel engine exhaust pipe shall be excluded from the Diesel Generator Building. Postulated piping failures shall be evaluated in accordance with BTP ASB 3-1 and the location shall be established in accordance with BTP MEB 3-1. The design of the piping systems shall utilize supports, restraints, spray shields and adequate floor drain system to prevent direct impingement of water on the diesel engine or electrical components and to prevent flooding of the diesel generator building.

c) The design of the Diesel Generator Building and the EDELS system shall be in accordance with BTP CMEB 9.5-1 to minimize the potential and consequences of fires.

9.14.4.1.5 Testing, Surveillance and Qualification

a) The design of the EDELS shall include provisions for testing of the system to verify the parameters of operation. The design shall consider and select the location of instrumentation sensors and shall include status indication and alarm features. The sensors shall be accessible and designed to permit inspection and calibration in-place.

b) The EDELS shall be provided with surveillance instrumentation to provide status indication and facilitate troubleshooting and diagnosis.

c) The EDELS design shall provide for inservice inspection and testing in accordance with ASME Section XI requirements.

d) The minimum instrumentation for the EDELS shall include level indication and alarms for the fuel oil storage tanks and fuel oil day tanks, differential pressure indication for the fuel oil transfer pump, inlet filters, and temprature indication to assure that the "cloud point" requirements for the fuel oil are not violated.

9.14.4.1.6 Applicable Codes and Standards

1) Regulatory Guide 1.9, "Selection, Design and Qualification of Diesel-Generator Units Used as Standby (Onsite) Electric Power Systems at Nuclear Power Plants"

2) Regulatory Guide 1.68, "Initial Test Programs for Water Cooled Reactor Power Plants"

3) Regulatory Guide 1.115, "Protection Against Low-Trajectory Turbine Missiles"

4) Regulatory Guide 1.117, "Tornado Design Classification"

5) Branch Technical Position ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment", attached to SRP Section 3.6.1

6) Branch Technical Position MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment", attached to SRP Section 3.6.2

7) Branch Technical Position ASB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Stations", attached to SRP Section 9.5.1

8) Branch Technical Position ICSB-17 (PSB), "Diesel-Generator Protective Trip Circuit Bypasses", attached to SRP Section 8.3.2, Appendix 8A.

9) IEEE Standard 387, "IEEE Standard Criteria for Diesel Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations"

10) Diesel Engine Manufacturers Association (DEMA) Standards.

11) NUREG/CR-0660, "Enhancement of Onsite Emergency Diesel Operating Reliability"

9.14.4.2 System Description

Each of the three(3) diesel engine units is provided with an independent pressure lubrication system to lubricate the various moving parts and cool all bearing and rubbing surfaces, and to cool the power piston heads. Each system contains a makeup storage tank for adding lubricating oil to the circulating system. This tank is for operating convenience only and is not required to replenish the sump tank during prolonged emergency operation.

The Diesel Generator Building which houses the three(3) units is designed to Seismic Category I requirements, and is designed to withstand environmental effets as defined in Chapter 3. Each diesel generator unit, with its dedicated support systems, is located in a separate room. Each unit is arranged to supply power to its own auxiliaries so that a single failure will not interfere with the operation of the other two(2) units.

All EDELS components, other than the Diesel Engine and all casted diesel vendor supplied components, are designed to ASME Section III, Class 3.

The diesel engine and all casted diesel vendor supplied components are designed to ANSI B31.1 and DEMA standards. The engine and engine mounted components are tested and qualified to the normal and accident environmental conditions. The environmental design and qualification meet the criteria of IEEE Standard 323.

The Division 1 and Division 2 lube oil systems are "dry sump" systems in which the supply of lubricating oil for the engine system is stored in a separate sump tank, independent of the engine crankcase. As oil accumulates in the engine crankcase, it drains by gravity into the tank which is set at an elevation lower than the crankcase. The oil is picked up from the sump tank by the lubricating oil circulating pump and circulated throughout the engine as required. This system minimizes the degradation of the oil by minimum exposure to crankcase gases and oxidation and also has the advantage of providing storage capacity for a seven (7) day supply of lube oil at full load under emergency conditions. The Division 3 diesel engine utilizes a large capacity oil pan which is sized for seven day operation without lube oil makeup.

The dry sump systems consist of a sump tank with thermostatically controlled keep warm immersion heater, a diesel engine mounted and driven lube oil circulating pump, a lube oil cooler, filters and strainers, a keep warm pump, and a makeup storage tank. The Division 3 diesel engine utilizes the lube oil cooler for keep warm purposes, taking heat from the jacket water keep warm system.

The purposes of the keep warm components are to keep the engine bearing surfaces warm and prelubricated while the engine is not running. When the engine is running, the keep warm immersion heater (for the Division 1 and 2 engines) and the keep warm pump is automatically turned off. When the engine is not running, the keep warm immersion heater (for the Division 1 and 2 engines) and the keep warm pump is turned on. The immersion heater with its thermostatic control or the lube oil heat exchanger for Division 3 engine then maintains the oil sump temperature between 110°F and 125°F. This warm oil is circulated through the engine, with the exception of the two (2) turbochargers (thrust bearings are prelubricated) by the keep warm pump to keep the engine bearings warm and prelubricated.

The Division 3 engine is provided with two keep warm pumps, one for the turbocharger thrust bearings and the other for the rest of the engine. The turbocharger keep warm pump operates at all times. The oil level is maintained below the camshaft elevation during the prelubrication period to prevent lube oil overflow to the exhaust manifold.

The lube oil sump tank or pan is fitted with an engine crankcase drainage nozle, a strainer, a lube oil circulating pump suction nozzle, an electric keep warm immersion heater (for Division 1 and 2 only) a fill line, vent line, drain nozzle, and instrumentation.

The lube oil circulating pumps, for the Division 1 and 2 diesels only, are engine mounted and driven from the auxiliary gearcase. The pumps have an internal high pressure-relief valve. Two (2) pressure regulators (by-pass type) are piped in parallel to the pump discharge and control main oil header pressure by bypassing back to the sump tank. The Division 3 diesel is provided with three engine mounted and driven lube oil pumps. The scavenger pump takes suction from the oil pan and delivers the lube oil to the common inlet manifold of the main lubricating and piston cooling pumps. The main lubricating and the piston cooling pumps are driven by the same shaft and located in a common casing. Their separate discharge ports supply lube oil to the various engine parts and to the pistons, respectively.

The lube oil cooler is shell and tube type with 100 percent of the lube oil flow on the shell side, and jacket water on the tube side. Tube pressure drop and surface area are designed to limit jacket water flow rate through the cooler and control the lube oil temperature within the prescribed temperature range.

The oil filter is a full flow duplex type with cartridge type elements. Filter elements can be changed while the diesel engine is running.

The strainers are all metal self-cleaning type with automatic bypass.

The keep warm pumps are electric motor driven rotary displacement types sized to maintain warm oil circulation through the diesel engine lubrication system while the engine is not running.

The makeup oil storage tank stores lubricating oil for adding to the circulating system. The tank is fitted with a screened and capped fill nozzle, a vent with flame arrestor, a level gauge, a drain, and a piped connection to the lube oil sump tank fill connection. The adding of lubricating oil to the makeup oil storage tank is under administrative controls which preclude the entrance of deleterious materials. The interior of the tank is coated to prevent corrosion. This makeup oil storage tank is for operating convenience only. The stored oil is not required to replenish the sump tank during seven (7) day prolonged emergency operation.

The turbochargers, except for the thrust bearings, are not prelubricated to minimize the possibility of oil leakage and collection in the hot gas turbine chambers which could cause a fire in the turbine when the engine is running. The residual oil left in the turbocharger bearings from test runs at 30 day intervals is sufficient prelubrication because the engine starts naturally aspirated and the turbocharger lubrication circuits are up to pressure by the time the turbocharger turbine picks up speed from the hot exhaust gas after the engine starts.

For the Division 1 and 2 engines, the lubricating oil flow rate at rated engine rpm will be 500 gpm. At full emergency power load, oil temperature on engine will be 157°F and oil temperature off engine will be 171°F. The heat transfer capacity of the lube oil cooler is sufficient to obtain and maintain these temperatures.

The lubricating oil characteristics are:

SAE Grade 40 Oil

	Maximum	Minimum
Viscosity Index (ASTM D567)	-	70
Gravity, API @60°F (ASTM D287)	30	20
Flash Point (ASTM D92)	-	425°F
Pour Point (ASTM D97)	-	10°F Below Coldest Oil Starting Temperature

Crankcase explosions while the engine is running are prevented by ventilating the crankcase with motor driven, engine mounted crankcase vacuum blowers and maintaining the crankcase pressure at 0.5 inches of water vacuum.

Oil leakage can be detected by abnormal decreases in sump tank or pan level. The point of leakage will then be found, repaired, and tested. The diesel generator will then be returned to ready status.

Lubricating oil pressure, temperature, and level gauges are provided both on the engine and on the engine control panel. Alarms are annunciated both at the engine control panel and at the main control room.

Following is a tabulation of the lubricating oil system alarms and safety-shutdowns:

Function	Alarm Setting	Shutdown Setting
Temperature	140°F Falling	-
Temperature	190°F Rising	200°F Rising
Pressure	40 psi Falling	30 psi Falling
Filter Pressure Drop	20 psi Rising	-
Turbocharger System Pressure	20 psi Falling	15 psi Falling
Sump Tank or Pan Level	Low	-

These shutdowns are a test or non-emergency conditions. When the engine is running under emergency conditions, the shutdowns are not active.

9.14.4.3 Safety Evaluation

During operation, integrity of the lubricating oil is protected by the following:

a. The lube oil system is a closed system.

b. A strainer is provided in the sump tank.

c. A filter is provided on the discharge of the lube oil pump.

d. A strainer is provided at the engine header.

e. A filter is provided on the discharge side of the keep warm pump.

f. A strainer is provided on the discharge side of the keep warm pump.

Provisions are made to assure only acceptable grade and quality lubricating oil is used for recharging of the system. Administrative controls are used for repairs, maintenance, and addition of oil to the system. These controls preclude the entry of deleterious material into the system.

9.14.4.4 Inspection and Testing Requirements

The diesel generator lubricating oil system components are inspected and serviced initially and periodically thereafter, in accordance with the schedule tabulated below:

Maintenance Action	Frequency
Temperature	Daily
Check for Leaks	Daily
Level in Sump Tank or Pan	Daily
Filter Pressure Drop	Monthly
Drain Water/Sludge from Filter	Monthly
Check Strainer Screens	Monthly
Check for Fuel Dilution with Viscosimeter	Monthly
Send Sample to Laboratory or Analysis	Monthly
Drain Sump, Clean, Refill	Annual
Check Lubricating Oil Jets at Gears	Annual

9.14.5 Diesel Generator Combustion Air Intake, Exhaust Systems

9.14.5.1 Design Bases

The Emergency Diesel Engine Combustion Air Intake and Exhaust System (EDECAIES) supplies combustion air of reliable quality to the diesel engines, and exhausts the products of combustion from the diesel engines to the atmosphere. The EDECAIES consists of outside air intakes, air intake filters, air intake silencers, and piping to the engine air intake connection, exhaust point where exhaust is released to the atmosphere, and the instrumentation required for the operation, monitoring and testing of the system.

Each diesel generator shall be provided with a fully independent combustion air intake and exhaust system. Interconnections shall not be provided between the systems. The independence of these systems shall be maintained by the independence of the electrical power supply to the system components.

9.14.5.1.1 Seismic Classification

a) The entire EDECAIES, including all components and piping, shall be designed to Seismic Category I requirements.

b) The design, construction and maintenance of the EDECAIES shall be in accordance with the requirements of Regulatory Guide 1.28 and ANSI N45.2-1977.

9.14.5.1.2 General Arrangements

a) The location of the Diesel Generator Building shall assure the independence of the three (3) EDECAIES trains. The fire separation between the EDECAIES trains shall be maintained in accordance with BTP CMEB 9.5-1. The Diesel Generator Building shall be placed outside of the turbine missile trajectory zone.

b) The components of the EDECAIES shall be located to provide adequate space for inspection, cleaning, maintenance and repair of the system.

c) The combustion air intakes and exhausts shall be located with sufficient horizontal and vertical separation to preclude short circuiting from the engine exhaust to the combustion air intake.

The combustion air shall be taken directly from outside the building. The bottom of the combustion air intakes shall be located a minimum of twenty(20) feet above grade elevation. These intakes shall be tornado protected and provided with HEPA filters adequately sized to remove the maximum expected sodium aerosol quantities.

d) The combustion air intake and exhaust systems shall be configured to insure that adverse atmospheric conditions, such as rain, ice or snow will not accumulate and cause possible clogging during standby or while in operation. The intakes shall be provided with filters and sized for extended life under maximum dust storm conditions.

e) Adequate dust control provisions shall be provided such as the filtering of combustion air as well as the filtering of the recirculating air conditioning system to prevent dust accumulation. In addition, concrete floors and walls shall be treated to prevent the accumulation of concrete dust.

f) The engine, with its air intake and exhaust, shall be tested and qualified to the project design environmental conditions for normal and accident conditions.

9.14.5.1.3 Protection from Natural Phenomena & Missiles

a) The design of the EDECAIES system shall be Seismic Category I and the building housing the system shall also be Seismic I design. The location of the Diesel Generator Building shall prevent failure of the system due to a potential failure of a non-Seismic Category I structure. The Diesel Generator Building shall be protected from tornado, tornado missile and floods.

b) The EDECAIES system shall be tornado protected and designed to mitigate the consequences of a sodium aerosol release accident.

c) The EDECAIES shall be protected from the consequences of moderate energy pipe line failures. Higher energy pipe lines shall be excluded from the Diesel Generator Building. The postulated piping failure shall be evaluated in accordance with BTP ASP 3-1 and the location shall be established in accordance with BTP ASP 3-1. The design of the piping systems shall utilize supports, restraints, and spray shields to prevent direct impingement of water on the diesel engine or electrical components and an adequate floor drain system to prevent flooding of the Diesel Generator Building.

d) The design of the Diesel Generator Building and the EDECAIES system shall be in accordance with BTP CMEB 9.5-1 to minimize the potential and consequences of fires.

9.14.5.1.4 <u>Testing Surveillance and Qualification</u>

a) The design of the EDECAIES shall include provisions for testing of the system to verify the parameters of operation. The design shall consider and select the location of instrumentation sensors and shall include status indication. The sensors shall be accessible and designed to permit inspection and calibration in-place.

b) The EDECAIES shall be provided with surveillance instrumentation to provide status indication and facilitate trouble and diagnosis.

c) The minimum instrumentation for the EDECAIES shall include combustion air manifold pressure and differential pressure indication for the intake filters.

9.14.5.1.5 <u>Applicable Codes and Standards</u>

1) Regulatory Guide 1.9, "Selection, Design, Qualification of Diesel-Generator Units Used As Standby (Onsite) Electric Power Systems At Nuclear Power Plants"

2) Regulatory Guide 1.68, "Initial Test Programs for Water-Cooled Reactor Power Plants"

3) Regulatory Guide 1.115, "Protection Against Low-Trajectory Turbine Missiles"

4) Regulatory Guide 1.117, "Tornado Design Classification"

5) Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures In Fluid Systems Outside Containment" (attached to SRP Section 3.6.1)

6) Branch Technical Position MEB 3-1, "Postulated Break and Leakage Locations In Fluid System Piping Outside Containment" (attached to SRP Section 3.6.2)

7) Branch Technical Position ICSB-17 (PSB), "Diesel-Generator Protective Trip Circuit Bypasses" (attached to SRP 8.3.2, Appendix 8A)

8) IEEE Standard 387 "IEEE Standard Criteria for Diesel Generator Units Applied As Standby Supplies for Nuclear Power Generating Stations"

9) Diesel Engine Manufacturers Association (DEMA) Standard

10) NUREG/CR-0660, "Enhancement of Onsite Emergency Diesel Generator Reliability"

9.14.5.2 System Description

Each of the three (3) diesel generator units is equipped with an independent combustion air intake and exhaust system. The three (3) systems are housed in physically separated rooms within the Diesel Generator Building. The building is designed to Seismic Category I requirements and to withstand the environmental effects as defined in Chapter 3. The Diesel Generator Combustion Air Intake and Exhaust System piping, filters, and silencers are arranged in separate rooms for each diesel generator unit, therefore a malfunction or failure of any system component associated with any single unit will not impair the operation of the other units. The subsystem thus meets the requirements of the single failure criteria.

Each diesel generator combustion air intake subsystem consists of a HEPA air intake filter, air intake silencers, and piping from the intake filter to the engine air intake connection. The engine exhaust subsystem includes an exhaust silencer, piping from the engine to the silencer, and piping from the exhaust silencer to the roof where the exhaust is released to the atmosphere. The exhaust piping above the roof is encased in a Seismic Category I tornado missile resistant concrete shield.

The inlet to the combustion air intake plenum room is in a building side wall not less than twenty (20) feet above grade. Vertical separation is provided between the inlet and engine exhaust outlet. The horizontal separation is approximately seventy (70) feet. The net separation distance is adequate to prevent short circuiting from the engine exhaust to the combustion air inlet.

The inlet to the combustion air intake will be configured to prevent blockage by ice or snow. The intake filters are HEPA type and sized for extended life under maximum dust storm conditions. In addition, the filters are selected and sized to remove sodium aerosol from combustion air to maintain operability of the diesel generators under a sodium release accident. Filter pressure drop under operating conditions will be monitored and the filters can be changed with the engine operating with no adverse affects.

The engine with its air intake and exhaust will be tested and qualified to the project design environmental conditions under normal and accident conditions. The environmental design and qualification shall meet the criteria of IEEE Std. 323: IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations. Design ambient pressure depressions will thus not degrade engine performance at full rated power.

No gaseous fire extinguishing mediums will be used in or in the vicinity of the Diesel Generator Building. Lowering the combustion air intake oxygen concentration is therefore precluded.

The Diesel Generator Building, the walls separating the three (3) diesel generator rooms, day tank rooms, and transfer pump rooms, and the systems within the rooms are designed to Seismic Category I requirements. The failure of one (1) diesel generator system will therefore not affect the other two (2) units.

Missiles and shrapnel generated within an engine room, and flooding by liquids within the room, will not affect the operation of the other two (2) units.

Each engine room has a separate recirculating type HVAC cooling system; therefore, smoke cannot migrate from room to room. The HVAC system consists of two 50% capacity fans which circulate the room air through cooling coils served by the emergency plant service water system.

Accumulation of dust on electrical equipment in the diesel generator engine room, which can cause electrical malfunctions, is kept under control by filtering all recirculated air. The door to each room is weather sealed. The concrete walls, ceilings, and floors are sealed and painted to prevent concrete dust. Engine combustion air, which sees only the inside of the engine, is filtered to minimize engine deposits and to minimize wear on sliding surfaces.

In addition, administrative control over housekeeping will be established early on and will be vigorously pursued. All equipment, appurtenances, and walls are kept wiped free of dust and floors are kept mopped.

The following pressure readouts and alarms are provided in the engine control panel:

a. Combustion Air Manifold Pressure, Right Bank

b. Combustion Air Manifold Pressure, Left Bank

c. HEPA Filter Differential Pressure High

9.14.5.3 Safety Evaluation

The Diesel Generator Combustion Air Intake and Exhaust System is designed to function before, during, and after an SSE, to ensure that a seismic event will not degrade the Diesel Generator Combustion Air Intake, and Exhaust System to the point that the function of a diesel generator unit is jeopardized.

Vertical and horizontal separation between the combustion air intake and engine exhaust gas discharge precludes any significant dilution of the combustion air by exhaust gases.

No gaseous fire extinguishing mediums will be used in or in the vicinity of the Diesel Generator Building. Significant dilution of the combustion air from gases of this type is therefore precluded.

9.14.5.4 Inspection and Testing Requirements

After installation, the entire Diesel Generator Combustion Air Intake and Exhaust System will be functionally tested on the plant site.

Each Diesel Generator Combustion Air Intake and Exhaust Subsystem is periodically tested to verify its ability to function as part of the diesel generator unit.

Under normal standby conditions, the Diesel Generator Combustion Air Intake and Exhaust Subsystem is inspected at predetermined intervals. These inspections include the air intake filter and water or debris accumulation in the exhaust silencers and piping. Inspections may be made at more frequent intervals, as dictated by the particular conditions and operating schedules of the diesel generator units.

10.0 STEAM AND POWER CONVERSION SYSTEM

10.1 Summary Description

The Steam and Power Conversion System is designed to convert the heat produced in the reactor to electrical energy. The operation of the equipment, piping and valves in the system do not affect the reactor and its safety features. The CRBRP is a three-loop concept plant. Sodium coolant in the Primary Heat Transport System enters the reactor where it is heated and pumped to intermediate heat exchangers (IHX's). The intermediate heat exchangers transfer heat to the intermediate sodium coolant, which is pumped through the Steam Generator System. Heat is transferred to the Main Steam System by the steam generator modules in each of three loops. Sufficient superheated steam is provided to to drive a tandem compound steam turbine with a maximum capability of 436,799 KWe for the stretched reactor output of 1121 MWt and its auxiliaries operating in a closed condensing cycle with six stages of regenerative feedwater heating. The turbine generator has a capability of 374,567 KWe for the rated reactor output of 975 MWt. Exhaust steam is condensed in one surface type steam condenser and returned to the steam generators as heated feedwater with a major portion of its gaseous, dissolved, and particulate impurities removed.

The major components of the Steam and Power Conversion System are: turbine-generator-exciter, main condenser, condensate pumps, turbine gland steam system, turbine bypass steam system, condensate demineralizer system, steam generator feed pumps and feedwater heaters (Figure 10.1-1). The heat rejected in the main condenser is removed by the circulating water system to the mechanical draft cooling tower for ultimate disposal of waste heat to the atmosphere.

The superheated steam produced by the steam generator is passed through the high pressure turbine where the steam is expanded and then exhausted to the low pressure turbines. From the low pressure turbines, the steam is exhausted into the main condenser where it is condensed, and then returned to the cycle as condensate. Condensate pumps take suction on the hotwell and discharge through the condensate demineralizer ion exchanger, steam packing exhauster, three stages of low pressure feedwater heaters and into the deaertor. The steam generator feed pumps take suction from the deaerator and supply feedwater through two stages of high pressure heaters then through topping heaters to the steam generators. The feedwater is heated in the heating cycle by steam supplied from turbine extractions and also by recovering heat from the continuous steam generator drum drains.

The Circulating Water System is designed to receive and dissipate 65% of the total heat produced in the reactor following an abnormal shutdown of the turbine generator from a rated load condition. Heat dissipation under these circumstances is accomplished in the various plant cooling systems, turbine bypass to the condenser and deaerator and the steam generator atmosphere relief valves. The turbine bypass system is designed to control steam generator pressure by dumping excess steam during startup, shutdown and for transient periods during power operation when the steam generation exceeds the turbine steam requirements.

The condenser is provided with an air extraction system to prevent loss of vacuum due to non-condensible gas accumulation in the condenser. The air extraction system is designed to maintain the condenser at 2" Hg absolute pressure and the exhaust pressure is monitored in the main control room. If the exhaust pressure increases to 4.5" Hg absolute, the alarm in the control room will be on and the second vacuum pump will have been automatically put in service at 4.0" Hg absolute.

Corrosion of the condenser tubes is controlled by the proper material selected (90 Cu-10 Ni/70 Cu-30 Ni) and chemical treatment of the circulated water. Corrosion/erosion of the exterior of the condenser tubes is controlled by the proper treatment of the condensate (i.e., deaerating, condensate polishing, blowdown) to ensure low dissolved oxygen and solid content and protection of the tubes from high velocity steam by the use of impingement plates.

The following design features have been provided to preclude failures of condenser tubes or components from turbine bypass, blowdown or other high temperature drains into the condenser shell.

a) Impingement baffles are provided at all inlets except the make-up water inlet, main steam bypass and the exhaust neck. These baffles which are provided for all drains and blowdown lines are designed to preclude any possibility of steam impingement tube erosion.

b) The condenser is protected during main steam bypass through the use of perforated pipe discharge headers. These headers are designed to distribute the bypass flow evenly throughout the condenser.

The principal design and performance characteristics of the Steam and Power Conversion System are summarized in Table 10.1-1. The system heat balances for both rated load and stretched load conditions are shown in Figures 10.1-2 and 10.1-3.

10.2.2 Description

The turbine consists of one single flow, high pressure cylinder and three double flow, low pressure cylinders. The turbine is equipped with extraction nozzles to provide steam for six stages of feedwater heaters.

Bleed steam for feedwater heating is provided from the following sources:

Heater	Extraction Source/Stage
6	LP turbine bleed - 13th
5	LP turbine bleed - 12th
4	LP turbine bleed - 11th
3 (Deaerator)	LP turbine bleed - 9th
2	HP turbine exhaust -7th
1	HP turbine bleed - 4th

10.2.2.1 Each of the four main steam lines is provided with a stop valve and a control valve which are automatically activated by the turbine control system. During an event resulting in turbine stop and control valve fast closure, turbine inlet steam flow will be stopped in less than .2 seconds. Since the steam goes directly from the high pressure (HP) turbine to the low pressure (LP) turbine instead of going to a reheater or moisture separator, no additional energy or large volume of stored energy exists and, therefore, stop and intercept valves are rot required between the HP and LP turbines.

10.2.2.2 A shaft sealing system, using steam to seal the annular openings where the shaft emerges from the casings, prevents steam outleakage and air inleakage along the shaft. The gland sealing system includes all necessary piping, valves, controls, and a steam packing exhauster which exhausts to atmosphere through a roof vent.

10.2.2.3 The hydrogen and water cooled generator, rated at 485.3 MVA at 90 percent power factor, produces power at 22KV and 60 Hz. Generator rating, temperature rise and class of insulation are in accordance with the manufacturer's codes and standards. Excitation is provided by a shaft driven alternator with its output rectified. Stator conductors are water cooled.

10.2.2.4 Turbine generator bearings are lubricated by a conventional oil system. A turbine shaft driven lube oil pump takes suction from the lube oil tank through an oil-driven booster pump. At shaft speeds below approximately 3,240 rpm, or upon a drop in oil pressure, a motor-driven auxiliary oil pump provides lubrication. In addition, upon succeeding drops in lube oil pressure to predetermined set points, the turbine generator will trip, and lubrication for coastdown will be provided by either an AC oil pump or a DC emergency bearing oil pump. Heat from bearing friction is removed by the Secondary Service Closed Cooling Water system in either of two full capacity oil coolers.

10.2.2.5 Supervisory instruments continuously monitor and record, except as noted, such turbine generator parameters as:

a. Shaft vibration at the main bearings
b. Shell expansion
c. Control valve position (when unit is synchronized)
d. Turbine speed (when unit is not synchronized)
e. Shaft eccentricity (at turning gear speed only)
f. Differential expansion
g. Rotor expansion
h. Shell temperature
i. Vibration phase angle (as needed)
j. Throttle pressure
k. Exhaust hood temperature
l. Stop and control valve temperatures
m. Steam seal header temperature
n. Crossover temperatures

Other parameters to be continuously recorded are:

a. Turbine generator bearing metal temperatures
b. Lube oil temperatures
c. Thrust bearing metal/drain temperatures
d. Throttle temperature

10.2.2.6 The turbine uses an Electro Hydraulic Control (EHC) System whose prime function is to control the speed of the turbine when the generator is not synchronized with the system and to control the output of the unit when the generator is on the line. This is accomplished by positioning the previously mentioned control valves to regulate the flow of steam to the turbine. The control valves are operated by piston type servo-motors, using a pressurized non-flammable hydraulic fluid for opening the valves. The hydraulic system receives control signals from the speed governor and emergency governor.

The Turbine Generator unit has a load following capability which can be initiated in several ways. Unit load changes can be accomplished through control signals initiated by the operator from the EHC section of the Main Control Panel. Alternatively, the EHC system can be put into the remote automatic mode whereby the loading or unloading signals are generated by the plant control system (refer to Section 7.7.1). In both cases, the controlling signals will ramp the unit at the selected rate to the desired load provided a plant limiting condition does not override the loading ramp.

To assure high reliability of the trip circuits, multiple logic consisting of two out of two and two out of three logic system for important and vital trip functions are utilized in the EHC System. The trip solenoid and the trip relay will be energized if at least two out of the three actuating relays close their contacts. Failure of one relay to close contacts will not prevent the trip action, and accidental actuation of one relay causing contact closure will not result in a false trip.

There are four methods of turbine overspeed control protection. They are:

a. EHC speed control unit
b. EHC trip anticipator
c. Mechanical overspeed trip
d. Back-up overspeed trip

The speed control unit of the electro hydraulic control system provides speed error signals for repositioning the control valves. Three distinct speed error signals are derived by this unit and applied to a low value gate which permits propogation of the signal demanding the smaller valve opening.

The trip anticipator's functions are to avoid a turbine overspeed following a load rejection which is accompanied by a failure of one or more of the control valves to close, and to prevent a turbine trip when the speed control unit is functioning properly. A closing signal to the main stop valves is generated by comparing the rotor speed with a load dependent reference signal. The reference signal has a characteristic which linearly decreases in magnitude as the load increases. Thus, the speed at which the trip anticipator provides a closing signal decreases with increasing load, thereby, reducing the possibility of an excessive overspeed. After the trip anticipator has closed the stop valves and shaft speed has decreased to near rated speed the trip anticipator will reset causing the stop valves to reopen. This will be followed by opening the control valves by the speed control unit to maintain the generator at rated speed. At this point, the Turbine-Generator unit is ready for reloading.

If the turbine accelerates to approximately 110% of rated speed, the mechanical overspeed trip mechanism trips the turbine. This system makes use of the conventional eccentric ring type overspeed trip device. The operation of the mechanical trip mechanism causes the stop and control valves to trip closed, as described in detail below, thereby, preventing all steam from entering the turbine.

In addition, there is a back up electrical overspeed trip set at approximately 1% above the mechanical overspeed trip setting. This protective system makes use of three magnetic speed pick ups which provide electrical signals proportional to rotor speed. If two out of three of these signals exceed the set point, a trip signal is generated. The set point differential between the mechanical and electrical overspeed trip systems permits each trip device to be tested separately.

The turbine has two separate and distinct trip systems, both of which cause hydraulic fluid to be dumped from the stop, control and air pilot valves. Refer to Figure 10.2-3, Protection System Block Diagram.

1. The mechanical trip system requires the activation of the mechanical trip latch assembly by one of the following: a) operation of the mechanical trip solenoid valve (MSTV) which is energized by an electrical signal fromthe 125V DC trip bus or the overspeed trip test logic, b) operation of the mechanical overspeed trip (OST) mechanism initiated by an overspeed or loss of bearing oil pressure, c) operation of the mechanical trip handle. Once the trip latch assembly is activated, it operates the mechanical trip pilot valve which in turn actuates the mechanical trip valve. This causes the high pressure hydraulic fluid to be released resulting in the closure of the stop control and air relay dump valves.

2. The electrical trip system operates by deenergization of the electrical trip solenoid valve (ETSV) with a signal from the trip anticipator, the 24 DC trip bus or the overspeed trip test logic. This solenoid actuates the electrical trip valve (ETV) which in turn will cause the release of high pressure hydraulic fluid and the closure of the stop control and air relay dump valves.

Either the mechanical overspeed or the backup overspeed trips will shut down the turbine by simultaneously closing all the main steam stop and control valves. the failure of any one stop or control valve to close will not disable the turbine overspeed control function, because the valves are in series. Therefore, if one valve fails to close, the other valve will stop the steam flow. A failure of one control valve causes the other valves to increase or decrease their opening to compensate for that valve. If one valve fails open at low load condition, the other valves close. If the closing of the other valves is not enough to compensate for that valve, the turbine overspeeds thereby resulting in the operation of the overspeed protection system.

The valves described above will be closed daily by using the valve test mode of the turbine control system. Pressure variations caused by closing a control valve cause the other control valves to open. Therefore, if operating near full load, testing must be done at a reduced power level to provide sufficient margin for pressure control.

In addition to providing speed and load control and overspeed protection, the control system automatically trips the turbine generator under any of the following conditions:

a. Excessive shaft vibration,
b. Generator electrical faults,
c. Low condenser vacuum,
d. Thrust bearing failures,
e. Low bearing oil pressure,
f. Low hydraulic pressure
g. High exhaust hood temperature,
h. Manual operation of several trip levers,
i. Loss of stator coolant, or
j. Low throttle pressure.

10.2.2.7 The extraction steam system is designed to withstand the transients imposed on it by a turbine trip and to prevent reverse flow of steam or water into the turbine. Each of the extraction steam lines has at least one non-return valve and a motor driven isolation valve with the exception of the extraction lines to the low pressure heaters 6A, 6B, 6C. Whether one or two non-return valves are required in an extraction line is dependent upon the amount of unrestrained energy available in the extraction line and heater.

Upon a turbine trip, air pressure is released from the actuator on the non-return valves allowing the springs in these valves to drive the valves in the closed direction. Under static conditions (no flow), these valves will close in less than 2 seconds. Upon a flow reversal these valves immediately close. The valves receive a close signal upon a turbine trip. Because of the fast closure time of the non-return valves and the short distance between the above valves and the extraction points at the turbine, steam in the extraction steam system does not affect the turbine coastdown following a turbine trip.

The total amount of energy which would accelerate the turbine upon a turbine generator trip is that steam which is trapped in the turbine and the lines to the extraction steam check valves. The turbine steam system does not incorporate stop and intercept valves between the high pressure and low pressure turbine since the steam goes directly from the high pressure turbine to the low pressure turbine instead of going to a reheater or moisture separator and, therefore, no additional energy or large volume of stored energy exists. This total stored energy is calculated based on the piping volume and extraction steam conditions and cannot exceed an energy value set by the turbine generator contractor for stable shutdown.

The Extraction Steam Check (Non-Return) Valve is a positive closing, free swinging disc check valve. The valve is of the power assisted (spring) closing type in which the operating cylinder is held in a neutral position (free swing) by air pressure until a trip signal releases the air the spring forces the check valve closed. Additionally, the extraction check valve is counter-weighted to reduce the required closing moment.

10.2.2.8 The turbine generator is designed to accept the loss of external electrical load and remain in service supplying the plant's auxiliary load. If the unit is suddenly subjected to a 40% or greater loss of load, the following events will take place in rapid succession.

1. The power load unbalance circuitry will start running the load set motor back toward zero load.

2. The turbine will begin accelerating.

3. The control valves will close at the maximum rate by means of the fast acting solenoid, this being initiated by the power load unbalance circuits.

   Also, if the unit is above approximately 70% load, the trip anticipator may close the stop valves as was discussed earlier.

4. The entrained steam between the valves and the turbine in the turbine casing and in the extraction lines will expand within approximately 1.5 seconds.

5. When the entrained steam has ceased expanding, the rotor speed will start decreasing gradually at a rate depending on the auxiliary load remaining on the generator.

6. If the trip anticipator was actuated, it will reset at this point opening the stop valves. The power/load unbalance circuit will clear automatically when the load reference motor reaches the no load flow point.

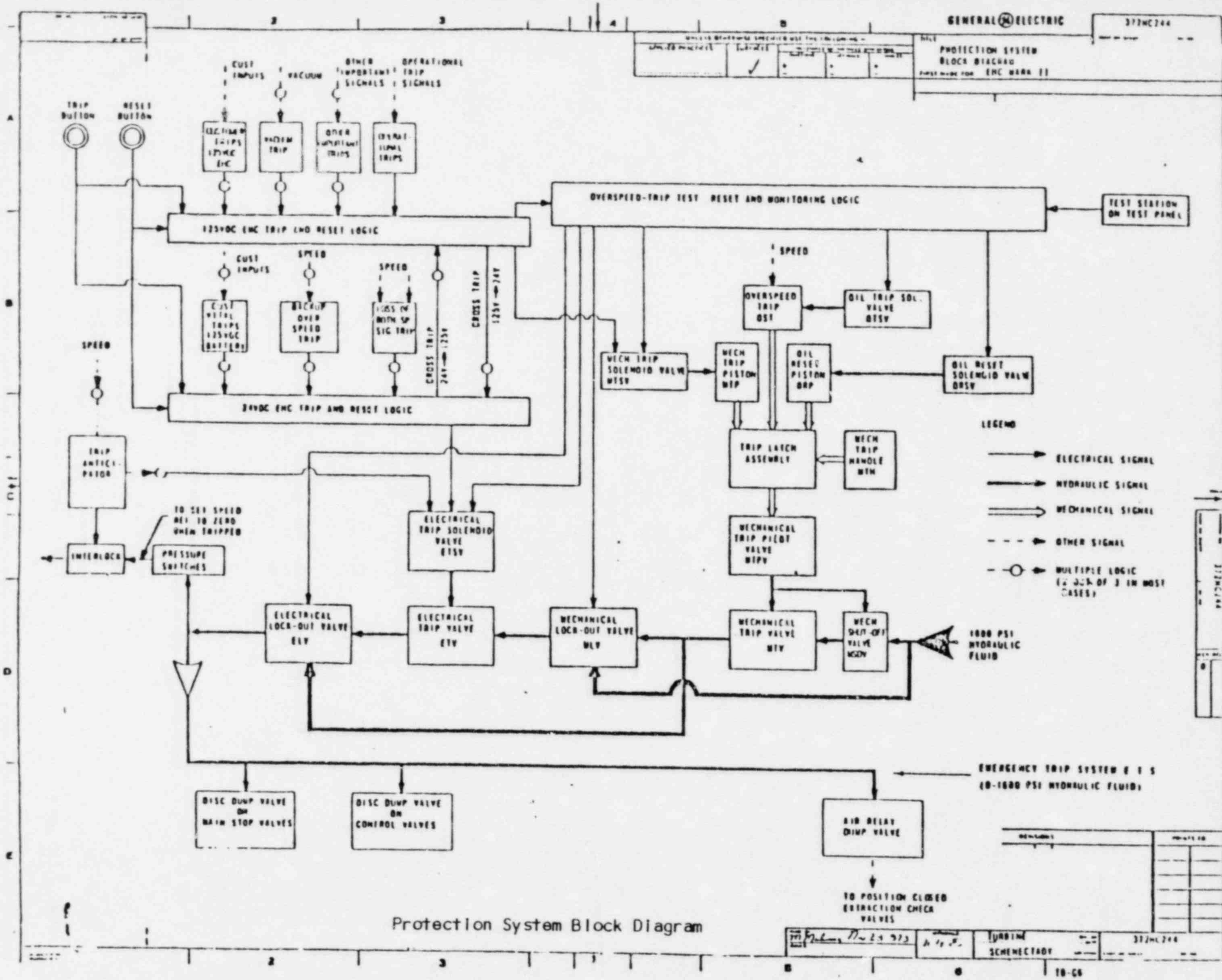
7. When the speed has decreased to approximately 100% of rated speed, the control valves will start to reopen under speed control.

8. The unit will now be close to rated speed ready for resynchronization.

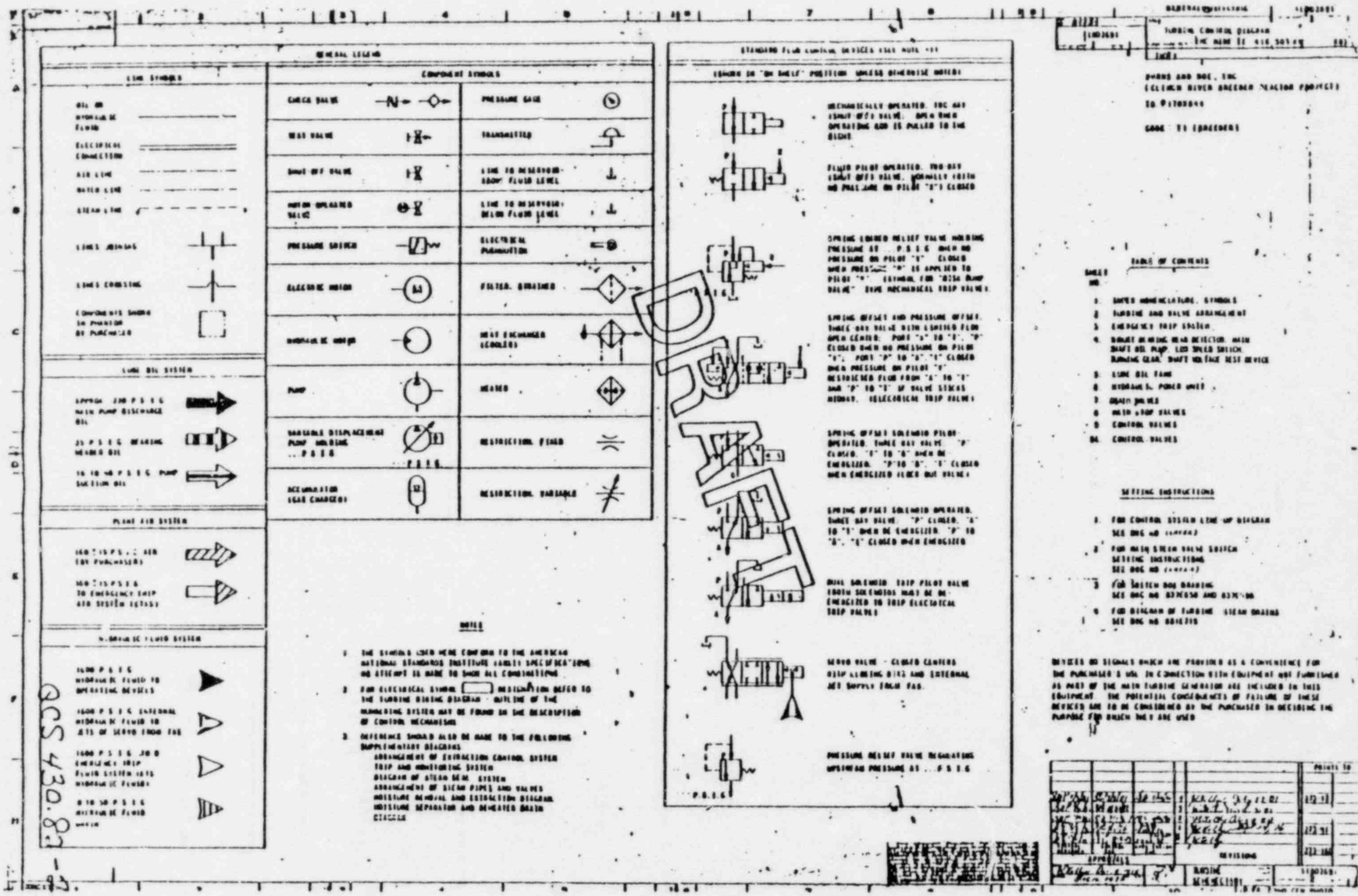
10.2.2.9 For overpressure protection rupture diaphragms are provided in each low pressure turbine exhaust hood. Additional protective devices include exhaust hood high temperature alarm and trip and a pilot dump valve for protective closing of extraction non-return valves.

10.2.2.10 The generator hydrogen control system includes pressure regulators for control of the hydrogen gas, and a circuit for supplying and controlling the carbon dioxide used in purging the generator during filling and degassing operations. To maintain the hydrogen within the generator casing at the purity level required, the generator is designed with shaft seals and associated control equipment to prevent leakage of the hydrogen. This seal function is provided for by a pressure oil supply which is furnished with a separate, package-type combination of equipment including filters, coolers, emergency DC seal oil pump, seal oil control equipment and necessary detraining tanks, loop seals and pressure switches required for detraining the gases from the oil before it is sent to the shaft seals.

10.2.2.11 The bulk hydrogen and carbon dioxide storage systems consist of several pre-assembled modules located outdoors with interconnecting piping. The storage bank is composed of ASME Coded Section VIII storage units manifolded in active and reserve banks. Each storage cylinder is mounted in supporting frames restrained from movement. Shut off valves and vents are provided for each storage cylinder.



Protection System Block Diagram


GENERAL LEGEND
LINE SYMBOLS
COMPONENT SYMBOLS
CHECK VALVE
PRESSURE GAGE
TEST VALVE
TRANSMITTER
SHUT OFF VALVE
MOTOR OPERATED VALVE
PRESSURE SWITCH
ELECTRIC MOTOR
FILTER, STRAINER
HYDRAULIC MOTOR
HEAT EXCHANGER (COOLER)
PUMP
HEATER
RESTRICTION, FIXED
ACCUMULATOR (GAS CHARGED)
RESTRICTION, VARIABLE
LUBE OIL SYSTEM
PLANT AIR SYSTEM
HYDRAULIC FLUID SYSTEM
NOTES
TURBINE CONTROL DIAGRAM
BURNS AND ROE, INC
(CLINCH RIVER BREEDER REACTOR PROJECT)
TABLE OF CONTENTS
1. SHEET NOMENCLATURE, SYMBOLS
2. TURBINE AND VALVE ARRANGEMENT
3. EMERGENCY TRIP SYSTEM
5. LUBE OIL TANK
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9. CONTROL VALVES
10. CONTROL VALVES
SETTING INSTRUCTIONS
1. FOR CONTROL SYSTEM LINE-UP DIAGRAM
3. FOR SWITCH BOX DRAWING
4. FOR DIAGRAM OF TURBINE STEAM DRAINS
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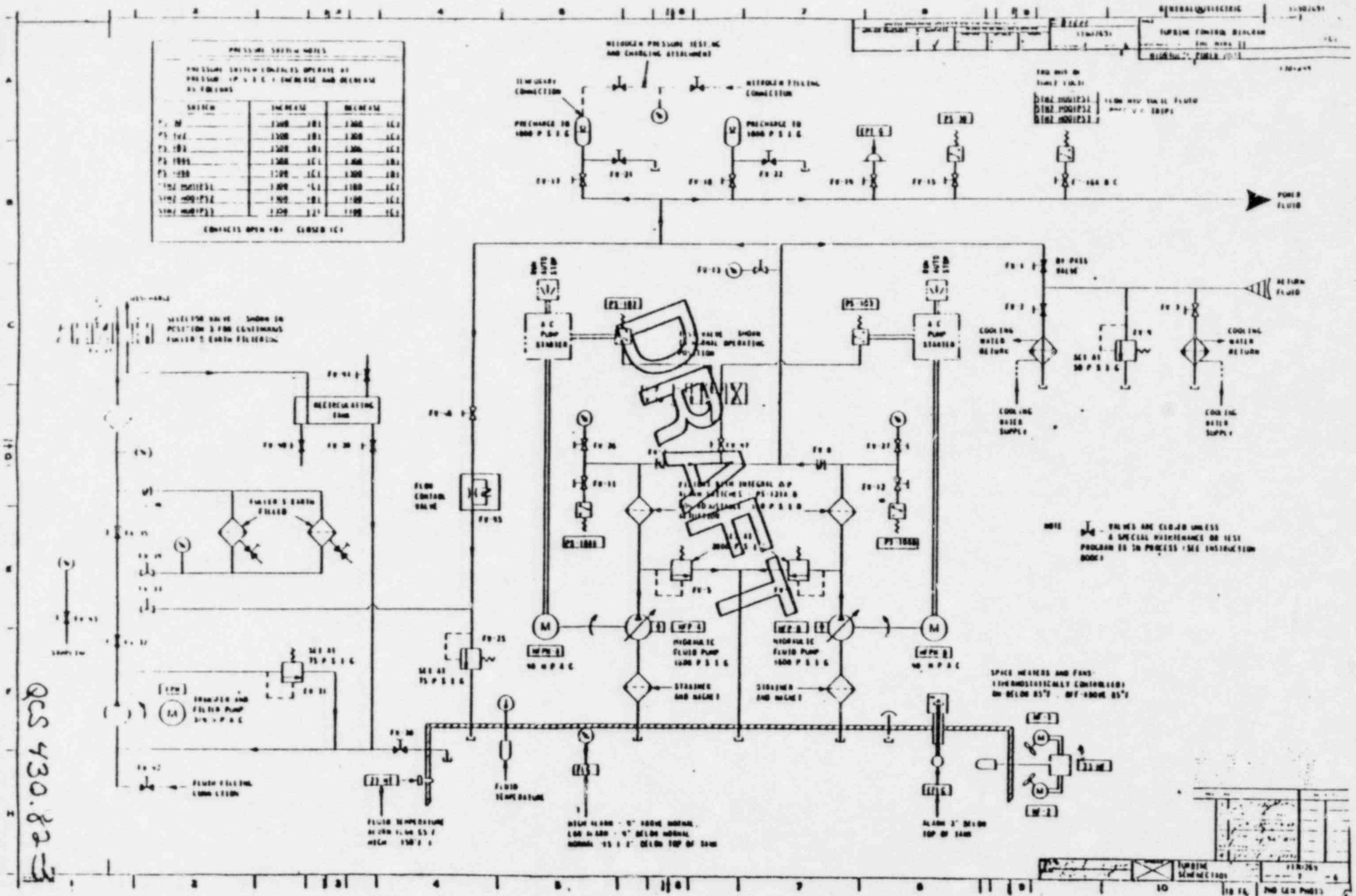
PRESSURE SWITCH NOTES
GENERAL ELECTRIC
TURBINE CONTROL DIAGRAM
POWER FLUID
RETURN FLUID
BY PASS VALVE
COOLING WATER RETURN
COOLING WATER SUPPLY
A C PUMP STARTER
FLOW CONTROL VALVE
RECIRCULATING TANK
FULLER'S EARTH FILTER
HYDRAULIC FLUID PUMP 1600 P S I G
STRAINER AND MAGNET
FLUID TEMPERATURE
TURBINE SCHENECTADY
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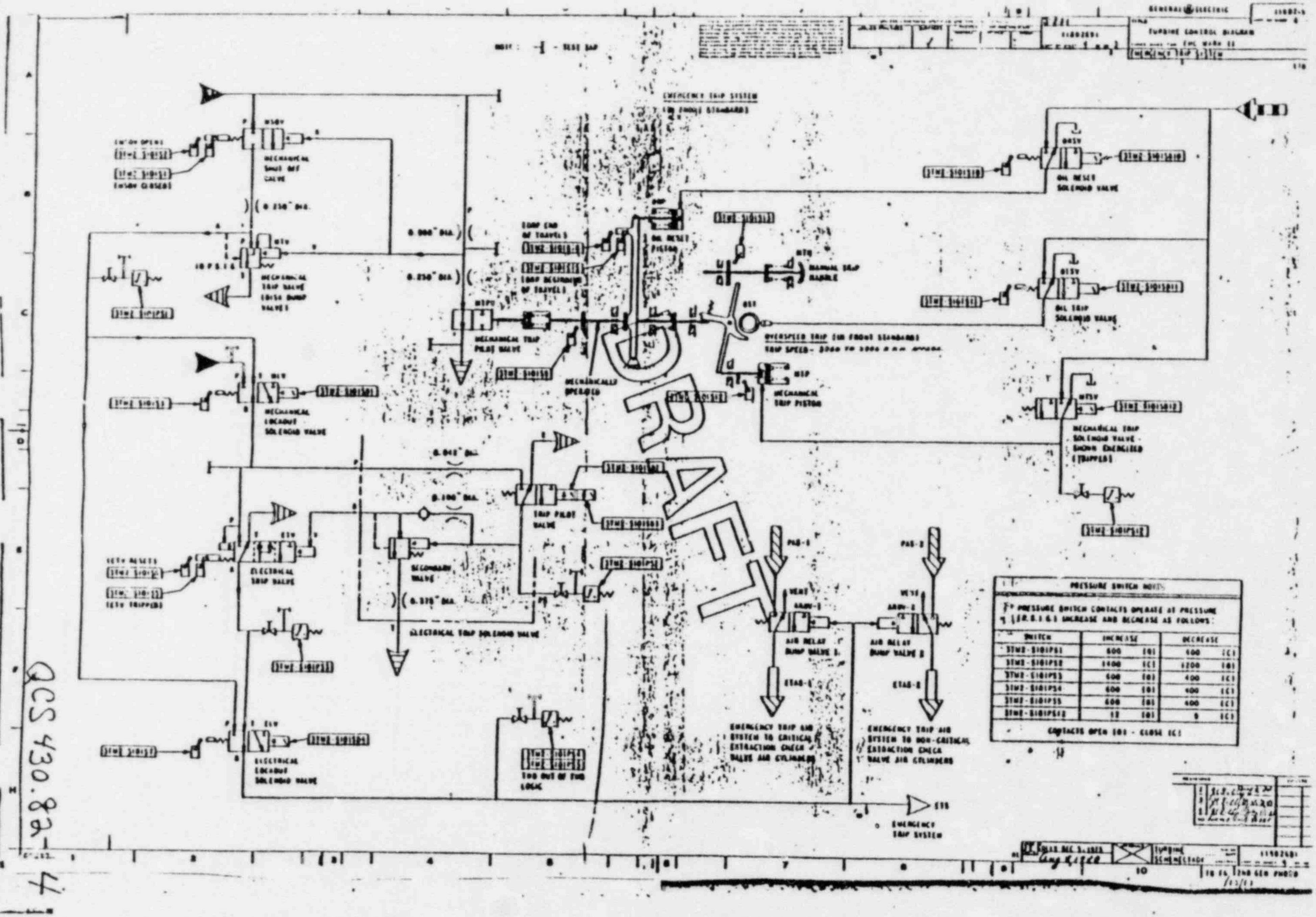
QCS 430.82-3



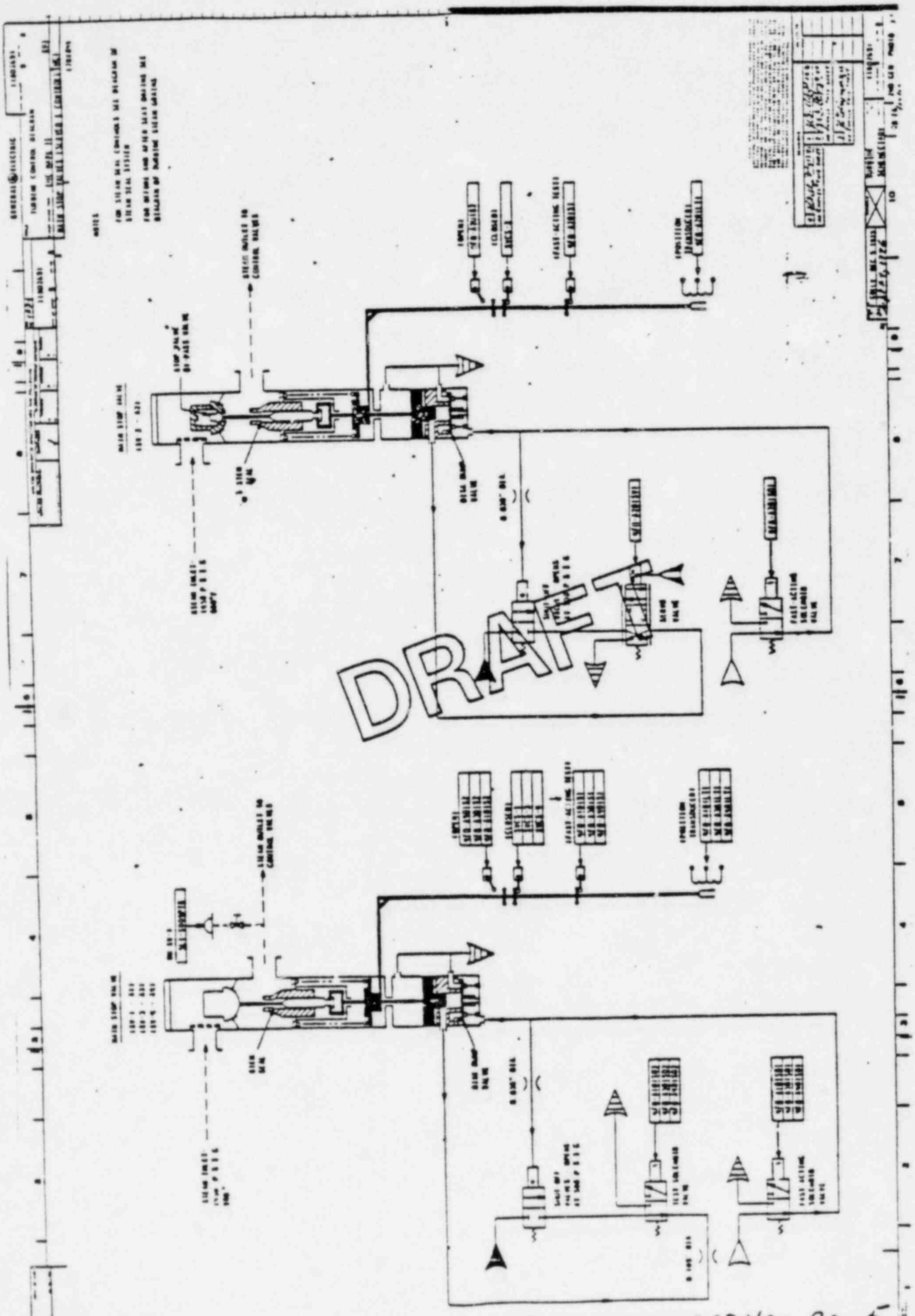
PRESSURE SWITCH NOTES

PRESSURE SWITCH CONTACTS OPERATE AT PRESSURE INCREASE AND DECREASE AS FOLLOWS:

SWITCH	INCREASE		DECREASE	
3TM2-S101PS1	600	(O)	400	(C)
3TM2-S101PS2	1400	(C)	1200	(O)
3TM2-S101PS3	600	(O)	400	(C)
3TM2-S101PS4	600	(O)	400	(C)
3TM2-S101PS5	600	(O)	400	(C)
3TM2-S101PS12	12	(O)	9	(C)

CONTACTS OPEN (O) - CLOSE (C)

QCS 430.82-4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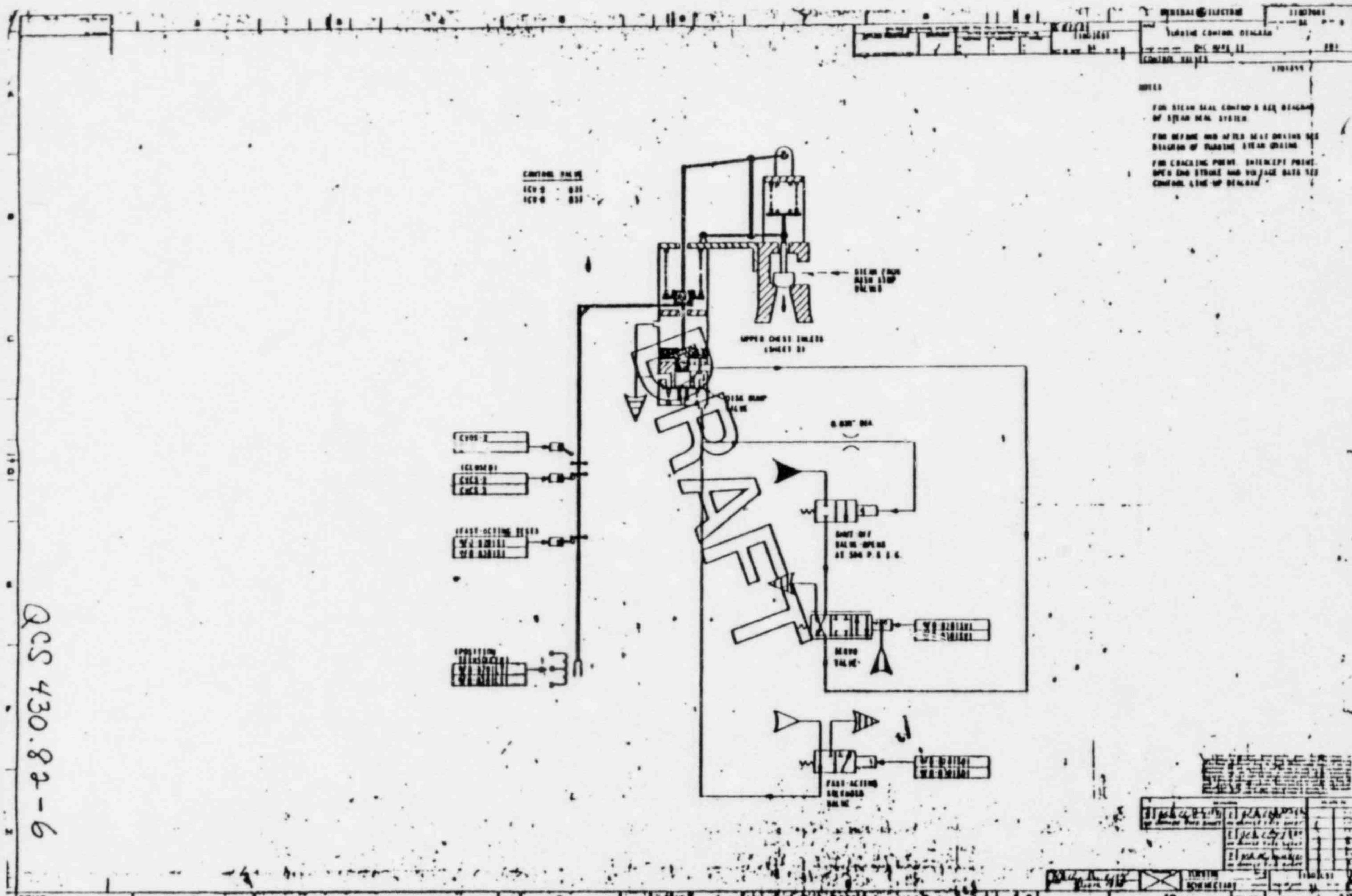
GENERAL ELECTRIC
TURBINE CONTROL DIAGRAM
CONTROL VALVES
NOTES
UPPER CHEST INLETS (SHEET 3)
SERVO VALVE
FAST-ACTING SOLENOID VALVE
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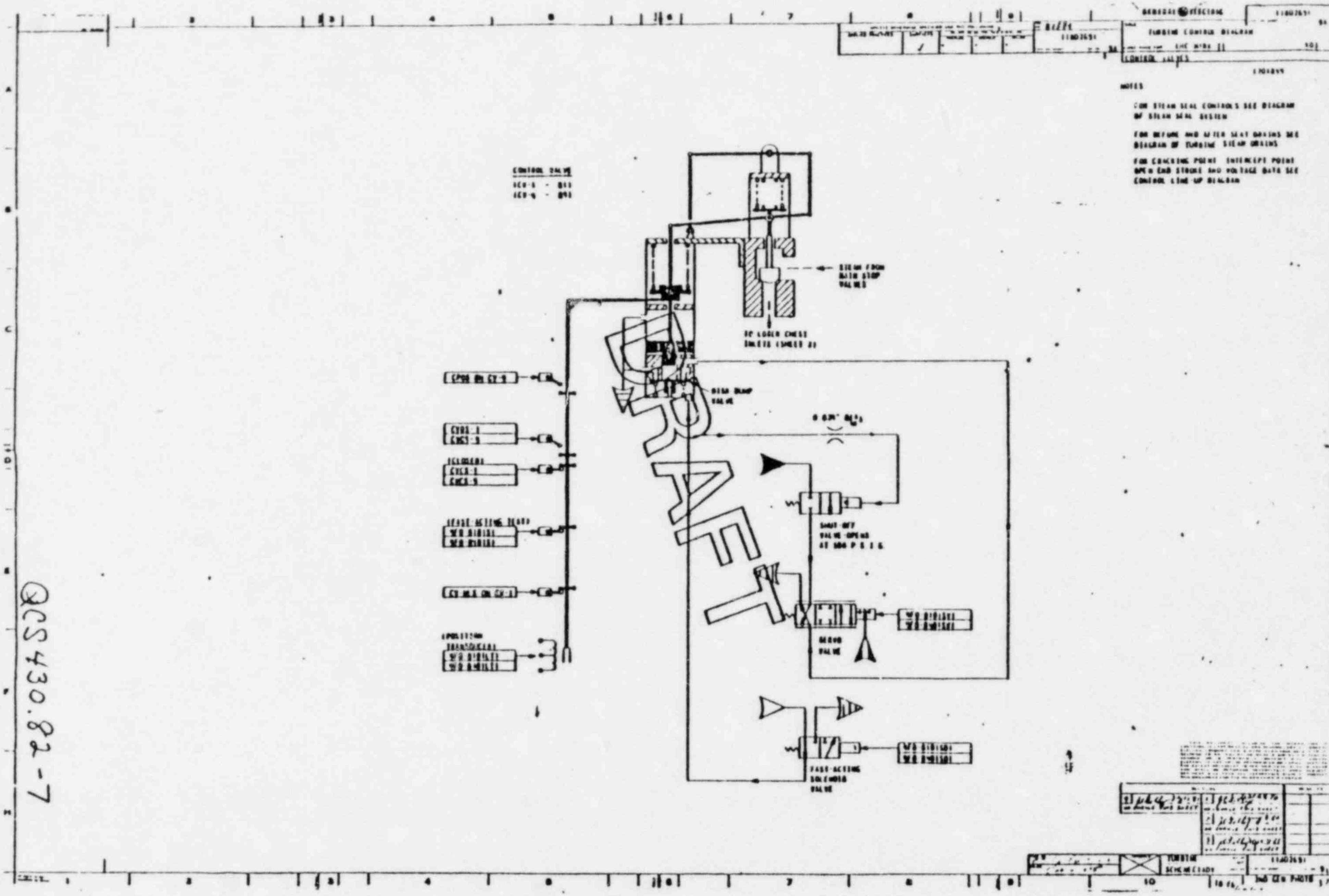
QCS 430.82-6


GENERAL ELECTRIC
TURBINE CONTROL DIAGRAM
CONTROL VALVES
NOTES
FOR STEAM SEAL CONTROLS SEE DIAGRAM OF STEAM SEAL SYSTEM
FOR BEFORE AND AFTER SEAT DRAINS SEE DIAGRAM OF TURBINE STEAM DRAINS
FOR CRACKING POINT INTERCEPT POINT OPEN END STROKE AND VOLTAGE DATA SEE CONTROL LINE UP DIAGRAM
CONTROL VALVE
STEAM FROM MAIN STOP VALVES
TO LOWER CHEST INLETS (SHEET 2)
SHUT-OFF VALVE OPENS AT 500 P.S.I.G.
SERVO VALVE
FAST-ACTING SOLENOID VALVE
DRAFT

QCS430.82-7

10.3 Main Steam Supply System

The Main Steam Supply System is shown in Figure 10.3.1.

10.3.1 Design Bases

The Main Steam Supply System includes steam piping and components downstream of the steam piping anchor at the steam generator building penetration and conveys superheated steam from each of the three steam generator loops to the high pressure turbine. Each steam generator loop is designed to furnish approximately 1,110,000 pounds per hour of 1535 psig, 906°F steam at the superheater outlet nozzle.

The portion of the Main Steam Supply System downstream of the piping anchor at the steam generator building penetration up to the turbine stop valves and including the turbine by-pass piping is designed to ANSI B31.1. The piping and component upstream of that point are safety related and designed in accordance with ASME Code Section III as discussed in Section 5.5. Piping downstream of the turbine by-pass valves and the isolation valve for the steam seal regulator are designed in accordance with ANSI B31.1, or manufacturer's standard. This portion of the system has no safety function, accordingly, no special precautions have been taken for protection from environmental effects.

A turbine by-pass system bypasses up to 80 percent of the rated steam flow (975 MWt) directly from the main steam header to the condenser and the deaerator.

No safety-related equipment is located in the turbine building. Therefore, a main steam line break cannot jeopardize any safety-related equipment. The ventilation system for the turbine generator building is not safety-related and effluent resulting from a main steam line break will not affect the HVAC system for any vital area.

10.3.2 Description

Three separate lines convey the superheated steam from the three steam generator loops to the main steam header. Following temperature and pressure equalization in the main steam header, the steam is carried to the turbine by four parallel pipes. Each of these pipes contains a stop valve and a turbine governor control valve.

The turbine bypass is connected to the main steam header located before the turbine stop valves. Figure 10.3-1 shows a diagrammatic arrangement of the Main Steam Piping System.

Steam to the deaerator is controlled by a 6" control valve. Construction details are not available at this time. This valve serves two functions:

1. During low load operation (less than 25%) the valve maintains a minimum pressure of 21 psia in the deaerator.

2. Upon a turbine trip, the valve allows as much as 15% of rated steam flow to the deaerator to maintain a pressure of 65 psia in the deaerator.

To protect the deaerator the valve fails closed and safety valves are provided on the deaerator.

Steam to the condenser is controlled by four pressure reducing control valves. These valves are 6" globe-type, air operated diaphragm, butt weld ends, alloy steel, 2500 ANSI pressure rating, fail closed normally closed. The pressure reducing control valves operate as follows:

> During normal plant operation (above 40% reactor power) the valves are automatically controlled by the Plant Control System based upon a load error signal (TG load vs. reactor power). For rapid reductions in the load, the valves are opened to minimize transients on the reactor and the valves are then generally closed as reactor power approaches the load.
>
> During turbine trip or operation below 40% power the bypass valves are controlled by steam pressure only. That is, they will open and close as necessary to keep steam header pressure at 1,450 psig.
>
> See PSAR Section 7.7.1.8 for more detailed information on the steam dump and bypass control system.

Each valve can pass 16% of rated steam flow and maintain control down to 1/2 of 1% of rated steam flow. To protect the condenser, the valves are fail closed design. They also close upon high condenser vacuum (5" Hg absolute) and desuperheater malfunction. Desuperheater malfunction is determined by monitoring bypass steam temperature to the condenser. The pressure reducing control valves reduce the pressure to 250 psia and are designed to open in less than three seconds.

The desuperheater consists of a mixing nozzle mounted in a 24" diameter pipe spool which is located in the bypass dump line between the condenser and the pressure reducing control valve. The mixing nozzle injects atomized condensate into the dump line in order to lower the dump steam temperature to 450°F. The temperature is controlled by a water control valve which regulates the amount of condensate to the desuperheater nozzle. The water control valve is regulated by a thermocouple downstream of the desuperheater. Because of the fast opening time of the pressure reducing valves, the water control valve initially opens to the full open position and remains full open for 5-10 seconds and then responds to the thermocouple controller, thus avoiding the possibility of superheated steam being dumped into the condenser. The condensate is atomized by steam from the main steam header. A drip pot is located downstream of the desuperheater and any condensate in the line is returned to the desuperheater.

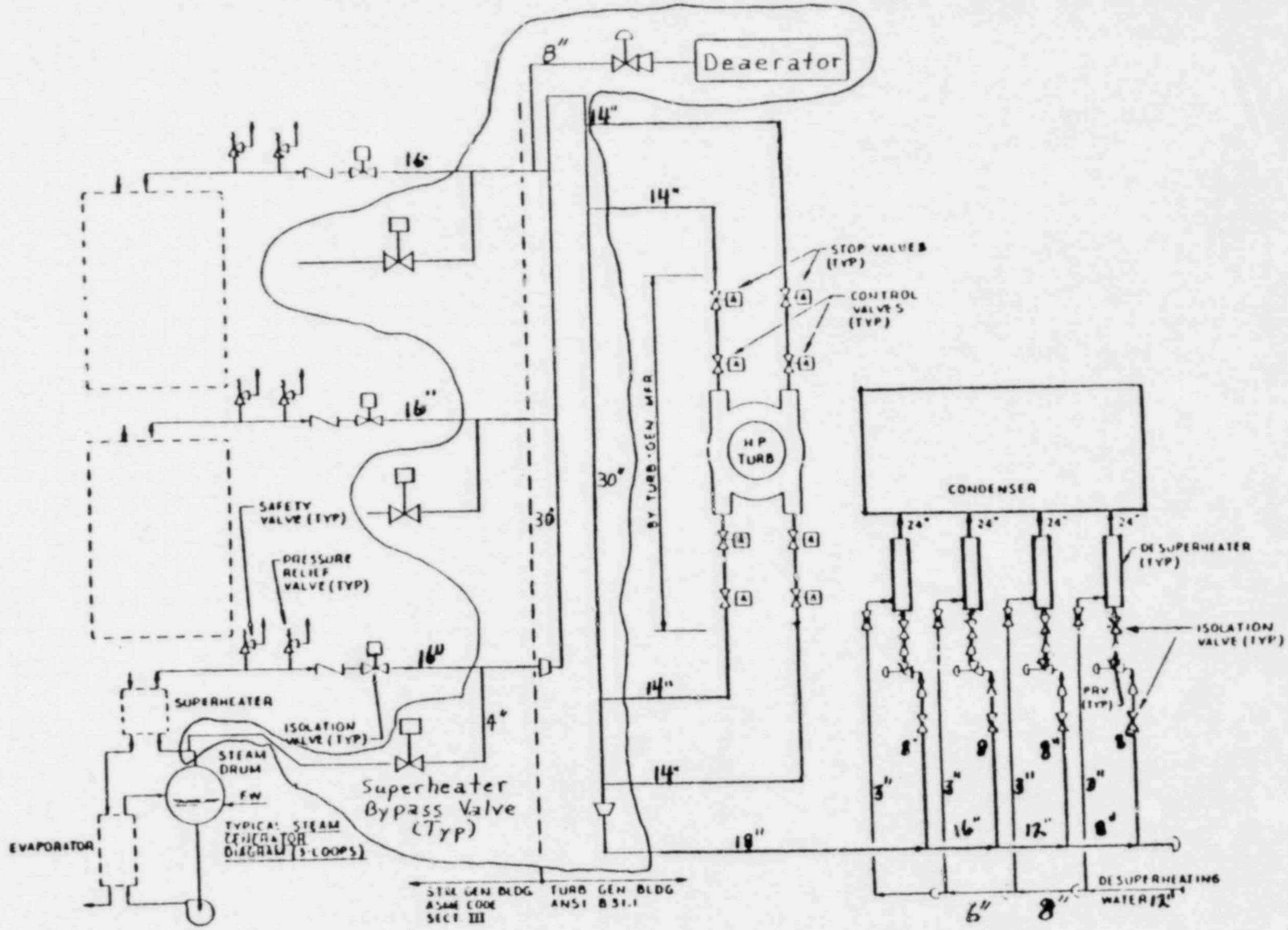


Figure 10.3-1. Basic Flow Diagram - Main Steam and Steam Dump System

10.4 OTHER FEATURES OF STEAM AND POWER CONVERSION SYSTEM

None of the subsystems described in this section are related to plant nuclear safety. Tests, inspections, and instrumentation applications will therefore not exceed those dictated by conventional good practice for steam power plants. Residual heat removal systems are discussed in Section 5.6.

10.4.1 Condenser

10.4.1.1 Design Bases

The condenser is designed for operation at all loads up to and including the maximum expected load (stretch load 115 percent of rated load); it also provides capability to accept up to 65 percent of the steam flow at 975 MWt upon instantaneous turbine load rejection. The condenser hotwell is designed for three minute storage capacity, approximately 17,200 gallons, at maximum load and to provide capability for deaeration in order to maintain a dissolved oxygen concentration of less than 0.005 cc/l. Table 10.4-1 gives design and performance parameters.

The condenser is furnished in accordance with Heat Exchanger Institute Standards for Steam Surface Condensers. It is not regarded as safety related equipment because emergency residual heat removal is performed by the SGAHRS (see Section 5.6).

10.4.1.2 Description

The single shell condenser is mounted beneath the low pressure turbine exhausts with the condenser tubes oriented parallel to the turbine shaft and provides capability to accept up to 65 percent of the steam flow at 975 MWt upon instantaneous turbine load rejection. Four 24-inch diameter turbine bypass steam inlets to the condenser shell provide means of exhausting the rejected steam into the condenser without any detrimental effects to the condenser or turbine internals.

The condenser is divided into two sections, east and west. Thus, to correct a condenser cooling water inleakage problem the plant could be powered down so that the condenser section found to be leaky can be isolated. The leak will then be located, repaired and the isolated condenser section put back into service.

10.4.1.3 Evaluation

The condenser is designed to maintain an oxygen content of 0.005 cc/l or less. The non-condensible gases are concentrated in the air removal zones of the condenser and are removed by the air removal system (Section 10.4.2).

10.4.1.4 Testing and Inspection Requirements

Following erection, the condenser is checked for leakage by filling the shell to a level above the expansion joint. The waterboxes are shop hydrostatically tested.

The condenser shell, hotwell, and waterboxes are proved with access openings to permit inspection or repairs.

10.4.1.5 Instrumentation Application

Level controllers and alarms are provided as required in the condenser hotwell. The condenser pressure and temperature are continuously monitored. Pressure switches trip the turbine upon low exhaust hood vacuum.

10.4.2 Condenser Air Removal System

The Condenser Air Removal System is shown in figure 10.4-1.

10.4.2.1 Design Bases

The Condenser Air Removal System removes air and non-condensible gases from the condenser. The system includes two full capacity mechanical vacuum pumps. Piping is furnished in accordance with ANSI B31.1. The air removal system is not safety related. Detection of tritium in the exhaust of Condenser Air Removal System is discussed in Section 11.4.2.2.4. Detection of tritium in the drains from the vacuum pump is discussed in Section 11.2.6.2.

10.4.2.2 Description

The two full capacity mechanical vacuum pumps have an individual holding capacity of 20 scfm of free dry air at a suction pressure of 1 inch Hg Abs. At startup, a vacuum of 4 inch Hg. Abs. is obtained in approximately 40 minutes by operation of both vacuum pumps. Each rotary-type vacuum pump is furnished with sealing water.

The two vacuum pumps are arranged in parallel and take suction from a common header which is connected to the condenser shell.

The condenser vacuum pump exhaust (off-gas) is routed to the turbine building ventilation system. Drains from the two vacuum pumps will be directed to a sump and processed through the waste water treatment system.

10.4.2.3 Evaluation

In normal operation, one of the two full capacity vacuum pumps is operating with the other pump in standby. The standby vacuum pump will start automatically if the suction manifold pressure increases to 4.0 inch Hg. Abs. or if the running vacuum pump trips. In the event that the above actions are not sufficient to maintain the requisite condenser vacuum, the turbine will automatically trip upon low exhaust hood vacuum.

10.4.3.3 Evaluation

The Turbine Gland Sealing System is designed to provide the required amount of sealing steam under all modes of operations. Major control valves in the steam seal regulator are bypassed by a motor operated control valve which can be controlled from the main control board in case of steam regulator malfunction. The steam seal header is protected from overpressure by safety valves.

10.4.3.4 Testing and Inspection Requirements

Piping is inspected and tested in accordance with Paragraph 136 and Paragraph 137, respectively, of ANSI B31.1, except for the piping furnished by the turbine manufacturer. That piping is inspected and tested in accordance with the manufacturer's standards. The shell and tube side of the steam packing exhauster will be hydrostatically tested to one and one-half times their design. Standby equipment will be periodically cycled in service to ensure its availability and for preventive maintenance.

10.4.3.5 Instrumentation Applications

Temperature, pressure, radiation monitors, and control instrumentation are provided to ensure that the Gland Sealing System performs its required function automatically. The system is operated continuously during the warm-up and power operation of the turbine generator.

10.4.4 Turbine Bypass System

The Turbine Bypass System is shown in Figure 10.3-1.

10.4.4.1 Design Bases

The Turbine Bypass System is designed to perform the following functions:

a. Provide a means to recover 80 percent of the main steam flow at 975 MWt following a full load turbine trip by diverting 15% of the main steam flow to the deaerator to maintain approximately 300°F feedwater to the SGS and 65% of the main steam flow to the condenser.

b. Provide a means to make rapid changes in the power of the turbine while the reactor is being maneuvered at ordinary rates.

The piping system associated with the Turbine Bypass System is designed, fabricated, inspected, and erected in accordance with ANSI B31.1 Power Piping.

10.4.4.2 Description

The Turbine Bypass System consists of four automatically and sequentially operated pressure reducing control valves piped individually through a desuperheater to the main condenser and one automatically operated pressure reducing control valve piped directly to the deaerator.

The Turbine Bypass System is utilized in the following manner:

During startup, before the turbine is synchronized, the turbine will be in speed control and the turbine bypass control valves to the condenser will be automatic. Steam header pressure is controlled by the bypass valves to the condenser. After synchronization is accomplished and initial load is applied to the turbine, the turbine control will be in load control. As reactor power and turbine load are increased the turbine bypass system dumps excess steam to maintain steam header pressure. When the reactor and turbine are at a high enough power, the turbine, turbine bypass control valves, and the reactor are controlled by the supervisory control system. The turbine bypass control valves perform a similar function during plant shutdown.

An interlock prevents the turbine bypass valves to the condenser from opening during a period of either low condenser vacuum or high desuperheater discharge temperature. During a turbine trip when extraction steam is no longer available for feedwater heating, the control valve in the bypass line to the deaerator will open automatically, pegging the deaerator at approximately 67 PSIA. This seeks to maintain approximately 300°F feedwater temperature to the SGS drums.

10.4.4.3 Evaluation

A failure of the Turbine Bypass System to the condenser will have no adverse effect on the nuclear steam supply system. If the Turbine Bypass System should fail upon loss of full load, the Main Steam Safety Valves (described in Section 5.5) can dissipate to the environment all of the energy existent or produced in the steam generators. The effects of malfunctions of the Turbine Bypass System and the effects of such failure on other components are evaluated in Section 15.3.2.4.

10.4.4.4 Testing and Inspection Requirements

The valves and major components of the Turbine Bypass system are subjected to manufacturer's shop tests including hydrostatic and performance tests.

Tests and inspection of the Turbine Bypass System piping, such as the radiographic inspection of the welds and the hydrostatic leak test prior to initial operation, is made in accordance with ANSI B31.1 Power Piping.

All system valves can be inspected and tested during normal operation on a scheduled basis.

10.4.4.5 Instrumentation Applications

Instrumentation applications are discussed in Section 7.7.1.

10.4.5 Circulating Water System

The Circulating Water System is shown in Figure 10.4-2. The circulating water analysis is given on Table 10.4-2.

b. Suspended and dissolved solids which may be introduced by small leakages of circulating water through the condenser tubes.

c. Solids carried in by the makeup water and miscellaneous drains.

At the design condensate flow and with circulating water inleakage within the capacity of the system the Condensate Cleanup System will produce effluent of the quality required by the Steam Generation System given in Section 5.5.3.11.

The Condensate Cleanup System polishes 100 percent of the condensate and is designed for continual performance. Total head loss from inlet to outlet terminal points will not exceed 50 psi. In addition, the system design provides for removing impurities in the condensate caused by an intermittent inleakage in the condenser of cooling water from the Circulating Water System. To assure that condensate/feedwater quality is maintained within the safe limits, the condensate polishing system is provided with capability to operate, without regeneration, for a period of 8 hours, with permissible cooling water inleakage of 90 GPM. The basis for this operating condition is as follows:

a) one vessel on line and at a point of exhaustion under normal operating conditions.

b) one vessel on line and half exhausted under normal operating conditions.

c) one vessel in standby and fully regenerated.

The condensate polishing system is also capable of operating for 5 days, with cooling water inleakage of 5 GPM and meet the effluent requirements for operation above 5% Power. The basis for this operating condition is that regeneration shall not be required for more than one service vessel per day.

The circulating water analysis is given on Table 10.4-2. The maximum analysis shall be used for the condenser leak design conditions.

The design also provides a bypass of the entire Condensate Cleanup System. The design of the polisher units and regeneration equipment is based on the Condensate Cleanup System operating on the hydrogen cycle.

Piping is furnished in accordance with ANSI B31.1 Power Piping. Pressure vessels which fall within the jurisdiction of ASME Section VIII are furnished in accordance with that code. The Condensate Cleanup System is not safety related.

10.4.6.2 <u>Description</u>

The Condensate Cleanup System consists of three half-capacity ion exchanger, each containing a bed of mixed resins in the proportion of one-part cation resin to one-part anion resin by volume. The third (spare) ion exchangers may be placed in service if desired or in the event of a condenser tube leak. The Condensate Cleanup System is piped directly into the feedwater cycle downstream of the condensate pumps.

Each resin bed is periodically transferred from the ion exchanger to an external backwash and regeneration system as required for removal of solids and/or chemical regeneration.

Spare charges of resins may be held in the external backwash and regeneration system for immediate replacement of the exhausted beds so that an exchanger may be made available for prompt replacement of a spent exchanger. An effluent strainer in the discharge piping from each ion exchanger protects the feedwater system against a discharge of resin in the event of an underdrain failure.

TABLE 10.4-1

DESIGN AND PERFORMANCE PARAMETERS FOR THE CONDENSER

Surface (ft^2)	226,780
Number of passes	1
Number of tubes	19,464
Effective tube length (ft)	60
Tube diameter (in)	7/8
Tube material- - Periphery and air removal sections	18,004 tubes of 90-10 Cu-Ni 1,460 tubes of 70-30 Cu-Ni
Tube velocity (fps)	6.0
Condenser duty (Btu/hr)	2326×10^{6} (2)
Circulating water flow (gpm)	185,200
Maximum expected inlet circulating water temperature (deg. F)	88 (1)
Cooling water temperature (deg. F)	Normal 87, Max. 90
Circulating water temperature rise (deg. F)	25 (2)
Exhaust steam temp. (no bypass) (deg. F)	Normal 108-158, Max. 160
Turbine bypass steam temp. (deg. F)	Normal 450, Max. 450 (3)
Condenser vacuum with maximum expected circulating water temperature (in. Hg. Abs.)	3.35 (2)
Max. O_2 concentration cc/l at rated load	0.005
Min. Hotwell Storage (gallons)	17,200
Overall dimensions	75'-9"L x 18'-0"W x 38'-6"H

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(1) based on 76 deg. F Wet Bulb 1 percent of peak summer hours
(2) stretched load condition = 1121 MWt
(3) maximum turbine bypass flow occurs with turbine tripped

TABLE 10.4-2

CIRCULATING COOLING WATER ANALYSIS*

	Expressed as	Average	Maximum
Calcium	Ca	85	108
Magnesium	Mg	19.5	21.3
Sodium	Na	5.3	6.3
Potassium	K	3.5	4.8
Chlorice	Cl	11.8	32.5
Sulfate	SO_4	38	58
Nitrate	NO_3	3.3	5.5
Phospate	PO_4	0.13	1.0
Silica	SiO_2	9.8	15.3
Manganese	Mn	0.13	0.18
Total Iron	Fe	0.95	1.72
Total Alkalinity	$CaCO_3$	240	290
pH		7.9	8.3
Total Dissolved Solids		355	435
Total Suspended Solids		33	115
Chlorine Residual**	Cl_2	0.2	5 (upset)
Specific Conductance @ 25°C (micromhos/cm)		787	936

* Concentrations and conductance are based on 2.5 times river water values. All analysis values except pH and Specific Conductance are stated in ppm as expressed above.

**Chlorine is added intermittently as a biograde and controlled by special instrumentation.

The maximum analysis used for the condenser leak design conditions.

Eight (8) release points (points 20A thru 20H in Fig. 11.3-9) are associated with Thermal Margins Beyond Design Basis (TMBDB) design features which receive exhausts from the Annulus Air Cooling System (this system is described in Section 9.6.2). This system is not required to operate during normal operations or to mitigate the consequences of any design basis accidents. Activity would only be released from these points in the event of very low probability accidents beyond the design basis, such as a hypothetical core disruptive accident. If required these exhausts would be initiated no sooner than twenty-four (24) to thirty-six (36) hours after the TMBDB scenario. On line monitoring for particulate, iodine and radiogas will be provided for these exhausts in the event of such an accident.

The Containment Cleanup System/Annulus Pressure Maintenance and Filtration System have a common exhaust (release point 21 in Fig. 11.3-9). During normal operation, the Annulus Pressure Maintenance and Filtration System exhausts thru release point 21 on top of the RCB dome. In the event of very low probability accidents beyond the design basis (TMBDB) the Containment Cleanup System would exhaust thru the same release point, and the Annulus Pressure Maintenance and Filtration System would no longer be in use. Particulates, radioiodines, radiogases, and plutonium are monitored continuously in the effluent stream.

11.3.6.2 Balance of Plant

A small fraction of tritium produced in the fuel and control rods passes into the steam-water system by diffusion through stainless steel in the IHX and through the steam generator tubes. Tritium is expected to be in the steam-water system in the form of tritiated water. The condenser air removal system removes non-condensible gases (vapors) from the condensing steam. Tritiated water vapor, present in the off-gas flow, constitutes the only expected gaseous release contribution from the balance of the plant.

Mechanical vacuum pumps will remove the vapors together with the noncondensible gases and will discharge them to the exhaust plenum of the Turbine Generator Building (which corresponds to release point 7 on Figure 11.3-9). The vapors will mix with the exhaust air. The resulting gaseous tritium release from the TGB is provided in Table 11.3-16.

The Deaerator Exhaust and Steam Packing Exhauster exhaust are independently vented to atmosphere from the Turbine Generator Building (release points 24 and 25 on Figure 11.3-9). The BOP tritium contribution is included in the dose calculations presented in Section 11.3-8. Balance of Plant tritium release is based on the following assumptions: (1) Plant Capacity Factor of 0.68, (2) Vacuum Pump Operating Factor of 0.85, (3) Radioactivity input to Steam-Water System 0.016 Ci/day, and (4) Condenser off-gas removal 7 scfm. The design value release of tritiated water vapor amounts to 6.3×10^{-5} Ci/day.

Description, design bases, and evaluation of the BOP design are provided in Section 10.

Thirteen other release points associated with the balance of plant could contain some radioactivity. These points are:

1) Plant Service Building (PSB) exhausts from the hot laboratory and decontamination area, identified as Point 19 on Figure 11.3-9. Levels of radioactivity in these areas will make no significant contribution to off-site dose rates.

2) Turbine Generator Building exhausts receiving ventilation exclusively from the Turbine Generator Building atmosphere are identified as Points 7 thru 18 on Figure 11.3-9. Levels of radioactivity in these areas are expected to make no significant contribution to off-site dose rates. However, as per Section 11.4.2.2.3, samples of the TGB atmosphere will periodically be analyzed.

The location, height, discharge flow rate, discharge velocity, discharge air temperature, and size and shape of the discharge orifice, for each BOP release point, are presented in Table 11.3-20.

11.3.7 Dilution Factors

The maximum dose at the site boundary due to normal releases from the gaseous waste system will occur at a point on the boundary that has the highest average annual x/Q as determined from meteorological data. For the CRBRP site, the average annual x/Q for this point is 5.10×10^{-5} s/m^3.

11.3.8 Dose Estimates

The release of radioactive noble gases in the gaseous effluent from the CRBRP during normal operation will create a slightly radioactive plume downwind of the site; this will expose the public located in the downwind direction to small doses of external gamma and beta radiation. An external beta dose to body tissue will be received from the relatively small amount of tritium discharged to the atmosphere. It should be noted that these exposure pathways imply a public completely exposed to the environment, whereas, in reality, most persons spend a significant portion of the lives within structures that reduce the exposure of these types of radiation. The reduction in external dose could range from a factor of two to 1,000 depending on the type of structure and the location of the person within (Ref. 1).

Exposure to tritium in the form of tritiated water vapor (HTO) can occur through several pathways including:

1) Inhalation and skin absorption

2) Ingestion of milk contaminated by the fallout of HTO to the cow's forage and by inhalation by the cow

11.4 PROCESS AND EFFLUENT RADIOLOGICAL MONITORING SYSTEM

11.4.1 Design Objectives

Process radiation monitors are provided to allow the evaluation of plant equipment performance and to measure, indicate and record the radioactive concentration in plant process and effluent streams during normal operation and anticipated operational occurrences. The monitors are provided in accordance with CRBRP (Section 3.1) Design Criterion 56.

Radiation monitoring of process systems provides early warning of equipment malfunctions, indicative of potential radiological hazards, and prevents release of activity to the environment in excess of 10CFR 20 limits. Each monitor will be equipped with a loss-of-signal instrument failure alarm and a high level alarm, (a high-high level alarm is also provided when required). These alarms alert operating personnel to channel malfunction and excessive radioactivity. Corrective action will then be manually or automatically performed.

Monitoring of liquid and gaseous effluents under normal operating conditions will be in accordance with NRC Regulatory Guide 1.21 and any activity released will be within limits established in 10CFR20.

The number, sensitivities, ranges, and locations of the radiation detectors will be determined by requirements of the specific monitored process during normal and postulated abnormal (accident) conditions. All monitors will be designed so that saturation of detectors during a severe accident condition will not cause erroneously low readings. Monitoring during severe post accident conditions will be accomplished by the high-range gamma area monitors discussed in Section 12.1.4, in conjunction with the sampling lines described in Section 11.4.2.2.1.

Radioactivity in the low level waste releases will be integrated and recorded. Control signals will be provided by the radiation monitor(s) to terminate liquid or gaseous effluent if an out-of-limit signal is recorded. The monitoring and control exerted by the process radiation monitoring equipment and the operator during any release will also be verified by periodic manual sampling and laboratory analysis in accordance with Technical Specifications. For tritiated process liquids, tritium surveillance will be by sampling and lab analysis.

All detectors will be shielded against ambient background radiation levels so that required activity measurements can be maintained. Monitors associated with accident conditions are also discussed in 3.A.3.1. Area monitors and airborne radioactivity monitors are discussed in 12.1.4 and 12.2.4, respectively. The radiological effluent sampling program is discussed in Section 11.4.3 and meets the reporting requirements of Regulatory Guide 1.21.

11.4.2 Continuous Monitoring/Sampling

11.4.2.1 General Description

The descriptive tabulation of the various continuous monitors/samplers for process and effluent radioactivity monitoring, which includes those gas and liquid monitoring devices in or associated with liquid or gas process streams considered in this discussion, is found in Table 11.4-1. The basis for selecting the locations as well as the control functions associated with the monitor, are described below.

Each continuous monitor will be equipped with power supplies, micro-processor and accessories, indication and local alarm indicator lights. Each monitor will transmit radioactivity level and alarm status information for display and logging by Radiation Monitoring equipment located in the Control Room with redundant display and logging equipment located in the Health Physics Area of the Plant Service Building. The alarms are provided to indicate instrument malfunctions or a radioactivity level in excess of the monitor's alarm setpoint. Each continuous monitor has a local indicator at the detector location to facilitate the testing and/or calibration of the equipment.

The lowest scale division of each continuous monitor's range is the maximum detector sensitivity deemed appropriate for the intended service. The range of the monitor will be a minimum of five decades above the maximum sensitivity level; and will allow for a minimum of one decade span above the monitor high-high setpoint (when high-high setpoints are employed). The effluent alarm setpoint corresponds to the alarm annunciation level dictated by the CRBRP Technical Specifications (Chapter 16.) For each monitor, a sample chamber and/or detector is selected and will be installed in such a way as to minimize sampling losses and electromagnetic and background interferences. The output of all effluent monitors will be continuously sampled and recorded by the CRBRP Plant Data Handling and Display System. The Reactor Containment Isolation Monitors (PPS), Control Room Air Intake monitors and other safety-related monitors will be powered by Class IE, redundant 120 VAC power.

11.4.2.2 Gaseous System Description

11.4.2.2.1 Post-Accident Containment Atmosphere Monitors

The capability to monitor the containment atmosphere radioactivity level following containment isolation during an accident condition shall be provided. Three pair of penetrations, located 120° apart around the containment structure will allow air samples to be taken by mobile or portable monitors and sampling equipment. The penetrations design and locations will consider the following criteria:

1. The penetration opening on the inside of containment will be positioned to obtain a representative sample.

2. The penetration opening on the outside of containment will be positioned in an accessible area to enable connection of the monitoring and/or sampling equipment.

3. Each penetration will have two isolation valves; a remote manual controlled valve inside containment and a manual, locked valve outside containment with a blind flange.

4. The penetration design will comply with CRBRP Design Criteria Numbers 45 and 47 (Section 3.1)

Each pair of penetrations can be connected to a mobile monitor which will be utilized for continuous monitoring of the containment atmosphere. The sample is withdrawn from containment, passes through the monitor for radiation detection and returned to containment. Grab samples will also be obtained for further laboratory analysis.

11.4.2.2.2 Reactor Containment Isolation Monitors

The radiation level in the head access area will be monitored by three detectors for direct gamma activity. The output of these detectors is routed to the plant protection system to initiate closure of containment isolation valves if a preset limit is reached by two out of three of the detectors.

In addition, the radiation level in containment exhaust, upstream of the isolation valves will be isokinetically monitored for gaseous activity by three gas monitors. Their output will also be provided to the PPS for initiation of containment isolation when a preset radiation level is reached by two of the three detectors.

The monitoring system will be designed to comply with IEEE 279 1971. The overall containment isolation system design and protection logic is discussed in Section 7.3. Figure 12.2-1 shows a typical block diagram of these channels and Figure 7.3-1 shows the trip logic configuration.

11.4.2.2.3 Building Ventilation Exhaust Monitors

The number and location of building exhaust plenums from which potentially radioactive plant gaseous release may emanate are: One located in the Intermediate Bay (SGB-IB), nine located near the top of the RCB dome, two located in the Reactor Service Building (RSB), one located in the Radwaste Area (Bay), one located in the Plant Service Building (PSB), fourteen in the Turbine Generator Building (TGB), and three located in the Steam Generator Building (SGB). Continuous monitoring will be performed at those exhausts which could conceivably undergo a significant increase in detectable levels in radioactivity. The remaining exhausts will be sampled periodically.

The exhaust plenum located in the IB receives ventilation exhaust air from the Intermediate Bay area. A continuous air monitor (CAM) will be provided to detect particulate, radioiodine and gaseous activity in the effluent stream. The air sample will be obtained isokinetically from the exhaust, on a continuous basis. The operation of the three-channel CAM unit is described in Section 12.2.4.2.1.

The exhaust plenum located on the Radwaste Building receives ventilation exhaust air from the radwaste area. A Continuous Air Monitor (CAM) will be provided to detect particulate, iodine and gaseous activity in the effluent stream. The air sample will be obtained isokinetically from the exhaust, on a continuous basis. The operation of the three channel CAM unit is described in Section 12.2.4.2.1.

The two RSB exhausts will be continuously monitored for radioactivity releases. The first exhaust plenum located on the RSB roof which receives ventilation exhaust from the RCB will be continuously monitored for particulates, radio gases, and radioiodine activity in the effluent stream. The second exhaust plenum located on the RSB which receives ventilation exhaust from the RSB via the RSB clean-up filtration units will also be continuously monitored for particulate, gaseous and radioiodine activity.

The exhaust plenum located near the top of the RCB dome, which receives exhaust from the Containment Clean-up and Annulus Pressure Maintenance and Filtration System will be continuously monitored for particulate, radioiodine, radiogas, and plutonium activity in the effluent stream.

The 8 exhausts located at the top of the RCB dome for the Annulus Cooling Air become potential radioactivity release points only in the event of very low probability accidents beyond the design basis (e.g., Thermal Margin Beyond the Design Base). On line monitoring for particulates, radioiodines and radiogases have been provided for these exhausts in the event of such an accident.

TGB areas will be periodically grab sampled and samples will be analyzed for tritium activity.

The exhaust in the PSB receives ventilation from the combined laboratory. Samples will be collected isokinetically by a particulate (and iodine, if required) filter and analyzed for isotopic content in the Counting Room.

Certain effluent radiation monitors are identified as Accident Monitoring Instrumentation in Table 11.4-1. As such, these monitors will meet the requirements of Section 7.5.11 of the PSAR.

The reporting of effluent radioactivity released from the CRBRP will be consistent with the guidelines established in Regulatory Guide 1.21. This reporting will be based upon the results of Counting Room analysis of effluent samples obtained at each location listed above.

11.4.2.2.4 Condenser Vacuum Pump Exhaust, Deaerator Continuous Vents and Turbine Steam Packing Exhauster Tritium Samplers

A gas sample will be continuously withdrawn from each one of the condenser vacuum pump air, deaerator exhaust, and turbine steam packing exhauster air into tritium samplers comprised of silica gel dessicant column to enable determination of tritium activity to indicate unacceptable tritium diffusion in the steam generators. The sample will be analyzed using liquid scintillation techniques in the counting room.

11.4.2.2.5 Control Room Inlet Air Monitors

The main and remote Control Room air intakes will each be continuously monitored by two redundant monitors. These three channel (particulate/radioiodine/radiogas) CAMs will detect radioactivity in the air intakes and will determine which intake should be used during the Control Room isolation condition. Details concerning the sequence of operation during Control Room Isolation are given in Section 9.6.1.3.4.13. A fifth three channel CAM will be installed downstream of the parallel HVAC make-up air filters to monitor the performance of the HEPA filter trains. A detailed description of the operation of each of these CAM units is given in Section 12.2.4.2.1.

11.4.2.2.6 Inerted Cell Atmosphere Monitors

The capability for monitoring the atmosphere of each individual inerted cell for high radioactivity will be accomplished by three methods. One method is the sequential sampling of groups of cells with on-line gas monitors as described in 3.A.1.4.2. Each monitor shall have a trip signal determined by the process system to initiate activation of cell purging equipment. In addition, mobile particulate, iodine and gas monitors are provided to sample any individual inerted cells atmosphere, as described in 12.2.4.

Finally to provide a sensitive method of sodium leak detection, particulate monitors are provided for continuous monitoring of inerted cells within the RCB containing components contacting radioactive sodium. These monitors will alarm for activated sodium present in the cells atmosphere. The individual inerted cells that are continuously monitored for sodium leak detection are listed in Table 3.A.1-3.

11.4.2.2.7 RAPS and CAPS Monitoring

Gas monitors will be provided for the Radioactive Argon Processing System (RAPS) and Cell Atmosphere Processing System (CAPS). A monitor will be located at the CAPS inlet for controlling the rate of radioactivity input. Monitors will also be located at the output of these systems to ascertain that the radionuclide activity of the processed gas is within limits for reuse in RAPS or within 10 CFR 50, App. I and ALARA limits for those gases exhausted to the H&V system by CAPS.

11.4.2.2.8 Safety-Related Monitors

Certain monitors which provide control signals to safety related process systems or are used to monitor safety related systems are classified as safety related monitors. These monitors will be supplied with Class 1E power from redundant vital AC buses and will meet the requirements described in Section 7.1. Safety related monitors are identified in Table 11.4-1.

These monitors will each have a dedicated Display and Control Unit (DCU) in the Control Room. The DCU will also meet the requirements described in Section 7.1 and will be supplied with Class 1E power. The DCU's will be located in the back panel area of the Control Room adjacent to the Radiation Monitor Console (computer).

11.4.2.3 Liquid Systems Description

11.4.2.3.1 Radwaste Disposal System Liquid Effluent Monitor

Effluents from the Liquid Radwaste Disposal System are discharged into the cooling tower blowdown. A liquid radioactivity detector will continuously monitor, record, and control the activity released to the cooling tower blowdown stream. The blowdown flow rate available for liquid waste dilution and compliance with 10CFR20 will be considered in establishing a high radiation setpoint for this monitor. A high radiation signal will automatically close the isolation valve in the discharge line and alarm in the control room.

Frequent composite samples of the blowdown downstream of the radioactive liquid input will be taken for radionuclide determination including tritium.

11.4.2.4 Maintenance and Calibration

On completion of the monitoring system installation, each process monitor will be checked for proper operation and calibrated against a radiation check source(s) traceable back to the National Bureau of Standards or from an equally acceptable source. This initial calibration, and subsequent calibration at six month intervals will verify the electronic operation of both local and Control Room indications and also all annunciation points (loss-of-signal), loss-of-sample flow, high radiation, etc. In addition, each monitor is supplied with a built-in check source to provide rapid functional tests at periodic intervals.

11.4.3 Sampling

This section provides information on the CRBRP process and effluent sampling program. Process sampling provides the means for determining and monitoring various plant systems containing radioactive and potentially radioactive fluids. Effluent sampling provides the means for the reporting of radioactive releases to the environment. The effluent sampling will meet the reporting requirements of Regulatory Guide 1.21 and will provide data necessary for the semiannual report required by 10CFR50.36a.

11.4.3.1 Process Sampling

Periodic sampling is conducted to alert the operator of any abnormal condition that may be developing. Both local and remote liquid samples are taken. Gaseous samples are taken directly at the sample station adjacent to the gas analyzer. The locations for gaseous sample instrumentation are given in Section 11.3.3.3. Operating procedures and performance tests of gaseous samples are discussed in Section 11.3.4. Sampling of primary sodium, secondary sodium, ex-vessel sodium and cover gas is discussed in detail in Section 9.8, entitled "Impurity Monitoring System". This section also discusses the location of samples, expected composition and concentration, sampling frequency and procedures.

The basis for selecting the locations for sample stations is to provide an indication of the effectiveness of key process operations. Analyses of these samples are related to the process sequence from which they were obtained to evaluate specific equipment performance.

Gaseous samples are monitored for gross activity and periodically analyzed for isotopic content. Tables 11.3-1 through 11.3-15 list inventories of the expected concentration and composition of the effluent gas samples.

Sections 11.4.3.1.1 through 11.4.3.1.5 describe in detail each of the liquid sampling points in the Radioactive Waste Systems. Sampling procedure, analytical procedure, and sensitivity for each sample point are the same and are discussed in detail in the following paragraphs.

Sampling Procedure: Samples are collected in a sampling station located on the operating floor of the radwaste building. Sample circulating lines run through this sampling station. The upstream side of the sample lines are connected to the discharge of the pumps serving the tanks. After passing through the sampling station, the circulating sample fluid is returned to the tank from which it was drawn.

Analytical Procedure and Sensitivity: The quantity of sample to be counted for gross beta-gamma is pipetted onto a planchet. The planchet is placed on a turntable and evaporated to dryness under an infrared bulb. The rotation insures a uniformly distributed dried sample for reproducible counting. The height of the infrared bulb is adjustable to obtain a moderate rate of evaporation. Counting is done by means of an internal proportional counter.

The isotopic analysis is performed by a completely automated Pulse Height Analysis System. A shielded Ge (Li) detector is used with a computer-based pulse height analysis system. The system satisfies the reporting requirements of Regulatory Guide 1.21.

Provisions will also be made for alpha and tritium assay.

11.4.3.1.1 Intermediate Level Activity Liquid Waste Collection Tanks

These tanks receive decontamination waste from the Large Component Cleaning Cell. The analysis of this waste provides a check on the decontamination procedure.

The composition is expected to be sodium hydroxide solution, nitric acid solution and water rinses. After neutralization a solution of sodium sulfate or sodium nitrate results. Activity will be • Ci/cc.

The quantity to be measured is the gross activity.

Additional rinses would be required if the activity of the component is higher than expected. Additional passes through the purification equipment would be required if the activity of the product from the evaporator is too high. Corrective action would be taken if the DF is lower than the expected value. The expected recirculation flow through the sample line is 10 gpm.

11.4.3.1.2 Process Distillate Storage Tanks

These tanks receive the distillate from the Process Waste Evaporator. The sample provides the check on the DF of the evaporator and purity of the product to be recycled for plant uses or released to the environment after dilution with cooling tower blowdown. The composition is expected to be very dilute sodium sulfate or sodium nitrate with an activity 10^{-6} Ci/cc.

The quantity to be measured is the gross activity, if no excess inventory exists. If excess inventory exists and a portion of the content is to be released to the low activity liquid system, an isotopic analysis will be performed consistent with reporting requirements of Regulatory Guide 1.21. If the activity of the sample is unacceptably high, the contents of the tank are reprocessed through another evaporator-ion exchange cycle. Corrective measures would be taken if the DF is much lower than the expected value.

The expected recirculation flow through the sampling line is 10 gpm.

11.4.3.1.3 Low Level Activity Liquid Waste Collection Tanks

These tanks receive laboratory drains, floor drains, lavatory drains, and shower drains from areas that may contain radioactivity. An activity check at these points determines the possibility of the need for further processing. It also permits a check on the DF of the purification equipment by comparing it with the activity of the purified waste.

These tanks receive waste from several sources, hence the composition is not well defined. The conductivity will be measured to determine impurity level. The expected activity is 10^{-4} Ci/cc. The quantity to be measured is the gross activity.

The sampling frequency will be in accordance with reporting requirements of Regulatory Guide 1.21.

Higher sample activity indicates abnormal operations elsewhere in the plant. Corrective measures at those locations would be taken. Also, higher activity indicates that a second pass through the equipment would be required.

The expected recirculation flow of the sampling line is 10 gpm.

11.4.3.1.4 <u>Low Level Activity Distillate Monitoring Tanks</u>

Since these tanks are holding tanks for the purified product from the low level waste evaporator, pending release to the discharge canal, sample analysis is mandatory. The composition is expected to be equivalent to grade C water or comply with federal and state regulations and have an average activity of 10^{-6} Ci/cc.

A gross count is made before releasing to the environment. Tritium content will also be sampled. An isotopic analysis is performed for record purposes as required by Regulatory Guide 1.21. Sampling frequency will be determined by reporting requirements of Regulatory Guide 1.21.

High sample activity indicates the need for reprocessing the batch. Corrective measures would be taken if DF is lower than the expected level. No particular process flow is associated with this sample point.

11.4.3.1.5 <u>Concentrated Waste Collection Tank</u>

The material in this tank is intended to be solidified and shipped to the disposal site. To determine the type of packaging and degree of shielding required to meet the shipping regulation CFR Title 49, the analysis of sample is necessary. The composition is expected to be a solution of sodium sulfate or sodium nitrate and an activity of 50 Ci/cc. The quantity to be measured is the gross activity.

The sampling frequency will be determined in the FSAR. No process flow is associated with this sampling procedure.

11.4.3.2 <u>Effluent Sampling</u>

The radioactive effluents are continuously monitored or sampled as indicated in Section 11.4.2.2.3 by activity and by flow. The sampling system is designed to obtain a representative effluent sample to establish concentrations of radioactivity and to facilitate radioisotopic analysis to assure compliance with recognized codes and standards for radiation protection. The samples are taken before the effluent release to the environment. The gaseous effluents are discussed in detail in Section 11.3 and liquid effluents are discussed in Section 11.2.

The Cooling Tower blowdown, wastes and drains and other normally non-radioactive liquid effluent streams will be sampled for suspended/dissolved activity including tritium. The problem associated with continuous monitoring of low level activity in tritium is recognized and therefore, periodic batch samples from each liquid effluent stream will be taken and analyzed in the laboratory.

Building Storm drains and Plant Service Building liquid effluents are normally non-radioactive and will not be monitored, but will be periodically sampled for radioisotopic analysis as necessary.

To satisfy Regulatory Guide 1.21 requirements for gamma spectroscopy and sensitivity, a high resolution automated radioisotopic analysis system will be provided at the plant site to facilitate precise identification and analysis of complex radionuclide concentrations.

11.4.4 Reporting

An automated Report Processor will be provided which will generate the Effluent Radioactivity Release Reports in accordance with Appendix B of NRC Regulatory Guide 1.21. This computer based processor will be interfaced with the Radiation Monitoring System Controllers and the CRBRP Environmental Computer. The Report Processor will also accept manual entry of analyses performed by the Health Physicist.

TABLE 11.4-1 PROCESS & EFFLUENT MONITORING AND SAMPLING

Description	Bldg.	Elev.	Sample or Cont.	Range (Ci/cc) UOS	Expected Concent.	Quant. Meas.	Remarks
[illegible] Continued							
Isolation Monitors (PPS):							
-Containment Ventilation (3) Exhaust (Gaseous) CAM	RCB	842	Continuous	10^{-7}-10^{-2} Cs^{137}	See Section 11.3.2.6	Gross Concent.	Safety-related Class 1E PPS Related
-Head Access Area (3) Direct Gamma	RCB	802	Continuous	10^{-1}-10^{-4} mR/hr		Direct Gamma	See Section 7.3.1.2
Radwaste Monitor:							
-IALL Evaporator, Heating Element; Heating Water Out (Liquid)	RWA	775	Continuous	$4\times10^{-7}4\times10^{-2}$ Cs^{137}		Gross Concent.	
-LALL Evaporator, Heating Element; Heating Water Out (Liquid)	RWA	775	Continuous	$4\times10^{-7}4\times10^{-2}$ Cs^{137}		Gross Concent.	
-IALL Evaporator, Distill. Cooler; Cooling Water Out (Liquid)	RWA	775	Continuous	$4\times10^{-7}4\times10^{-2}$ Cs^{137}		Gross Concent.	
-LALL Evaporator, Distill Cooler; Cooling Water Out (Liquid)	RWA	775	Continuous	$4\times10^{-7}4\times10^{-2}$ Cs^{137}		Gross Concent.	
-LALL Effluent	RWA	795	Continuous	$4\times10^{-7}4\times10^{-2}$ Cs^{137}		Gross Concent.	
RAPS & CAPS Process Monitors:							
-Gas Entering RAPS Cold Box (Gaseous)	RCB	733	Continuous	2.7-2.7×10^{5} Kr^{85}		Gross Concent.	
-Coolant Leaving RAPS Cold Box (Gaseous) (2)	RSB	779	Continuous	2.7×10^{-6}-2.7×10^{-1} Kr^{85}		Gross Concent.	In-Line Monitoring
-Gas Leaving RAPS Cold Box (Gaseous)	RCB	733	Continuous	2.7×10^{-3}-$2.7\times10^{+2}$ Kr^{85}		Gross Concent.	
-Gas Leaving CAPS Surge Vessel (Gaseous Iodine)	RSB	779	Continuous	2.7×10^{-4}-$2.7\times10^{+1}$ Kr^{85} 10^{-5}-10^{0} I^{131}		Gross Concent.	
-CAPS Header Serving RCB Cells (Gaseous)	RCB		Continuous	2.7×10^{-6}-2.7×10^{-1} Kr^{85}		Gross Concent.	

TABLE 11.4-1 PROCESS & EFFLUENT MONITORING AND SAMPLING

Description	Bldg.	Elev.	Sample or Cont.	Range (Ci/cc) UOS	Expected Concent.	Quant. Meas.	Remarks
-Gas From Nitrogen Cell Atmosphere Sampling Unit (Gaseous)	RSB	755	Continuous	2.7×10^{-6}-2.7×10^{-1} Kr^{85}		Gross Concent.	
-Gas From Nitrogen Cell Atmosphere Sampling Unit (Gaseous)	RCB	752	Continuous	2.7×10^{-6}-2.7×10^{-1} Kr^{85}		Gross Concent.	
CAPS Process Gas Effluent to HVAC (Gaseous) (2) (Iodine)	RSB	779	Continuous	2.7×10^{-5}-2.7×10^{0} Kr^{85} 10^{-10}-10^{-5} I^{131}		Gross Concent.	
Effluent Gas From (2) Inerted Cells to HVAC (Gaseous)	RSB	800	Continuous	2.7×10^{-6}-2.7×10^{-1} Kr^{85}		Gross Concent.	
HVAC Duct Monitoring (CAM of RAPS/CAPS Cells:							
-RAPS Cold Box & Valve Gallery Cells (Gaseous)	RCB	733	Continuous	2.7×10^{-6}-2.7×10^{-1} Kr^{85}		Gross Concent.	In-line Monitoring & Cell Isolation
-RAPS Noble Gas Storage Vessel Cell (Gaseous)	RCB	733	Continuous	2.7×10^{-6}-2.7×10^{-1} Kr^{85}		Gross Concent.	In-line Monitoring & Cell Isolation
-RAPS Compressor and Aftercooler Cells (2) (Gaseous)	RCB	733	Continuous	2.7×10^{-6}-2.7×10^{-1} Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
-RAPS Vessels (Gaseous)	RCB	733	Continuous	2.7×10^{-6}-27×10^{-1} Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
-RAPS/CAPS Pipeway (Gaseous)	RCB	780	Continuous	2.7×10^{-6}-2.7×10^{-1} Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
-CAPS Cold Box Cell (Gaseous)	RSB	792	Continuous	2.7×10^{-6}-2.7×10^{-1} Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
-CAPS Vessel Cells & Gallery (Gaseous)	RSB	755	Continuous	2.7×10^{-6}-27×10^{-1} Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation

TABLE 11.4-1 PROCESS & EFFLUENT MONITORING AND SAMPLING

Description	Bldg.	Elev.	Sample or Cont.	Range (Ci/cc) UOS	Expected Concent.	Quant. Meas.	Remarks
-CAPS Compressor & (2) After Cooler Cells (Gaseous)			Continuous	$2.7 \times 10^{-6} - 27 \times 10^{-1}$ Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
-RAD Water Holding Vessel & Pump Cell (Gaseous)			Continuous	$2.7 \times 10^{-6} - 27 \times 10^{-1}$ Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
-Access Areas (4) (Gaseous)			Continuous	$2.7 \times 10^{-6} - 27 \times 10^{-1}$ Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
-Cover Gas Monitoring Cells (Gaseous)			Continuous	$2.7 \times 10^{-6} - 27 \times 10^{-1}$ Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
-Pipe Chase & Vapor Trap Cell (Gaseous)	RSB	772	Continuous	$2.7 \times 10^{-6} - 27 \times 10^{-1}$ Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
-HVAC Common Header For Various Cells (Gaseous)	RCB	766	Continuous	$2.7 \times 10^{-6} - 27 \times 10^{-1}$ Kr^{85}		Gross Concent.	In-Line Monitoring & Cell Isolation
Main HVAC Duct From All RAPS/CAPS Cells (Gaseous) CAM (Iodine)	RSB	779	Continuous	$2.7 \times 10^{-6} - 2.7 \times 10^{-1}$ Kr^{85} $10^{-10} - 10^{-5}$ I^{131}		Gross Concent.	
Sodium Leak Detection For Following Recirc. Gas Cooling Subsystems: (All Particulate)							
Reactor Cavity	RCB	733	Continuous	$2.94 \times 10^{-13} - 2.94 \times 10^{-5}$ Na^{24}		Gross Concent.	Alarm Only
PHTS Loop 1	RCB	766	Continuous	$2.94 \times 10^{-13} - 2.94 \times 10^{-5}$ Na^{24}		Gross Concent.	Alarm Only
PHTS Loop 2	RCB	766	Continuous	$2.94 \times 10^{-13} - 2.94 \times 10^{-5}$ Na^{24}		Gross Concent.	Alarm Only
PHTS Loop 3	RCB	766	Continuous	$2.94 \times 10^{-13} - 2.94 \times 10^{-5}$ Na^{24}		Gross Concent.	Alarm Only
Na Makeup Pump & Vessels	RCB	752	Continuous	$2.94 \times 10^{-13} - 2.94 \times 10^{-5}$ Na^{24}		Gross Concent.	Alarm Only
Na Makeup Pump & Pipeway	RCB	752	Continuous	$2.94 \times 10^{-13} - 2.94 \times 10^{-5}$ Na^{24}		Gross Concent.	Alarm Only

TABLE 11.4-1 PROCESS & EFFLUENT MONITORING AND SAMPLING

Description	Bldg.	Elev.	Sample or Cont.	Range (Ci/cc) UOS	Expected Concent.	Quant. Meas.	Remarks
Cold Tran. Nak Cells	RCB	794	Continuous	$2.94\times10^{-13}-2.94\times10^{-5}$ Na^{24}		Gross Concent.	Alarm Only
Control Room Main (2) Air Intake (Gaseous) CAM (Iodine) (Particulate)	CB	863	Continuous	$3\times10^{-7}-3\times10^{-2}$ Kr^{85} $4\times10^{-12}-4\times10^{-7}$ I^{131} $2\times10^{-10}-2\times10^{-5}$ Cs^{137}	See Section 12.2	Gross Concent.	Initiate C/R Isolation, see Sec. 7.6.4.5.6 Safety-Related (1E)
Control Room Remote (2) Air Intake (Gaseous) CAM (Iodine) (Particulate)	SGB	851	Continuous	$3\times10^{-7}-3\times10^{-2}$ Kr^{85} $4\times10^{-12}-4\times10^{-7}$ I^{131} $2\times10^{-10}-2\times10^{-5}$ Cs^{137}	See Section 12.2	Gross Concent.	Initiate C/R Isolation, see Sec. 7.6.4.5.7 Safety-Related (1E)
Control Room Common Duck Downstream of Filter Units (Gaseous) CAM (Iodine) (Particulate)	CB	847	Continuous	$3\times10^{-7}-3\times10^{-2}$ Xr^{85} $4\times10^{-12}-4\times10^{-7}$ I^{137} $5\times10^{-10}-5\times10^{-5}$ Cs^{137}	See Section 12.2	Gross Concent.	Monitor Only
IHTS Loop 1 (Direct Gamma)	SGB	765	Continuous	$10^{-2}-10^{3}$ mR/hr		Gross Activity	
IHTS Loop 2 (Direct Gamma)	SGB	765	Continuous	$10^{-2}-10^{3}$ mR/hr		Gross Activity	
IHTS Loop 3 (Direct Gamma)	SGB	765	Continuous	$10^{-2}-10^{3}$ mR/hr		Gross Activity	
Large Component Cleaning Cell (LCCC)	RCB	756	Continuous	$10^{-1}-10^{4}$ mR/hr		Gross Activity	
LCCC Cooling Water (Liquid)	RCB	733	Continuous	$4\times10^{-7}-4\times10^{-2}$ Cs^{137}		Gross Concent.	
LCCC Process Gas Effluent (Gaseous)	RCB		Continuous	$10^{-6}-10^{-1}$ Xr^{85}		Gross Concent.	
Fuel Handling Cell (FHC) Argon Gas (Gaseous) (Iodine) (Particulate)	RSB	779	Continuous	$10^{-6}-10^{-1}$ Kr^{85} $10^{-10}-10^{-5}$ I^{131} $10^{-10}-10^{-5}$ Cs^{137}		Gross Concent.	
EVST Argon Cover Gas (Gaseous)	RSB	842	Continuous	$10^{0}-10^{4}$ Kr^{85}		Gross Concent.	

TABLE 11.4-1 PROCESS & EFFLUENT MONITORING AND SAMPLING

Description	Bldg.	Elev.	Sample or Cont.	Range (Ci/cc) UOS	Expected Concent.	Quant. Meas.	Remarks
FHC Utility Monitor (Direct Gamma)	RSB	779	Continuous	$10^{-1}-10^{7}$ mR/hr		Gross Activity	
Radwaste Building Exhaust (Gaseous) CAM (Iodine) (Particulate)	RWB	867	Continuous	$3\times10^{-7}-10^{3}$ Kr^{85} $10^{-10}-10^{2}$ I^{131} $10^{-10}-10^{2}$ Cs^{131}		Gross Concent.	Initiate Filtering of Effluent from RWB
RSB Operating Floor (2) HVAC Exhaust (Gaseous) CAM (Iodine) (Particulate)	RSB	816	Continuous	$3\times10^{-7}-3\times10^{-2}$ Kr^{85} $4\times10^{-12}-4\times10^{-7}$ I^{131} $10^{-6}-10^{-1}$ Cs^{137}		Gross concent.	Initiate RSB Confinement see Section 7.6.4.3.3 (4) Safety related (1E)
Fuel Handling Cell (2) HVAC Exhaust (Gaseous) (Iodine) (Particulate)	RSB	779	Continuous	$3\times10^{-7}-3\times10^{-2}$ Kr^{85} $4\times10^{-12}-4\times10^{-7}$ I^{131} $10^{-6}-10^{-1}$ Cs^{137}		Gross Concent.	- same -
Annulus Filter (2) Discharge (Gaseous) (Iodine) (Particulate)	RSB	840 861	Continuous	$4.4\times10^{-6}-4\times4\times10^{-1}$ Kr^{85} $1.1\times10^{-7}-1.1\times10^{-2}$ I^{131} $1.2\times10^{-10}-1.2\times10^{-5}$ Cs^{137}		Gross Concent.	Select Filter train Section 7.6.4.2.2 (1) Safety Related (1E)
Annulus Filter Inlet/(2) Annulus Cooling Exhaust CAM (Gaseous) (Iodine) (Particular)	RSB	840 861	Continuous	$3\times10^{-7}-1\times10^{4}$ Kr^{85} $1\times10^{-10}-1\times10^{2}$ I^{131} $1\times10^{-6}-1\times10^{2}$ Cs^{137}		Gross Concent.	1) Start Filter see 7.6.4.2.2 (6) 2) Monitor Exhaust see 11.4.2.2.3 (Accident (Monitor)
RSB Clean Up Filter Discharge (Gaseous) (Iodine) (Particulate)	RSB	816 794	Continuous	$3\times10^{-7}-3\times10^{-2}$ Kr^{85} $1\times10^{-10}-1\times10^{-5}$ I^{131} $1\times10^{-6}-1\times10^{-1}$ Cs^{137}		Gross Concent.	Select Filter Train See Section 7.6.4.3.3(1) Safety Related (1E)
Radwaste Ventilation Exhaust Effluent (Gaseous) (Iodine) (Particulate)	RSB	867	Continuous	$1\times10^{-6}-1\times10^{3}$ Kr^{85} $1\times10^{-10}-1\times10^{2}$ I^{131} $1\times10^{-10}-1\times10^{2}$ Cs^{137}	See Section 11.3.6	Gross Concent.	Effluent, Accident Monitor

TABLE 11.4-1 PROCESS & EFFLUENT MONITORING AND SAMPLING

Description	Bldg.	Elev.	Sample or Cont.	Range (Ci/cc) UOS	Expected Concent.	Quant. Meas.	Remarks
RCB Ventilation Exhaust Effluent (Gaseous) (Iodine) (Particulate)	RSB	861	Continuous	$1 \times 10^{-6}-1 \times 10^{-1}$ Kr^{85} $1 \times 10^{-10}-1 \times 10^{-5}$ I^{131} $1 \times 10^{-10}-1 \times 10^{-5}$ Cs^{137}	See Section 11.3.2.6	Gross Concent.	
RCB Annulus/TMBDB (2) Effluent (Gaseous) (Iodine) (Particulate) (Plutonium/Alpha)	RSB	840 861	Continuous	$1 \times 10^{-6}-1 \times 10^{5}$ Kr^{85} $1 \times 10^{-10}-1 \times 10^{2}$ I^{131} $1 \times 10^{-10}-1 \times 10^{2}$ Cs^{137} $1 \times 10^{-12}-1 \times 10^{-7}$ Pu^{239}			Accident Monitor Safety Related (1E)
RSB Exhaust Effluent (Gaseous) (Iodine) (Particulate)	RSB	816	Continuous	$1 \times 10^{-6}-1 \times 10$ Kr^{85} $1 \times 10^{-10}-1 \times 10^{2}$ I^{131} $1 \times 10^{-10}-1 \times 10^{2}$ ^{137}			Accident Monitoring
SGB-IB Exhaust Effluent (Gaseous) (Iodine) (Particulate)	SGB	836	Continuous	$1 \times 10^{-6}-1 \times 10^{3}$ Kr^{85} $1 \times 10^{-10}-1 \times 10^{2}$ I^{131} $1 \times 10^{-10}-1 \times 10^{2}$ Cs^{137}	See Section 11.3.2.6		Accident Monitoring
Hot Laboratory, Counting Room, and Decontamination Area Ventilation Exhaust Particulate Sampler	PSB		Sample**			Gross Concent.	
Plant Discharge Canal Liquid Sampler	YARD	-	Sample ***		See Section 11.2.5	Concent.	

** Particulate collection on filter, analysis by proportional counters and spectroscopy system.
*** Liquid Samples collected in container. Analysis by proportional and liquid scintillation counters and spectroscopy system.

12.1.4 Area Radiation Monitoring

12.1.4.1 Design Criteria

Area monitors are provided in selected building locations to continuously detect, measure, and indicate the radiation level and to initiate alarms (audible and visual) for radiation levels above preset values. In high or varied noise level areas ($\geq$95db) strobe lights are also provided in addition to the audible alarms. These monitors advise plant personnel of existing radiation levels during normal operation and warn them of potential radiation hazards that may cause higher exposure levels than expected.

The detector ranges of these monitors are chosen to provide continuous monitoring of gamma radiation levels ranging from one decade below to three decades above the design background level at each monitor location.

The basis for location of the various personnel protection monitors shall consider the following factors:

1. The anticipated radiation level under operation, shutdown maintenance, and abnormal conditions.

2. The frequency and duration of occupancy, and the flow of traffic under normal and accident conditions.

3. The proximity of high radiation sources.

4. The consequence of an undetected increase in radiation level.

In addition to the personnel protection monitoring utilized during normal plant conditions, accident area monitoring will also be provided. Area monitoring for range 10^{-1} to 10^{4} R/hr will be provided in the following areas:

1. Inside buildings or areas which are in direct contact with primary containment where penetrations and hatches are located.

2. Inside buildings or areas where access is required to service equipment important to safety and the threat of radiation contamination exists.

Three high-range monitors of range 1 to 10^{7} R/hr will be provided to monitor the levels of gamma radiation in the Containment Area. The detectors for these monitors will be located approximately 120° apart around the Containment vessel periphery in the Annulus space so as to allow a measurement of gamma activity being radiated from containment. The location of these monitors is in the more benign environment of the Annulus rather than in containment to avoid the severe temperature transient and direct sodium aerosol which may occur during and following an acident. These monitors are safety-related and each is supplied which a separate division of Class 1E power.

The Accident Monitors as identified in Table 12.3-5, will meet the requirements of Section 7.5.11 of the PSAR

The locations of the area monitors provided for the CRBRP are shown on Figs. 12.1-1 to 12.1-19d and are listed in Table 12.3-5.

12.1.4.2 Monitoring System Description

Each area monitoring channel consists of a gamma detector, microprocessor and accessories, local indicators, alarms, and Control Room indication. The gamma detector energy dependence will be flat within ±20% for incident radiation above 100 Kev. Local monitor display includes loss-of-signal, high and high-high radiation indicator lights, high and high-high radiation audible alarms and mR/hr rate meter. Also, an essential feature of each monitoring channel will be its ability to avoid "foldover" following saturation in high radiation fields.

The detector signal is also displayed on redundant Radiation Monitoring System CRTs located in the Control Room and Health Physics Area of the Plant Service Building via their respective Central Processing Units and Mini-Computers(System Controllers). The indicating analog meter in each local monitor indicates exposure levels on a suitable multi-decade logarithmic scale. The alarm signals are also permanently recorded by the redundant Radiation Monitoring System Line-Printers located in the Control Room and Health Physics Area.

Group annunciation is also provided on the Main Control Board.

Each area monitor will contain a built-in solenoid actuated shielded check source which can be actuated from the remote process station in the vicinity. All monitor components will be modular, commercially available units designed for rapid replacement upon failure. Electronic components will be exclusively solid-state, as available; and power will be supplied from the instrument AC (120V, 60H_z) busses for the non-safety monitors. Area monitors performing containment isolation functions (PPS) will be supplied with Class 1E power from redundant vital AC busses.

The high radiation alarms of all area monitors are transmitted from the local monitors to the Remote Data Aquisition Terminal units in the vicinity. The Plant Data Handling and Display system will display and log all high alarms.

Figure 12.1-21 shows a functional block diagram of an area radiation monitor. Locations, design dose rates and ranges of sensitivities of the monitors are provided in Table 12.3-5.

12.1.4.3 Maintenance and Calibration

On completion of the monitoring system installation, each area monitor will be checked for proper operation and calibrated against a radiation checksource traceable to the National Bureau of Standards or from an equally acceptable source. The initial calibration and subsequent calibrations at six month intervals will utilize a minimum of two source strengths to verify the linearity of detector output. In addition, each monitor is supplied with a built-in check source to provide a rapid functional test at periodic intervals.

12.1.5 Estimates of Exposure

Peak External Dose Rates and Annual Doses at Unrestricted Locations

The peak dose rates and annual doses at the site boundary and control room due to direct plant radiation are low and considered small relative to the natural background radiation. These doses have been estimated and are shown in Table 12.1-49, Parts I, II, and III.

TABLE 12.1-48 HAS BEEN INTENTIONALLY DELETED

Sections 9.6.1 through 9.6.5 describe the ventilation systems for each building and the main control room. The conceptual design for the RCB provides 14,000 cfm of outside air. This is adequate to meet the design objectives for radiation protection. The conceptual design flow rate to each of the IHTS piping cells is 1000 cfm, which is sufficient to meet the design objective for radiation protection and to satisfy personnel access requirements. Other plant areas will be designed in accordance with conventional heating and ventilation requirements. Analysis of design requirements for other areas involving potential radioactive release will be undertaken and results incorporated, as necessary, in the heating and ventilation requirements for these areas.

12.2.3 Source Terms

The sources of radioactivity originate from the reactor cover gas leakage and H^3 diffusion. The estimated radioactive leakages rates into normally accessible cells are presented in Table 12.2-1. The basis of the table is provided in Section 11.3.

12.2.4 Airborne Radioactivity Monitoring

12.2.4.1 Design Criteria

Fixed and mobile continuous air monitors (CAM) will be employed in conjunction with portable air sampling equipment to satisfy the requirements of CRBRP General Design Criteria 17 and 56 and the relevant sections of 10CFR20; and to verify that radioactive atmospheric contamination within the CRBRP remains normally "as low as reasonably achievable".

The above radioactivity monitoring which is provided for the CRBRP reflects a design philosophy which identifies the following levels of radiation protection (exclusive of the portable personnel monitoring provisions described in Section 12.3).

1. Continuous monitoring (fixed) performed on the ventilation which serves the Reactor Containment Building (RCB) and Reactor Service Building (RSB) operating areas. Continuous monitoring is also performed to verify Control Room habitability.

2. Continuous monitoring (mobile) is performed in frequently occupied Nuclear Island operating areas adjacent to potential radioactivity sources. Frequently occupied areas include radiation zone I and II (Figures 12.1-1 through 12.1-19d) cells which house numerous process system control panels.

3. Low-volume (integrating) air sampling is performed in infrequently occupied operating areas within the Nuclear Island. Infrequently occupied areas include radiation zone II and III cells where routine tasks are performed on a limited access basis.

4. High-volume grab sampling is performed (with accompanying Counting Room analysis) prior to personnel entry into Zone IV radiation zones; and whenever a gross determination of short-lived airborne radioactivity in lower radiation zoned areas is desired.

Fixed CAM's are provided as effluent and process monitors (described in Section 11.4) at locations which could conceiveably be subject to increases in radioactivity levels during various plant evolutions. The process monitors are used to monitor the ventilation exhaust from a particular cell or group of cells. Upon detection of radioactivity above desired levels the radiation monitor will produce an alarm at the process system local panel (in addition to the Control Room) and some monitors will initiate a signal to automatically isolate the affected area. The effluent monitors perform surveillance functions and provide (in the Control Room) indication of an abnormal occurrence warranting investigation by Health Physics personnel. Since the effluent monitors don't perform initiation of isolation the ranges have been selected to provide monitoring during normal and accident conditions. These monitors are included in Table 11.4-1. Fixed CAMs, except those downstream of HEPA filters will withdraw the samples isokinectically in accordance with ANSI N13.1. In addition, the monitors will be located as close as practical to the sample point, and sample line bends are minimized to avoid plate out.

Fixed CAM's are also provided to ensure adequate protection against contamination of the Control Room atmosphere due to airborne radioactivity following an accident condition. This monitoring arrangement is described in Section 11.4. Fixed radiogas monitors (PPS) are also used to initiate Reactor Containment Isolation as discussed in Section 7.3.1.

Mobile CAM's will be provided in select locations throughout the CRBRP to perform the following functions:

1. Continuously monitor the atmosphere at any specific location where maintenance is performed.

2. Continuously monitor the atmosphere at any specific location where a process system failure is suspected of causing airborne radioactivity leakage.

3. Continuously monitor individual inerted cell purging activities as required by the Heating, Ventilating and Air Conditioning System.

4. Continuously monitor the RCB atmosphere following containment isolation, after connection to the post-accident containment sampling penetrations discussed in Section 11.4.2.2.1.

5. Provide backup support to inoperative stationary airborne radioactive monitors.

The mobile CAM's will provide local audible and visual alarm indication of airborne radioactivity levels which exceed the monitor setpoint(s). Locations and design parameters of the various mobile airborne activity monitors are given in Table 12.2-3.

High and low volume portable air samplers will be employed to obtain representative samples of breathing air at infrequently occupied operating areas of the CRBRP. Samples obtained will be analyzed in the Counting Room for gross activity and radioisotopic identification, as required. The portable air samplers will be supplied as health physics equipment, and their frequency of use will be governed by the operational procedures of the CRBRP Health Physics Program.

12.2.4.2 Monitoring System Description

12.2.4.2.1 Continuous Air Monitors

Continuous air monitors (CAM) are used to provide detection of radiogas, particulate, radioiodine and alpha (Pu) activity as indicated in Table 12.2-3. A combination of single and multichannel instruments are used to perform the required monitoring functions. The following is a description of each type of monitor provided:

Gaseous Radioactivity Monitors

Each radiogas CAM continuously draws gas/air samples through a particulate filter into a shielded 4-Pi sample chamber where the gas is viewed by a beta detector, and then returns the gas/air back to the original source. A regulated vacuum pump is used to maintain desired flow rate through the monitor. Samples withdrawn from process or effluent flow will be obtained isokinetically from the source stream. Each monitor consists of a radiogas detector, vacuum pump, microprocessor and accessories, local indicator and alarms. The detector will have a minimum sensitivity of 3×10^{-7} Ci/cc for Kr-85, at the 95% confidence level. Each monitor cabinet will include local loss-of-signal, high and high-high radiation indicator lights, gas/air sample flowmeter and count-rate meter. Taps will be provided to allow samples to be withdrawn for analysis in the Counting Room. For stationary monitors, the detection signal is continuously provided for display on redundant Radiation Monitoring System CRTs located in the Control Room and the Health Physics Area of the Plant Service Building, via their respective Central Processing Units and Mini-Computers (System Controllers). All control signals from monitors which are transmitted to interfacing systems will originate from Remote Process Stations which are part of the local monitor cabinet. The alarm signals are permanently recorded by the redundant Radiation Monitoring System Line Printers located in the Control Room and Health Physics Area.

Iodine and Gaseous Radioactivity Monitors

Radioiodine and radiogas CAM's provide two distinct detection channels within a single monitor housing. A regulated vacuum pump continuously draws a gas/air sample at a measured flow rate into the monitor assembly.

The sampled gas/air flows through a fixed iodine filter, where a gamma detector observes radioiodine activity through a discriminator window. The minimum radioiodine sinsitivity is 10^{-10} Ci/cc for I-131 at the 95% confidence level.

From the iodine filter the air sample passes into a 4-PI shielded chamber where a beta detector observes gaseous activity with a minimum sensitivity of 10^{-6} Ci/cc for Kr-85 at the 95% confidence level. The gas/air sample is then exhausted to the original source.

Each monitor contains the detectors, vacuum pump, microprocessor and accessories, and indicators. Display provisions at each monitor cabinet include (common for each detection channel) loss-of-signal, high and high-high radiation indicator lights, and (separate for each detection channel) count-rate meters. A sample flow rate gauge is also provided.

The detection signal is continuously provided for display on redundant Radiation Monitoring system CRTs located in the Control Room and the Health Physics Area of the Plant Service Building, via their respective Central Processing Units and Mini-Computers (system Controllers). All Control signals from monitors which are transmitted to interfacing systems will originate from Remote Process Stations which are part of the local monitor cabinet. The alarm signals are permanently recorded by the redundant Radiation Monitoring System Line Printers located in the Control Room and Health Physics Area.

Particulate, Iodine and Gaseous Radioactivity Monitors

Particulate, radioiodine and radiogas CAM's provide three distinct detection channels within a single monitor housing. A regulated vacuum pump continuously draws a gas/air sample at a measured flow rate into the monitor assembly. If process or effluent flow is being monitored, the sample is obtained isokinetically from the source stream. Particulates are collected on a filter paper having an efficiency of 99.0% for 0.3 microns particle sizes and viewed by a beta detector of minimum sensitivity of 10^{-10} Ci/cc for Cs-137 at the 95% confidence level, during an integrating time determined by sample flow rate. From the particulate filter, the sampled gas/air flows through a fixed iodine filter, where a gamma detector observes radioiodine activity through a discriminator window. The minimum radioiodine sensitivity is 4×10^{-12} Ci/cc for I-131 at the 95% confidence level.

From the iodine filter the air sample passes into a 4-PI shielded chamber where a beta detector observes gaseous activity with a minimum sensitivity of 3×10^{-7} Ci/cc for Kr-85 at the 95% confidence level. The gas/air sample is then exhausted to the original source.

Each monitor contains the detectors, vacuum pump, microprocessor and accessories, and indicators. Display provisions at each monitor cabinet include (common for each detection channel) loss-of-signal, high and high-high radiation indicator lights, and (separate for each detection channel) count-rate indicators. Mobile monitors are provided with a multipoint strip-chart recorder and audible and visual alarms for high and high-high radiation conditions.

For stationary monitors, the detection signal is continuously provided for display on redundant Radiation Monitoring System CRTs located in the Control Room and the Health Physics Area of the Plant Service Building, via their respective Central Processing Units and Mini-Computers (System Controllers). All control signals from monitors which are transmitted to interfacing systems will originate from Remote Process Stations which are part of the local monitor cabinet. The indicating analog meter in the Remote Process Station will indicate counts per minute on a five decade logarithmic scale. The alarm signals are permanently recorded by the redundant Radiation Monitoring System Line Printers located in the Control Room and Health Physics Area.

Gaseous In-Line Monitors

Gaseous in-line monitors provided to monitor radioactivity in some process systems including HVAC. The Monitor consists of a shielded section of pipe which is mounted by end flanges in the process line. A penetration through the pipe wall allows a beta scintillation detector to be placed in the process system flow. The detector will have a minimum sensitivity of 10^{-6} Ci/cc for Kr-85, at the 95% confidence level. Each monitor will have a local microprocessor with local indicator and alarms.

The detection signal is continuously provided for display on redundant Radiation Monitoring System CRTs located in the Control Room and the Health Physics Area of the Plant Service Building, via their respective Central Processing Units and Mini-Computers (System Controllers). All control signals from monitors which are transmitted to interfacing systems will originate from Remote Process Stations which are part of the local monitor cabinet. The alarm signals are permanently recorded by the redundant Radiation Monitoring System Line Printers located in the Control Room and Health Physics Area.

Alpha Radioactivity Monitors

Each alpha CAM (mobile units) provided will have the capability to differentiate plutonium alpha readings from the natural radon thoron alpha background through delayed detection techniques. Each alpha CAM continuously draws air samples into a shielded chamber where particulates greater than 0.3 microns are deposited on a filter with an efficiency of 99.0% and viewed by detector(s). A regulated vacuum pump will be used to maintain desired flow rate through the monitor arrangement, and return the air sample back to the original source. Each monitor contains the alpha detector(s), vacuum pump, microprocessor and accessories and indicators. The detector(s) will have a minimum sensitivity of 10^{-12} Ci/cc for Pu-239 at the 95% confidence level for a collection time of 8 hours. Display provisions at each monitor cabinet include loss-of-signal, loss-of-sample flow, high and high-high radiation indicator lights, sample flow-meter, count-rate meter, strip-chart recorder and audible alarms for high and high-high radiation conditions. These monitors shall have the capability to transmit data to the radiation monitoring consoles in the control room and health physics area when linked to the communication loop at the option of plant operators.

Figures 12.2-1 and 12.2-2 show typical block diagrams of the containment exhaust (PPS) and typical fixed (non-PPS) continuous air radiation monitoring channels. The PPS radiogas monitors used for Containment Isolation differ from the radiogas CAM described previously in the following manner:

1. Each Class 1E Monitor is individually wired to a dedicated Display and Control Unit (DCU) in the Control Room.

2. An analog output is provided by each monitor to the Plant Protection System (Containment Isolation System) Comparators, Logic and Safety Circuits.

3. The buffered output of each monitor is available for display on the Radiation Monitoring System CRTs and logging on Line Printers.

All CAM components will be modular, commercially available units designed for rapid replacement upon failure. Electric components will be exclusively solid-state, as available, and power will be supplied from the instrument AC busses (120V, 60Hz), with the exception of Class 1E monitors. These latter CAM's will receive Class 1E power (120 Vac, 60Hz) from redundant vital instrument AC busses. Certain design parameters, as well as locations of the various airborne activity monitors are given in Table 12.2-3.

12.2.4.2.2 Portable Air Samplers

Portable air samplers will be used to obtain representative samples of both long and short-lived airborne radioactive contaminants in operating areas of the plant. Their use and placement will be under the direction of the CRBRP site Health Physicist.

Low Volume Samplers

Each sampling station consists of a regulated air pump and filter arrangement to deposit particulates greater than 0.3 microns in size, and/or radioiodine, as required. The sample flow rate is set locally and recorded to enable an accurate determination of activity. The filters will be collected after a suitable integrating time interval, and brought to the Counting Room for analysis. The only local output from the sampler unit is the pump flow signal. The complete pump and filter(s) arrangement are standard, commercially available units designed for ease of maintenance and interchangeability of components.

High Volume Samplers

High volume samplers will employ high speed air blowers to enable grab samples to be obtained in the 20-35 cfm range. Particulate and/or charcoal filters will be used for sample collection, and analysis in the Counting Room will be performed. This type of sampler will be used to determine the airborne radioactivity contribution due to shorter lived isotopes.

12.2.4.3 Maintenance and Calibration

On completion of the monitoring system installation, each CAM will be checked for proper operation and calibrated against a radiation check source(s) traceable back to the National Bureau of Standards or from an equally acceptable source. This initial calibration, and subsequent calibration at six month intervals will verify the electronic operation of both local and Control Room ratemeters and also all annunciation points (loss-of-signal, high radiation, etc.). In addition, each monitor is supplied with a built-in check source to provide rapid functional tests at periodic intervals.

12.2.5 Inhalation Doses

Inhalation doses to plant personnel will be limited and controlled consistent with 10CFR20 requirements via the heating and ventilation system design. Resulting doses will be kept as low as practicable during operation and maintenance and exposures will be compatible with existing regulations (10CFR20).

The expected annual inhalation doses to plant personnel in normally accessible cells can be determined from the leakage rates given in Table 12.2-1 and the design flow rates for ventilation air in the Heat Access Area and Intermediate Sodium Piping cells.

The concentration in these cells, for the expected leakage rates, is estimated by assuming that there is a uniform concentration in the cell atmosphere and the ventilation air stream. Thus, an equilibrium concentration will exist when the curie content discharged per day is equal to the leakage into the cell. The expected concentrations in the accessible cells are given in Table 12.2-4. The doses from the expected concentration can be estimated by assuming the ratio of the concentration to MPC occupational limits for each isotope present and multiplying this by 5 rem, the annual dose which would result from exposure to the MPC for 40 hours per week for 50 weeks of the year.

As shown in Table 12.2-4, the combined expected activity level for the isotopes present is about 0.01 MPC (occupational) in the Head Access Area. Thus, the corresponding annual dose would be about 5mrem/year.

The release to the Intermediate Sodium Piping cells is tritium and the resulting equilibrium concentration is 0.0008 MPC. The resulting expected yearly dose would be about 4mrem/year.

Both of the above annual dose estimates are conservative since each assumes occupancy in the cells by an individual of 40 hours per week for 50 weeks of the year. The expected occupancy is considerably less.

The control room will be designed to assure continued occupancy during postulated accident conditions. The expected radioactivity in the control room during normal plant operations is background level. Additional discussion is provided in Section 12.1.5.

TABLE 12.2-3

LOCATION OF CONTINUOUS AIR MONITORS

LOCATION BLDG.	ELEV.	CELL NO.	TYPE OF MONITOR	MONITOR AREA DESCRIPTION	BASIS FOR LOCATION/FUNCTION	REMARKS
RCB	B16	161A	Particulate/Radio-	Operating Floor Iodine/Gaseous	Mobile monitor to provide monitoring of work areas within containment	See Figure 12.2-2, See Sections 12.2.4.1 & 12.2.4.2.1. This locations is the normal storage position of the mobile monitor.
RCB	B16	161A	Particulate/Radio-Iodine/Gaseous	Operating Floor	Mobile monitor to provide monitoring of work areas and inerted cells in the containment	See Figure 12.1-2, See Sections 12.2.4.1 & 12.2.4.2.1. This location is the normal storage position of the mobile monitor.
RCB	B16	161A	Alpha	Operating Floor	Mobile monitor to provide monitoring of work areas within containment	See Figure 12.1-2, See Sections 12.2.4.1 & 12.2.4.2.1. This location is the normal storage position of the mobile monitor.
RCB	766	105M	Particulate/Radio-Iodine/Gaseous	Operating Floor	Mobile monitor to provide monitoring of work areas and inerted cells in the containment	See Figure 12.2-5, See Sections 12.2.4.1 & 12.2.4.2.1.. This location is the normal storage position of the mobile monitoring.

TABLE 12.2-3

LOCATION OF CONTINUOUS AIR MONITORS

LOCATION BLDG.	ELEV.	CELL NO.	TYPE OF MONITOR	MONITOR AREA DESCRIPTION	BASIS FOR LOCATION/FUNCTION	REMARKS
RCB	816	161A	Particulate/Radio-Iodine/Gaseous	Operating Floor	Mobile monitor to provide monitoring of work areas within containment	See Figure 12.2-2, See Sections 12.2.4.1 & 12.2.4.2.1. This locations is the normal storage position of the mobile monitor.
RCB	816	161A	Particulate/Radio-Iodine/Gaseous	Operating Floor	Mobile monitor to provide monitoring of work areas and inerted cells in the containment	See Figure 12.1-2, See Sections 12.2.4.1 & 12.2.4.2.1. This location is the normal storage position of the mobile monitor.
RCB	816	161A	Alpha	Operating Floor	Mobile monitor to provide monitoring of work areas within containment	See Figure 12.1-2, See Sections 12.2.4.1 & 12.2.4.2.1. This location is the normal storage position of the mobile monitor.
RCB	766	105M	Particulate/Radio-Iodine/Gaseous	Operating Floor	Mobile monitor to provide monitoring of work areas and inerted cells in the containment	See Figure 12.2-5, See Sections 12.2.4.1 & 12.2.4.2.1.. This location is the normal storage position of the mobile monitoring.

TABLE 12.2-3 (Cont'd)

LOCATION						
BLDG.	ELEV.	CELL NO.	TYPE OF MONITOR	MONITOR AREA DESCRIPTION	BASIS FOR LOCATION/FUNCTION	REMARKS
RSR	779	307B	Particulate/Radio-iodine/Gaseous	Operating Floor	Mobile monitor to provide monitoring of local work areas and post-accident monitoring of containment atmosphere	See Figure 13.1-11, See Sections 12.2.4.1, 12.2.4.2.1 & 11.4.2.2.1. This location is the normal storage position of the mobile monitor.
RSB	816	308A	Alpha	Operating Floor	Mobile monitor to provide monitoring of local work areas and post-accident monitoring of containment atmosphere	See Figure 12.1-9, See Sections 12.2.4.1, 12.2.4.2.1, & 11.4.2.2.1. This location is the normal storage position of the mobile monitor.
RSB	816	308B	Particulate/Radio-iodine/Gaseous	Operating Floor	Mobile monitor to provide monitoring of local work areas	See Figure 12.1-9, See Sections 12.2.4.1 & 12.2.4.2.1. This location is the normal storage position of the mobile monitor.
SGB-IB	816	262	Particulate/Radio-iodine/Gaseous	Operating Floor	Mobile monitor to provide monitoring of SGB-IB local work areas and post-	See Figure 12.1-19a, See accident monitoring of containment Sections 12.2.4.1, atmosphere12.2.4.2.1 & 11.4.2.2.1. This location is the normal storage position of the mobile monitor.

TABLE 12.2-3 (Cont'd)

LOCATION			TYPE OF MONITOR	MONITOR AREA DESCRIPTION	BASIS FOR LOCATION/FUNCTION	REMARKS
BLDG.	ELEV.	CELL NO.				
CB	816	431	Particulate/Radio-iodine/Gaseous	Operating Floor	Mobile monitor to provide monitoring of control room and local work areas	See Section 12.2.4.1 & 12.2.4.2.1. This location is the normal storage position of the mobile monitor.

TABLE 12.3-5

PERSONNEL PROTECTION MONITOR - AREA MONITORS

LOCATION BLDG.	ELEV.	CELL	AREA AND/OR PROCESS MONITORED	MONITOR TYPE	METER RANGE mR/hr	OPERATIONAL BACKGROUND (mR/hr)	MONITOR OUTPUT**	BASIS FOR LOCATION*
RCB	824'	162	I&C Cubicle	Direct Gamma	$0.01-10^3$	0.2	A	1.
RCB	824'	163	I&C Cubicle	Direct Gamma	$0.01-10^7$	0.2	A	1,5
RCB	824'	164	I&C Cubicle	Direct Gamma	$0.01-10^7$	0.2	A	1.,4,3
RCB	780'	105U	Primary PTI Operating Area	Direct Gamma	$0.1-10^4$	2.0	A	1.,2
RCB	766'	105S	Operating Floor	Direct Gamma	$0.1-10^4$	2.0	A	1.,2.,5
RCB	780'	161G	Operating Floor	Direct Gamma	$0.1-10^4$	2.0	A	1.,2.
RCB	794'	152	Operating Floor	Direct Gamma	$0.1-10^4$	2.0	A	1.,2.
RCB	752'	105H	Operating Floor	Direct Gamma	$0.1-10^4$	2.0	A	1.,2.
RCB	766'	105Q	Operating Floor	Direct Gamma	$0.1-10^4$	2.0	A	1.,2
RCB	[illegible]	105A	Operating Floor	Direct Gamma	$0.1-10^4$	2.0	A	1.,2,5
RSB	842'6"	311	Refuel. Comm. Center	Direct Gamma	$0.01-10^3$	0.2	B	1.,3
RCB	802'	151	Head Access Area	Direct Gamma	$0.1-10^7$	25.0	A	1.,2.,4.
RSB	816'	308A	Operating Floor	Direct Gamma	$0.01-10^3$	0.2	B	1.,2.,3,6
RSB	816'	308A	Operating Floor	Direct Gamma	$0.01-10^3$	0.2	B	1.,3,6
RWB	816'	643	Decontamination Bay	Direct Gamma	$0.1-10^4$	2.0	B	1.,2
RCB	794'	105V	Operating Floor	Direct Gamma	$0.1-10^4$	2.0	A	1.,2,5
RSB	779'	307A	Ex-Vessel SSP Operating Area	Direct Gamma	$0.1-10^4$	2.0	A	1.
RCB	752'	105K	Operating Area	Direct Gamma	$0.1-10^4$	2.0	A	1.
RSB	755'	306A	Ex-Vessel PTI Operating Area	Direct Gamma	$0.1-10^4$	2.0	A	1.
SGB	836'	271	SGB(IB) Remote Shutdown Panels Area	Direct Gamma	$0.01-10^7$	Unrestricted (See NOTE 2)	A	1.

TABLE 12.3-5 (Cont'd)

LOCATION BLDG.	ELEV.	CELL	AREA AND/OR PROCESS MONITORED	MONITOR TYPE	METER RANGE mR/hr	OPERATIONAL BACKGROUND (mR/hr)	MONITOR OUTPUT**	BASIS FOR LOCATION*
RCB	733'	105F	Make-up Pump Valve Operating Gallery	Direct Gamma	$0.1-10^4$	2.0	A	1,5
RCB	733'	105D	Operating Area	Direct Gamma	$0.1-10^4$	2.0	A	1.
RCB	766'	105M	Primary SSP Operating Area	Direct Gamma	$0.1-10^4$	2.0	A	1.,2.
RWB	795'	605C	IALL Distillate Storage Tank Area	Direct Gamma	$0.1-10^4$	2.0	A	1
RWB	795'	620	Filter Handling Room	Direct Gamma	$0.1-10^4$	2.0	A	1
RSB	733'	305B	Operating Areas	Direct Gamma	$0.1-10^4$	2.0	A	1
RSB	779'	307A	Operating Floor	Direct Gamma	$0.1-10^4$	2.0	B	1.,2
RSB	781'	341	Fuel Handling Cell	Direct Gamma	$0.01-10^8$	2.0×10^8	B	3.
RSB	779'	339A	FHC Operating Gallery	Direct Gamma	$0.01-10^3$	0.2	B	1.,2.
RSB	749'	336	Spent Fuel Cask Corridor and Shaft	Direct Gamma	$0.01-10^8$	5.0×10^4	B	3.
RSB	755'	306AA	Operating Areas	Direct Gamma	$0.1-10^4$	2.0	A	1.,2.
RSB	733'	335	SFSC Service Station Equipment	Direct Gamma	$0.1-10^4$	10.0	B	1.,2.,3
SGB	816'	262	Operating Areas	Direct Gamma	$0.1-10^7$	Unrestricted (See NOTE 2)	A	1.,4
SGB	794'	253	Emerg. Airlock/Analysis Operating Area	Direct Gamma	$0.1-10^4$	Unrestricted (See NOTE 2)	A	1.,4,6
CB	816'	431	Control Room	Direct Gamma	$0.1-10^7$	Unrestricted (See NOTE 2)	A	1.
PSB	816'	146	Combined Lab	Direct Gamma	$0.01-10^3$	Unrestricted (See NOTE 2)	A	1.
RWB	775'	605A	IALL Distillate Storage Tank Area	Direct Gamma	$0.01-10^7$	2.0	A	1.

TABLE 12.3-5 (Cont'd)

BLDG.	LOCATION ELEV.	CELL	AREA AND/OR PROCESS MONITORED	MONITOR TYPE	METER RANGE mR/hr	OPERATIONAL BACKGROUND (mR/hr)	MONITOR OUTPUT**	BASIS FOR LOCATION*
RCB	816'	161A	Equipment/Personnel Airlock Area	Direct Gamma	$0.01-10^3$	0.2	A	1.
RCB	816'	169A	RCB Annulus	Direct Gamma	10^0-10^7	0.2	A	4
RCB	816'	169A	RCB Annulus	Direct Gamma	10^0-10^7	0.2	A	4
RCB	816'	169A	RCB Annulus	Direct Gamma	10^0-10^7	0.2	A	4
RCB	794'	161E	Primary Pump Drive	Direct Gamma	$10^{-1}-10^4$	2.0	A	5
RCB	794'	161D	Primary Pump Drive	Direct Gamma	$10^{-1}-10^4$	2.0	A	5
RCB	794'	161C	Primary Pump Drive	Direct Gamma	$10^{-1}-10^4$	2.0	A	5
RCB	766'	105Y	Valve Operating Gallery	Direct Gamma	$10^{-1}-10^4$	2.0	A	5
RCB	733'	111	Stairwell	Direct Gamma	$10^{-1}-10^4$	2.0	A	5
RCB	733'	105E	Access Area	Direct Gamma	$10^{-1}-10^4$	10.0	A	5
RCB	825'	106	Polar Crane Operating	Direct Gamma	$10^{-1}-10^4$	0.2	A	5
RCB	842'	165	EI&C Cubicle	Direct Gamma	$10^{-1}-10^4$	0.2	A	5
RCB	842'	167	EI&C Cubicle	Direct Gamma	$10^{-1}-10^4$	0.2	A	5
SGB	794'	247	Power Distrib. Panel Area	Direct Gamma	$10^{-1}-10^4$	Unrestricted	A	5,6
SGB	794'	271	Operating Area	Direct Gamma	$10^{-1}-10^4$	Unrestricted	A	5,6
SGB	794'	271	Operating Area	Direct Gamma	$10^{-1}-10^4$	Unrestricted	A	5,6
SGB	794'	262	Operating Area	Direct Gamma	$10^{-1}-10^4$	Unrestricted	A	5,6
SGB	794'	262	Operating Area	Direct Gamma	$10^{-1}-10^4$	Unrestricted	A	5,6
SGB	794'	211A	Valve Gallery	Direct Gamma	$10^{-1}-10^4$	5×10^2	A	6
SGB	794'	248	IHTS Pipe Chase	Direct Gamma	$10^{-1}-10^4$	1×10^4	A	6
SGB	794'	251	IHTS Pipe Chase	Direct Gamma	$10^{-1}-10^4$	1×10^4	A	6
SGB	794'	252	IHTS Pipe Chase	Direct Gamma	$10^{-1}-10^4$	1×10^4	A	6

TABLE 12.3-5 (Cont'd)

LOCATION BLDG.	ELEV.	CELL	AREA AND/OR PROCESS MONITORED	MONITOR TYPE	METER RANGE mR/hr	OPERATIONAL BACKGROUND (mR/hr)	MONITOR OUTPUT**	BASIS FOR LOCATION*
RSB	785'	348	Cont. Cleanup Scrubber	Direct Gamma	10^{-1}-10^{4}	0.2	A	6
RSB	785'	349	Cont. Cleanup & HVAC Duct	Direct Gamma	10^{-1}-10^{4}	0.2	A	6
RSB	840'	332	NDHX 3rd Loop Cell	Direct Gamma	10^{-1}-10^{4}	0.2	A	5
RSB	864'	395A	Annulus Filter	Direct Gamma	10^{-1}-10^{4}	0.2	A	6
RSB	733'	350	NAP Storage Vessel Cell	Direct Gamma	10^{-1}-10^{4}	2.0	A	6
RSB	733'	305M	Access Area	Direct Gamma	10^{-1}-10^{4}	2.0	A	6
RSB	733'	305C	RSB/SGB Passageway	Direct Gamma	10^{-1}-10^{4}	2.0	A	6
RSB	743'	311	SDD 82, 85 & 94 Area	Direct Gamma	10^{-1}-10^{4}	1×10^{2}	A	6
RSB	797'	314	SDD 23 Instru. Area	Direct Gamma	10^{-1}-10^{4}	0.2	A	5
RSB	755'	359	Cont. Cleanup Filter Cell	Direct Gamma	10^{-1}-10^{4}	0.2	A	6
RSB	779'	376	RAPS Pipe Gallery	Direct Gamma	10^{-1}-10^{4}	5×10^{3}	A	6
RSB	775'	3511	EVS Cooling Pipeway	Direct Gamma	10^{-1}-10^{4}	2×10^{3}	A	6

LEGEND

RCB - Reactor Containment Bldg.
RSB - Reactor Service Bldg.
SGB - Steam Generator Bldg.
CB - Control Bldg.
PSB - Plant Service Bldg.
RWB - Radwaste Area (Bay)

*BASIS FOR LOCATION

1. Provide personnel protection in trafficked area.
2. Monitor adjacent high radioactivity area.
3. Monitor refueling operations.
4. High level reactor containment radiation monitor (Accident Monitor).
5. Monitor areas conntaining safety-related equipment (Accident Monitor).
6. Monitor areas with hatches or penetrations from containment (Accident Monitor).

**MONITOR OUTPUT

A. Local and Control Room: Loss of signal indicator light, high level radiation alarm, high-high level radiation alarm, exposure meter (mR/hr).
B. Local, Control Room and Refueling Communication Center: (same as above).

NOTES:
Unrestricted: Defined by 10 CFR 20, Paragraph 20.105.
Background specified in table is maximum design background value during operation, based on Na-24 gamma field.

15.3.2.4 Failure of the Steam Bypass System

15.3.2.4.1 Identification of Causes and Accident Description

The turbine steam bypass system regulates the flow of steam to the main condenser following a turbine trip to maintain steam pressure at 1450 psig. The system contains four bypass valves.

A failure of a bypass valve to open following a turbine trip, may result in a pressure increase in the steam system to the power relief valve set point. The temperature transient at the core for this event is conservatively bounded by failure of all the bypass valves to open. In the event of a failure of all bypass valves to open, the main condenser would be unavailable for cooling. Flow in the main steamline would be interrupted resulting in a rapid increase in pressure until the power relief valves at the superheater exists opened. The reactor would be scrammed by any one of the three steam-feedwater flow ratio trips.

When the available normal feedwater supply is exhausted, the Steam Generator Auxiliary Heat Removal System (SGAHRS) would be activated by the low drum level trip and feedwater provided by the auxiliary feedwater pumps (see Section 5.6). A backup trip is provided by low steam drum level that occurs after the normal feedwater supply is exhausted.

A failure of the bypass system valves to the open position would result in increased steam flow to the condenser. The action of the shutdown systems would depend upon initial power level and the magnitude of the bypass flow. In the limiting case, at full power with the failure of all valves open, the steam-feedwater flow ratio quickly trips the plant.

15.3.2.4.2 Analysis of Effects and Consequences

A turbine trip with the plant operating at rated conditions is assumed to occur accompanied by a complete failure of the steam bypass system to operate. The steam line pressure increases and the superheater power relief valves open and blow steam to the atmosphere. The reactor trips on low steam-feedwater flow ratio in about two seconds. The resulting core temperatures are very similar to those for a normal trip from full power. After the normal feedwater supply has been exhausted (greater than 20 minutes) the Steam Generator Auxiliary Heat Removal System (SGAHRS) is actuated on low steam drum level and automatically maintains drum water level. The event is conservatively bounded by the Loss of Normal Feedwater (Sec Section 15.3.1.6).

15.3.3 Extremely Unlikely Events

15.3.3.1 Steam or Feed Line Pipe Break

15.3.3.1.1 Identification of Causes and Accident Description

The breakage of a steam or feed pipe in the steam generator system is considered an extremely unlikely event. If such a break should occur, the resulting accident might have one of several forms, depending on where the break is located in the system, its size and whether or not it is insolatable. It should be noted that a reactor trip by the Plant Protection System will shut down the reactor before any of the steam system temperature changes have been transported back to the reactor core (at pony motor speed approximately 150 seconds) hence no problem results with immediate reactor safety. The event instead is considered in the plant design for its effect on plant component service life through thermal-transient-induced stress.

The plant has incorporated design features to protect against the steam line break. For instance the Superheater Outlet Isolation Valve and Superheater Bypass Valve in each loop are active valves and will close within 3 seconds following a steam line break. Closing of these valves in the failed loop will prevent blowdown of more than one loop through the postulated pipe break. The valves in the failed loop will close by either a Low Superheater Outlet Pressure (< 1100 psig) or a High Steam/Feedwater Flow Mismatch. When a high steam/feedwater flow ratio occurs, the Superheater Outlet Isolation Valves and Superheater Bypass Valves in the other two loops will close. A detailed description of the Outlet Steam Isolation Subsystem (OSIS) is presented in Section 7.4.2. The superheater Outlet Check Valve provides additional back-up to prevent blowdown but is not relied upon in any analysis. The Superheater Bypass Valve is normally closed during operation.

In the event of failure of an active valve to close, the Superheater Outlet and Bypass Valves in the other two loops preclude their blowdown.

Breaks at the following locations have been investigated:

a. Main steam line rupture.

b. Steam line from a superheater to the main steam header.

c. Saturated steam line between the steam drum and the superheater.

d. Feedline break.

e. Recirculation line break.

The saturated steam line break has been selected as the most severe thermal transients of the events presented above. Analysis results for this event are presented in Figure 15.3.3.1-1. All of the above cases are summarized as follows:

Main steam line rupture:

A steam break at the main steam header would, if not isolated, produce a severe cold leg temperature transient in all three loops consisting of a down transient due to initial excess cooling followed by an up-transient after dryout. It is not plausible, however, to assume that isolation would fail to occur in all three loops, hence for case (a) automatic isolation was assumed at three seconds with isolation initiated by the Plant Protection System (PPS).

Once the superheater outlet isolation valves close, the plant achieves a new operating point based on steam load through the safety valves and hence no other excessive plant temperatures are produced. As noted below, a reactor shutdown is initiated by the PPS based on either the primary shutdown system (steam/feed flow mismatch) or secondary system (Low Drum Level), terminating high power operation before excessive loss of water inventory. Either the high steam-to-feedwater flow ratio or the Low Steam Drum Water Level Trip also activates the steam generator auxiliary heat removal system (SGAHRS) as noted below and discussed in Section 5.6. All three loops would provide heat removal from the core. With the superheat steam line isolated, pressure in the steam system will build up to the relief setpoint. The drum water level will drop due to steam venting and the low steam drum water level trip will then activate SGAHRS if it has not been activated earlier in the transient by the High Steam to Feedwater Flow Ratio.

Rupture in a Steam Line Between a Superheater and the Main Steam Header:

This event results from a break occurring in the superheater exit steam line upstream of the isolation valve. A similar event follows from a break downstream of the isolation valve (including a break in the main steam line) if the isolation valve fails to close. For these cases, isolation can still be effectively accomplished by the superheater inlet isolation valve, either by manual initiation or automatically when steam drum pressure falls below 500 psig. Consequently, a break in the superheater-to-header line has an effect similar to the preceding main steam line break case, but its effects are limited to a single loop.

Saturated Steam Line Break:

In the saturated steam line break, case (c) above, the break may be located such that loss of water in the affected steam drum cannot be prevented. Isolation valves on the modules could still be closed, but safety valve outflow will still lead to module dryout. Consequently, no credit is taken for isolation in these cases.

As steam is removed from the system by the break, increased flashing of water into steam within the steam generator occurs, removing additional heat and causing the sodium temperature initially to decrease at the evaporator exit. A plant shutdown, when initiated by low steam feed flow, will cause coastdown of the intermediate sodium pump, and hence will amplify the initial decrease in evaporator exit temperature. Subsequently, when most of the moisture has been discharged from the steam generator, both evaporators and superheater will dry out, and the evaporator exit sodium temperature will increase to approach the intermediate hot leg temperature. The cold leg temperature increase will eventually be transported back to the reactor inlet, after being conducted through the IHX of the affected loop. Due to extended transport delays at pony motor flowrates, the temperature increase

An alternate location for this break is at the exit of one evaporator module. Closure of the other isolation valves, including the inlet valve on the affected module, would lead to a dryout of the generator similar to previous cases. If the inlet isolation valve on the module does not close, the contents of the drum would be dumped through the affected module, producing a severe temperature down-transient on that module. The remaining module will dry out and its resulting increase in sodium exit temperature will mix with that from the faulted module to attenuate the net intermediate cold leg temperature transient.

For the steam and feed break cases, the following conditions have been applied to assure a conservative analysis:

a. The largest possible break size is assumed, corresponding to the full guillotine severance of the pipe involved.

b. The earliest PPS trip is used to predict the largest span for the sodium temperature transient for cases in which the intermediate cold leg temperature is considered.

c. The transients were run from a starting point at the 1121 MWt reactor power design condition (stretch power).

d. Credit has not been taken for heat storage in shell and structural metal in active or unheated parts of the modules in mitigating the thermal transients. Credit was taken only for 75% of the tube metal in the heated part of the modules.

e. No isolation was performed on the affected unit during the drum to superheater break, feed break and recirculation line break cases and the steam generator was allowed to go to full dryout.

The action of the Plant Protection System (PPS) in the above cases is the following:

Primary Shutdown System

a. Reactor and plant trip - steam-feedwater flow ratio

Secondary Shutdown System

a. Reactor and plant trip - high evaporator outlet temperature

TABLE 1
(cont'd)

X = AVAILABLE

AREA			TYPE OF COMMUNICATION FROM CR & RSP TO AREA			
BLDG	CELL	CELL DESIGNATION	PA-IC	PAX	MCJ	PRS*
RCB	151	Head Access Area	X	X	X	X
	161A	Operating Floor	X	X	X	X
	163	EI&C Cubicle	X	X	X	X
	165	EI&C Cubicle	X	X	X	X
	167	EI&C Cubicle	X	X	X	X
	169A	Annulus Above Operating Floor			X	X
	105F	Makeup Pump & Valve Cell	X	X	X	X
	105G	Personnel & Equipment Access	X		X	X
	105H	Corridor & Valve Gallery	X	X	X	X
	105Z	Makeup Pump Cooler Cell			X	X

TABLE 1
(cont'd.)

X = AVAILABLE

AREA			TYPE OF COMMUNICATION FROM CR & RSP TO AREA			
BLDG	CELL	CELL DESIGNATION	PA-IC	PAX	MCJ	PRS*
RSB	305B	El 733' Access Area	X		X	X
	305E	USS Cell	X		X	X
	305F	USS Cell	X		X	X
	305G	Heat Exchanger Cell	X		X	X
	305I	Heat Exchanger Cell	X		X	X
	306A	El. 755' Access Area	X	X	X	X
	306B	El. 755' Access Area	X		X	X
	307A	El. 779' Access Area	X	X	X	X
	307B	El. 779' Access Area	X		X	X
	308B	RSB Operating Floor	X	X	X	X
	309	MCC Area	X	X	X	X
	311	Refueling Communication Center	X	X	X	X
	314	Instrumentation Area	X		X	X
	325	EVSS Pump & Pipeways Cooler			X	X
	326	ABHX Cell Unit Cooler	X	X		X
	327	ABHX Cell Unit Cooler	X		X	X
	347	Containment Clean-up Filter Cell	X		X	X
	347A	Radiation Monitor Cell			X	X
	348	Containment Clean-up Chase			X	X
	349	Containment Clean-up Chase			X	X
	352A	EVST, ABHX Loop A Cell	X		X	X
	353A	EVST, ABHX Loop B Cell	X		X	X

TABLE 1
(cont'd)

X = AVAILABLE

AREA			TYPE OF COMMUNICATION FROM CR & RSP TO AREA			
BLDG	CELL	CELL DESIGNATION	PA-IC	PAX	MCJ	PRS*
RSB	359	Containment Clean-up Scrubber & Washer Cell	X		X	X
	391	Containment Clean-up Filter Cell	X		X	X
	395	RCB Annulus Filter Unit Cell	X		X	X
	398	RCB Annulus Filter Unit Cell	X		X	X

TABLE 1
(Cont'd)

X = AVAILABLE

AREA			TYPE OF COMMUNICATION FROM CR & RSP TO AREA			
BLDG	CELL	CELL DESIGNATION	PA-IC	PAX	MCJ	PRS*
ECT	121	Division 1 MCC Area	X	X	X	X
	122	Division 2 MCC Area	X	X	X	X