FLORIDA POWER & LIGHT COMPANY

TURKEY POINT UNITS 3 AND 4

EMERGENCY POWER SYSTEM ENHANCEMENT PROJECT RESPONSE TO NRC'S REQUEST FOR ADDITIONAL INFORMATION (RAI'S) REVISION 1

MAY 1990

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
EMERGENCY POWER SYSTEM ENHANCEMENT PROJECT

The following are FPL's updated responses to the NRC's January 6, 1989 Request for Additional Information (RAI) regarding the Emergency Power System (EPS) Enhancement Project. The original responses have been revised to reflect the latest design information. For your convenience, the response to each question immediately follows the duplicated RAI. Also for tracking purposes, the questions related to EDG qualification testing per Enclosure 2 of the January 6, 1989 request, have been numbered RAI 52 through RAI 60.

RAI 1

Identify the applicable Codes, Standards, Regulatory Guides, NUREGs, General Design Criteria, Generic Letters, and other documentation (hereafter "Standards") that are to be applied to the system enhancement. For each Standard identified, indicate to which part or parts of the system enhancement that the Standard will apply.

Response to RAI 1

1) Civil/Structural Design

The new EDG building, all internal structures, and all new exterior structures (i.e., ductbanks and manholes) as shown on Figure 1-1 will be designed in accordance with the following criteria. Modifications and additions to existing structures will be designed in accordance with the criteria specified in the FSAR.

a. Structural Analysis

1. The load combinations and structural acceptance criteria to be used in the design will be in accordance with NUREG 0800 (Standard Review Plan - SRP) Section 3.8.4.

2. Seismic

Maximum horizontal ground accelerations will be 0.15 g (Maximum Earthquake E' in FSAR) and 0.05 g for OBE (Design Earthquake E in FSAR). Maximum vertical ground accelerations will be two-thirds of the maximum horizontal ground acceleration values. Ground response spectra will be developed enveloping the Newmark curves in accordance with Regulatory Guide (RG) 1.60 "Design Response Spectra for Seismic Design of Nuclear Power Plants".

Damping values used in the design and analysis will be those presented in RG 1.61 "Damping Values for Seismic Design of Nuclear Power Plants". Combination of modes in maximum response analysis will be done using the "square-root-of-the-sum-of-the-squares" method in accordance with RG 1.92 "Combining Modal Responses and Spatial Components in Seismic Response Analysis". Orthogonal earthquake components will be combined using the SRSS method to determine maximum response as presented in RG 1.92. Building floor response spectra curves will be developed from synthetic time-

histories using the methods described in RG 1.122 "Development of Floor Design Response Spectra for Seismic Design of Floor Supported Equipment or Components". The building mathematical model used in the dynamic analysis will consist of a lumped mass cantilever coupled to the acceleration time-history input by soil springs.

3. Wind Analysis

Wind velocity pressures will be calculated in accordance with ANSI 58.1 "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures". ASCE Paper No. 3269 "Wind Forces on Structures" will be used to obtain effective wind pressure for cases which ANSI A58.1 does not cover. This wind load criteria conforms to the SRP Section 3.3.1. In addition, the South Florida Building Code wind load criteria will be reviewed and used if it yields governing results.

4. Tornado Winds and Missiles

Tornado wind velocities and differential pressure drop will be in accordance with RG 1.76 "Design Basis Tornado for Nuclear Power Plants" and SRP Section 3.3.2. The velocity pressure will be calculated in accordance with ANSI 58.1 with no variation taken for height of the structure or exposure and a gust factor of unity.

The building will be designed to resist the impactive forces of tornado generated missiles combined with the velocity pressure and differential pressure in accordance with SRP Section 3.3.2. The tornado missile spectrum will be that given in SRP 3.5.1.

b. Missile Protection

Missile protection will be provided for the new EDG building and new exterior ductbanks and manholes shown on Figure 1-1. Missile barriers will be designed to resist penetration and impactive dynamic loading in accordance with the criteria provided in SRP 3.5.3. The following missiles will be considered in barrier design.

1. Tornado generated missiles in accordance with SRP 3.5.1
2. Internally generated missiles from the diesel generator.

Protection of the new EDG building from a turbine missile is achieved by its physical location and the low probability of occurrence as described in the FSAR.

c. Flood Design

The new EDG building will be protected from flooding by barriers designed in accordance with RG 1.102 "Flood Protection". The maximum flood and wave run-up elevations will be in accordance with the FSAR.

d. Concrete and Steel Design

Reinforced concrete design will be in accordance with ACI 349-85 "Code Requirements for Nuclear Safety Related Structures" as modified by RG 1.142 "Safety Related Concrete Structures".

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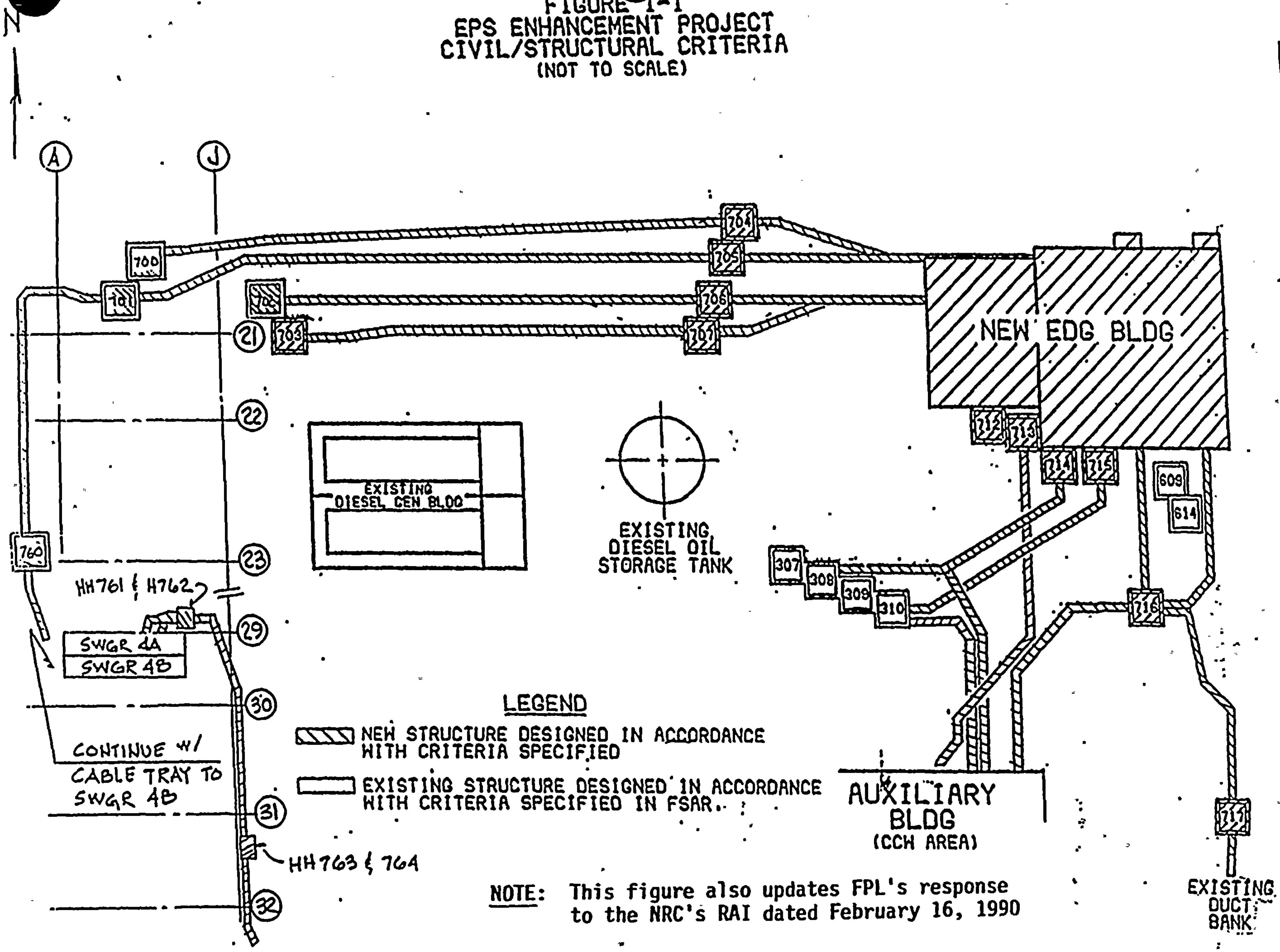
FIGURE 1-1
EPS ENHANCEMENT PROJECT
CIVIL/STRUCTURAL CRITERIA
(NOT TO SCALE)



NOTE: This figure also updates FPL's response to the NRC's RAI dated February 16, 1990

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Structural steel design will meet the requirements of the eighth edition of AISC "Manual of Steel Construction."

e. Soil Properties

Allowable bearing capacity values and foundation design concepts will be based upon soil data contained in Dames and Moore report "Foundation Investigation, Proposed Nuclear Units, Turkey Point, Florida", dated February 5, 1965, and additional data obtained from testing following the guidelines of RG 1.132 "Site Investigation for Foundations" and RG 1.138 "Laboratory Investigation of Soils".

2) Mechanical System Design

The Codes and Standards utilized in piping and component design, analysis and shop fabrication are delineated in the following system-specific descriptions. Field installation, erection, welding and any field fabrication will be performed in accordance with the Codes and Standards (i.e., ANSI B31.1) called for in the existing procedures presently used at the Turkey Point site. The existing procedures are part of FPL's Quality Assurance Program in compliance with 10CFR50, Appendix B.

a. Diesel Oil Storage and Transfer System

The new diesel oil storage and transfer system up to the tie-in with the existing oil transfer system will be designed in accordance with Regulatory Guide 1.9 and ANSI Standard N195-1976, as endorsed by Regulatory Guide 1.137. In addition, the system will meet the performance requirements of SRP 9.5.4 as follows:

1. Safety related portions of the diesel oil storage and transfer system will be located inside Seismic Category I structures or otherwise protected from the effects of natural phenomena and external missiles.

2. The failure of non-seismic Category I structures and components will not affect the safety related function of the diesel oil storage and transfer system.

3. The design will ensure that a minimum of seven days of fuel oil is available for each new EDG to meet the engineered safety feature load requirements following a loss of offsite power and design basis accident.

Specific design standards for system components include the following:

o Diesel Oil Storage Tanks

The diesel oil storage tanks will be designed in accordance with ASME Section VIII and will meet Seismic Category I requirements.

Sample connection to the tanks will be provided in accordance with ASTM-D270. Connections to non-safety related piping will be provided with ASME Section III, Class 3, isolation valves.

- o Diesel Oil Transfer Pumps

  The diesel oil transfer pumps will meet ASME Section III, for Class 3 components and Seismic Category I requirements. In service testing capability for these pumps will be provided in accordance with ASME Section XI.

- o Diesel Oil Transfer System Piping

  The diesel oil transfer system piping, external to the engine skid, will be designed in accordance with ASME Section III, for Class 3 components and will meet Seismic Category I requirements.

  All two inch and smaller valves will be ANSI Class 600 minimum. Two and one-half inch and larger valves will be ANSI Class 150 minimum.

  The engine mounted piping, as a minimum, will be designed and analyzed to ANSI B31.1 and meet Seismic Category I requirements.

b. Diesel Engine Cooling Water System

The diesel engine cooling water system will be designed in accordance with RG 1.9. The system, except for the engine skid piping, the surge tank and radiator, will be designed to ASME Section III, for Class 3 components and will meet Seismic Category I requirements. The engine mounted piping, as a minimum, will be designed to ANSI B31.1 and meet Seismic Category I requirements. The radiators and surge tank will be designed in accordance with ASME Section VIII and will meet Seismic Category I requirements.

The design of the diesel engine cooling water system will meet the performance requirements of SRP 9.5.5 as follows:

1. System components and piping will have sufficient physical separation or shielding to protect the system from externally generated missiles. In addition, since each EDG and its associated cooling water system is independent and physically separated from the other via concrete wall, an internally generated missile (i.e., EDG missile), will not result in failure of the other EDG or its associated cooling water system.

2. The system will be protected from the effects of pipe cracks and breaks in piping since there are no high- or moderate-energy lines in the new EDG building.

3. The system will be housed in structures designed to seismic Category I requirements.

4. Failures of non-seismic Category I structures and components will not affect the safety-related function of the diesel engine cooling water system.

5. Functional capability of the diesel engine cooling water system will not be adversely affected during periods of abnormally high water levels (i.e., the maximum probable flood).

6. The design of an independent cooling water system for each EDG ensures that the failure of a cooling system due to excessive leakage or malfunction will not affect the performance capability of the other EDG. In addition, the capability to detect system leakage will be provided.

7. The system material will be compatible with the corrosion inhibitors or antifreeze compounds used as a coolant.

8. The capacity of the cooling system will be sufficient to ensure proper diesel engine operation under all loading conditions.

9. Proper instrumentation will be provided to permit operational testing of the system.

10. The system design will include provisions to bypass protective interlocks of the cooling system during emergency operation.

c. Diesel Engine Starting System

The diesel engine starting system will be designed in accordance with Regulatory Guide 1.9. The system including air receivers and system piping external to the engine skid will be designed to ASME Section III for Class 3 components. System piping will meet Seismic Category I requirements.

The engine mounted piping, as a minimum, will be designed to ANSI B31.1 and meet Seismic Category I requirements.

All 2 inch and smaller valves will be ANSI Class 600 minimum. Two and one-half inch and larger valves will be ANSI Class 150 minimum. The design of the diesel engine starting system will meet the performance requirements of SRP 9.5.6 as follows:

1. Each diesel engine will be provided with a dedicated air starting system consisting of two air compressors (one diesel driven and one motor driven), an air dryer, four air receiver(s), four air start motors, piping, injection lines and valves, and devices to crank the engine as recommended by the engine manufacturer.

2. As a minimum, the air starting system will be capable of cranking a cold diesel engine five times without recharging the receiver(s).

3. Alarms will be provided which alert operating personnel if the air receiver pressure falls below the minimum allowable value.

4. Provisions will be made for the periodic blowdown of accumulated moisture and foreign material in the air receiver(s).

5. Starting air will be dried to a dew point of not more than 50°F when installed in a normally controlled 70°F environment, otherwise the starting air dew point will be controlled to at least 10°F less than the lowest expected ambient temperature.

6. System components and piping will have sufficient physical

separation or barriers to protect the system from externally generated missiles. In addition, since each EDG and its associated starting air system is independent and physically separated from the other via concrete wall, an internally generated missile (i.e., EDG missile), will not result in failure of the other EDG or its associated starting air system.

7. The system will be protected from the effects of pipe cracks and breaks in piping since there are no high- or moderate-energy lines in the new EDG Building.

8. The system will be housed in structures designed to seismic Category I requirements.

9. Failure of nonseismic Category I structures or components will not affect the safety-related functions of the system.

10. Functional capability of the starting air system will not be adversely affected during abnormally high site water levels (i.e., maximum probable flood).

d. Diesel Engine Lubrication System

The diesel engine lubrication system will be designed in accordance with RG 1.9.

All engine lube oil piping will be designed to ANSI B31.1 and will meet Seismic Category I requirements.

The design of the diesel engine lubrication system will meet the performance requirements of SRP 9.5.7 as follows:

1. System components and piping will have sufficient physical separation or barriers to protect the system from externally generated missiles. In addition, since each EDG and its associated lube oil system is independent and physically separated from the other via concrete wall, an internally generated missile (i.e., EDG missile), will not result in failure of the other EDG or its associated lube oil system.

2. The system will be protected from the effects of pipe cracks or breaks in piping since there are no high- or moderate-energy lines in the new EDG building.

3. The system will be housed in structures designed to seismic Category I requirements.

4. Failure of nonseismic Category I structures or components will not affect the safety-related functions of the system.

5. Functional capability of the lube oil system will not be adversely affected during abnormally high site water levels (i.e., maximum probable flood).

6. The design of an independent lube oil system for each EDG ensures that the failure of a lube oil system due to excessive leakage or

malfunction will not affect the performance capability of the other EDG. In addition, the capability to detect system leakage will be provided.

7. Measures to assure the quality of the lubricating oil will be provided.

8. Instrumentation and control features will be provided to permit operational testing of the system and to bypass protective interlocks of the lube oil system during emergency operations.

9. Measures will be provided for cooling the system and removing system heat load.

10. Protective measures (such as relief ports) will be utilized to prevent unacceptable crankcase explosions and to mitigate the consequences of such an event. (See response to RAI 47.)

11. The temperature of the lubricating oil will be automatically maintained above a minimum value by means of an independent recirculation loop including its own pump and heater, to enhance the "first-try" starting reliability of the engine in the standby condition.

12. The diesel engine will be provided with a dedicated lube oil system design which includes measures to provide lubrication to the diesel engine wearing parts during standby conditions and/or normal and emergency starts.

e. Diesel Engine Combustion Air Intake and Exhaust Systems

The diesel engine combustion air intake and exhaust systems will be designed in accordance with RG 1.9.

The exhaust piping is designed in accordance with the requirements of B31.1-1986 and is seismically supported. The silencer is supplied by the EDG vendor and is safety-related.

These systems will also be designed to meet the performance requirements of SRP 9.5.8 as follows:

1. Each new diesel engine will be provided with an independent and reliable combustion air intake and exhaust system. The systems will be sized and physically arranged such that no degradation of engine function will be experienced when the diesel generator set is required to operate continuously at the maximum power output.

2. The combustion air intake system will be provided with a means of reducing airborne particulate material over the entire time period that emergency power is required assuming the maximum airborne particulate concentration of the combustion air intake.

3. Design precautions will be taken to preclude degradation of the diesel engine power output due to exhaust gases and other dilutents that could reduce the oxygen content below acceptable levels.

f. Diesel Generator Building Ventilation System

The ventilation associated with the EDG control panel rooms and 4kV switchgear rooms will be designed safety related and meet Seismic Category I requirements.

The design of these systems will meet the performance requirements of SRP 9.4.5 as follows:

1. A single active failure will not result in loss of the system functional performance capabilities. Specifically, since each EDG control panel room is equipped with a dedicated ventilation system, a single active failure resulting in loss of one ventilation system will not affect the performance capability of the other ventilation system. For each 4kV switchgear room, a dedicated ventilation system consisting of redundant fans (i.e., one fan connected to an "A" train power source and the other connected to a "B" train power source), is provided. Therefore, a single active failure will not result in the loss of both fans to either switchgear room.

2. Failure of nonseismic Category I equipment or components will not result in damage to essential portions of the ventilation system.

3. The ventilation system will be designed to maintain a suitable ambient temperature range in the areas serviced.

4. The ability of the safety features equipment in the areas being serviced by the ventilation system to function under the worst anticipated degraded ventilation system performance will be assured.

5. The capability of the system to automatically actuate components not operating during normal conditions, or to actuate standby components (redundant equipment) in the event of a failure or malfunction, as needed will be provided.

6. The capability of the system to control airborne particulate material (dust) accumulation will be provided.

7. Functional capability of the ventilation system will not be adversely affected during periods of abnormally high water levels (i.e., maximum probable flood).

8. Ventilation system components will have sufficient physical separation or shielding to protect the system from internally or externally generated missiles.

9. The system components will be protected from the effects of pipe cracks and breaks in piping since there are no high- or moderate-energy lines in the new EDG building.

3) Electrical/Control System Design

Under the EPS Enhancement Project, two new emergency diesel generators and associated electrical equipment will be installed and integrated into the existing Turkey Point EPS. The electrical modifications required to

implement the EPS enhancements will take place throughout existing plant areas and inside the new EDG building, with the majority of work occurring inside the new EDG building.

It is FPL's intent under the EPS Enhancement Project to comply with the latest standards for electrical design inside the new EDG building. Outside the new EDG building, electrical design will as a minimum, meet the criteria specified in the FSAR, or the latest standards wherever practical. This approach to the application of electrical design standards is considered acceptable and appropriate for the following reasons:

- o Due to the physical configuration and vintage of Turkey Point's existing EPS, compliance with the latest standards outside the new EDG building would not be possible without the redesign and rework of numerous existing EPS structures/components including manholes, ductbanks, raceway and electrical enclosures throughout the plant. The effort to redesign and rework existing EPS structures/components to achieve compliance with latest standards would be prohibitive and is considered beyond the intent of the EPS Enhancement Project.

- o From a human factors standpoint, we believe it is important to maintain a consistent design approach inside the existing plant. The application of latest standards for electrical design outside the new EDG building would introduce physical configuration differences with the surrounding systems and components. The application of FSAR criteria will ensure that a consistent design approach is maintained throughout the existing plant.

- o By referring to Figure 1-2, it can be seen that most of the existing EPS is unchanged by the EPS enhancement modifications. Therefore, considering the capability of the EPS as a whole, it is our position that an appreciable increase in safety would not be achieved through the application of latest standards outside the new EDG building.

Specific standards which will be applied to electrical design inside the new EDG building are identified below. The use of these standards in conjunction with the FSAR criteria for the work outside the new EDG building will ensure that the capability of the enhanced EPS to comply with the Turkey Point General Design Criteria as specified in the FSAR, remains valid.

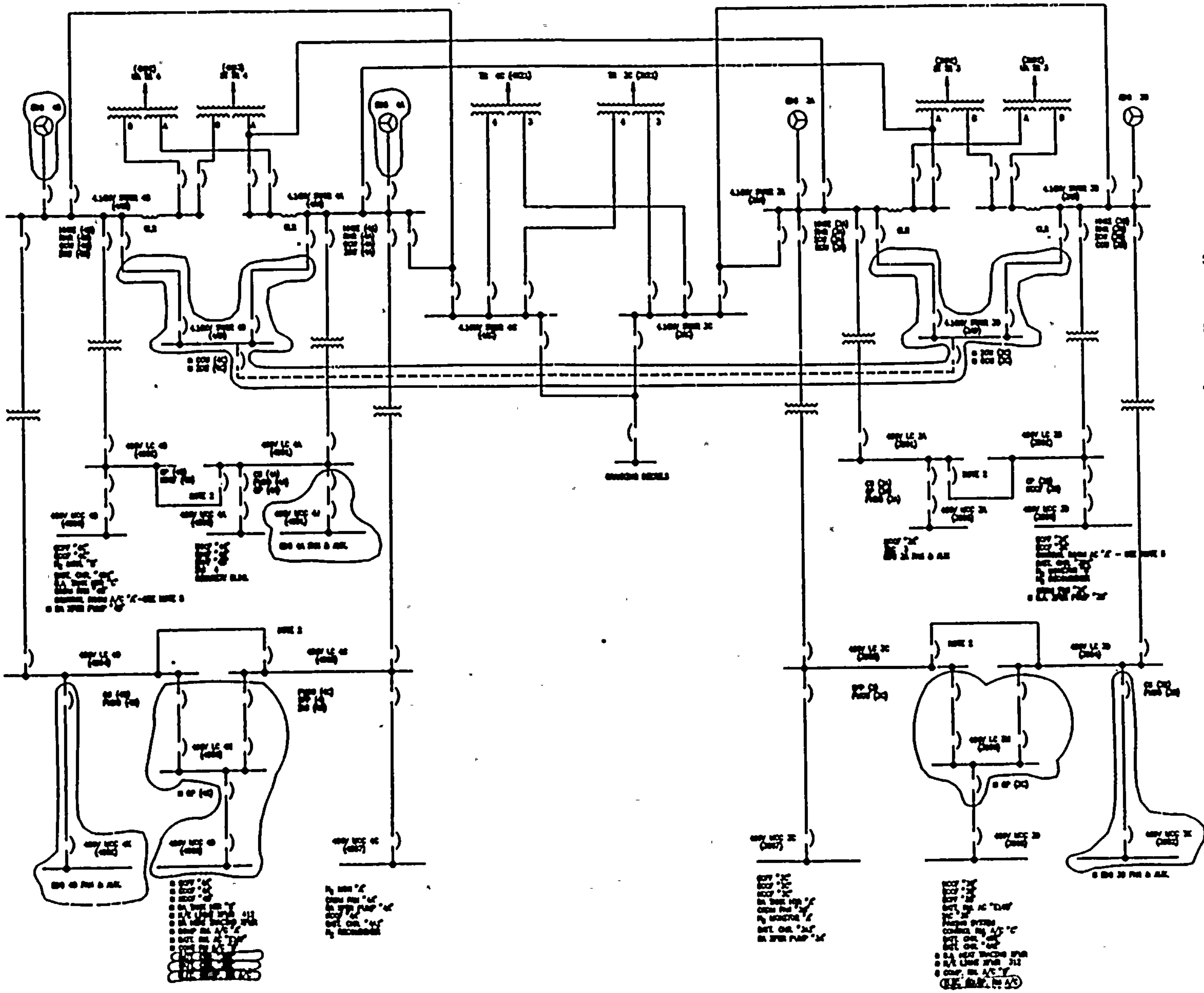
a. Protection Against Natural Phenomena

The new EDG's and safety related power distribution system components will be located in Seismic Category I structures which provide protection from the effects of earthquakes, tornadoes, hurricanes and floods. Also, see response to RAI 4 and RAI 5.

b. Environment and Missiles

See response to RAI 4 and RAI 5.

c. Sharing of Power System



SYMBOLS:

* RELOCATED EQUIPMENT (POWER SUPPLY) NOTE 1

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NOTES:

1. ONLY SELECTED SAFETY RELATED LOADS ARE SHOWN
2. BREAKER NORMALLY RACKED OUT
3. THE FOLLOWING NEW EQUIPMENT IS BEING ADDED UNDER EPS ENHANCEMENT PROJECT:
   - EDGs 4A & 4B
   - 4.16KV SWGR 3D & 4D
   - 480V LOAD CENTERS 3H & 4H
   - MCCs 3K, 4D, 4J & 4K
   - BATTERY CHARGERS 3A2 & 3B2
4. THE FOLLOWING EXISTING EQUIPMENT IS RELABELED UNDER EPS ENHANCEMENT PROJECT:

EXISTING	RELABELED
EDG A	EDG 3A
EDG B	EDG 3B
MCC D	MCC 3D
BATTERY CHARGER 3A	BATTERY CHARGER 3A1
BATTERY CHARGER 3B	BATTERY CHARGER 3B1
BATTERY CHARGER 3S	BATTERY CHARGER 4B2
BATTERY CHARGER 4A	BATTERY CHARGER 4A1
BATTERY CHARGER 4B	BATTERY CHARGER 4B1
BATTERY CHARGER 4S	BATTERY CHARGER 4A2

EXISTING BATTERY CHARGERS WILL BE REPLACED AND RELABELED AS SHOWN ABOVE.

5. CONTROL ROOM AC "A", FED FROM MCC 3B, CAN BE POWERED FROM MCC 4B VIA TRANSFER SWITCH.

INDICATES EQUIPMENT ADDED BY EPS ENHANCEMENT PROJECT

FLORIDA POWER & LIGHT COMPANY

TURKEY POINT PLANT UNITS 3 & 4

EMERGENCY POWER SYSTEM ENHANCEMENT

AC ONE-LINE DIAGRAM

FIGURE 1-2

MAY 18 1990

See response to RAI 5.

d. Independence Between Redundant Load Groups

For electrical design in the new EDG building, the enhanced EPS will comply with the requirements of Regulatory Guide 1.6 for independence between redundant load groups (i.e., AC trains).

e. Design of Diesel Generator Units

The selection, design and qualification of the new EDG's and associated auxiliary systems will comply with the requirements of Regulatory Guide 1.9 with the following exceptions.

1. FPL has requested exemption from the 300 Start and Load Acceptance Test provisions of IEEE Standard 387-1984 (Reference FPL letter L-88-454 dated October 19, 1988). In lieu of a 300 Start and Load Acceptance Test, FPL has proposed that a 30 Start and Load Acceptance Test be performed. The NRC has reviewed this proposal and has found it to be acceptable (Reference NRC letter to FPL dated August 10, 1989 with Safety Evaluation enclosed).

2. Physical independence of the new EDG's, equipment and circuits within the new EDG building is discussed in Item g below.

[illegible]

f. Bypassed and Inoperable Status Indication

The EPS Enhancement Project will provide for the installation of two (2) additional emergency diesels generators, two additional battery chargers and reconfigurration or addition of 4160V switchgears, 480V load centers, and 480V MCC's, but does not encompass all other safety systems such as containment isolation, safety injection and other systems which are required for the mitigation of the DBA or safe shutdown. Presently, Turkey Point Units 3 and 4 does not employ a Bypassed and Inoperable Status Indication System. Therefore, a Bypassed and Inoperable Status Indication System is not provided with the EPS Enhancement Project modifications. Status indication for the new EDG's and associated auxiliaries is discussed in our responses to RAI's 15, 16, 20, 36, 43, 48 and 49.

g. Physical Independence

Physical independence of the new EDG's, equipment and circuits within the new EDG building will comply with the requirements of RG 1.75 and IEEE 384-1981 except as follows:

1) Non-Class 1E circuits which are associated with Class 1E circuits via electrical connection to a Class 1E power supply without the use of an isolation device, and/or proximity to Class 1E circuits and equipment without the required physical separation or barriers, will comply with the requirements of associated circuits except as follows:

   a. Identification - Associated circuits will not be uniquely identified as such. The terminology "associated" is not presently in use at Turkey Point. From a human factors standpoint, we believe it is important to maintain a consistent design approach throughout the plant. The introduction of this new terminology would create inconsistency in the plant, especially where cables originating in the new EDG building interface with the existing plant.

   b. Qualification Requirements

   Connected non-Class 1E circuits (except those noted in b.2 below), comply with the requirements placed on Class 1E circuits such as derating, environmental qualification (mild environment), flame retardance, splicing restrictions and raceway fill, except that connected non-Class 1E loads are seismically supported, not seismically qualified.

   Miscellaneous 120 VAC circuits (i.e., lighting and receptacles) which are routed in independent conduit systems and located within Class 1E enclosures will meet the flame retardance requirements of UL 83 in lieu of IEEE-383.

2) Consistent with current plant criteria, dry contacts of relays and control switches are considered isolation devices for instrumentation and control circuits. In the enclosure where these relays and switches are located, the wiring associated with the contacts are routed in the same wireways as the wiring associated with the redundant or non-Class 1E circuits. Once the cables exit the enclosure, control circuits to redundant equipment are routed in separate raceways per current plant criteria, ensuring that any physical damage affecting one circuit will not affect the redundant circuit.

3) Identification of Class 1E Cable - IEEE 384 requires that cables installed in exposed Class 1E raceways be marked at intervals of approximately five feet to facilitate initial verification that the installation is in conformance with the separation criteria. In accordance with current Turkey Point criteria, this marking will not be provided.

4) For Class 1E control panels, boards and racks, IEEE Standard 420-1982 requires that non-Class 1E equipment and circuits located within the same control panel be separated consistent with the criteria of IEEE 384. For the EPS Enhancement Project, the separation criteria of IEEE 384 as noted above will apply.

h. Application of Single Failure Criteria

Single failure criteria as specified in Regulatory Guide 1.53 will be applied to the modifications implemented under the EPS Enhancement Project.

RAI 2

Identify and provide justification or the reasons for deviations that are known at this time from these Standards. As work progresses, periodically update any further deviations from the Standards and the reasons for such deviations. Also, identify any additional Standards that become applicable as work progresses.

Response to RAI 2

FPL's approach to the application of codes and standards for the EPS Enhancement Project along with justification for identified exceptions is provided in response to RAI 1.

The control of applicable standards will be performed in accordance with FPL's Plant Change/Modification (PC/M) process. Under this process, the specific standards being applied to the detailed design will be specified in each PC/M. Any changes in design criteria from that specified in RAI 1 will be documented and justified. As PC/M's are developed, finalized and issued, they can be made available for NRC review, as necessary.

RAI 3

Make a positive statement that all electrical systems and equipment associated with the System Enhancement and important to safety are classified as 1E.

Response to RAI 3

All safety related electrical systems and equipment associated with the EPS Enhancement are classified as 1E.

RAI 4

Make a positive statement that the Class 1E electrical equipment and systems associated with the System Enhancement are qualified consistent with Regulatory Guide 1.89. If there are exceptions, specifically note the exceptions and provide the reasons.

Response to RAI 4

Class 1E electrical equipment and systems associated with the EPS Enhancement Project are qualified consistent with Regulatory Guide 1.89.

RAI 5

Make a positive statement that SSC important to safety meet the requirements of GDC 2, 4 and 5.

Response to RAI 5

GDC 2

The new EDG and Diesel Oil Storage Building, containing the majority of the new EPS equipment, is designed and constructed as a seismic Category I structure and is designed to withstand design basis natural phenomena including earthquake (Maximum Hypothetical Earthquake of 0.15g), wind, tornado (including tornado-generated missiles) and flooding. The latest criteria, including the applicable Regulatory Guides which address natural phenomena (e.g., RG 1.76), were used in the design of this structure. The new equipment housed in this structure thus meets the current GDC 2. Any of the new equipment which is located outside of the new structure is also housed in seismic Class I structures and protected against the effects of natural phenomena. As a minimum, equipment located outside the new structure meets the criteria specified in the FSAR for compliance with GDC 2.

GDC 4

The new equipment being installed for the EPS Enhancement Project is appropriately specified and designed to accommodate the effects of and be compatible with the environmental conditions associated with normal operation, maintenance and testing. The equipment in the new building is in a mild environment, and is not subject to a design basis accident harsh environment as currently defined in 10 CFR 50.49. Any new equipment being located in the Auxiliary Building is designed as a minimum to meet the environmental conditions specified for the existing equipment located in the same locations.

The new equipment installed in the new building is not subject to high energy pipe break effects (i.e. dynamic effects, missiles, pipe whip or jet impingement) or to moderate energy pipe cracks. Any new equipment located in the Auxiliary Building is evaluated against the existing pipe break criteria presented in the Turkey Point FSAR. In addition, the location of new equipment will consider the pipe break criteria presented in NUREG-0800, Appendix B to Branch Technical Position ASB 3-1.

GDC 5

The enhanced EPS configuration is not intended to modify the existing design of shared equipment, but is designed to provide additional installed EDG capacity. Under the Enhancement Project, shared systems currently available to Turkey Point Units 3 & 4 are retained. Consistent with GDC 5, such sharing does not significantly impair their ability to perform their safety functions including (in the event of an accident in one unit) an orderly shutdown and cooldown of the other unit.

RAI 6

It is understood that 125 VDC Bus 3A is to be connected to 125 VDC Bus 4B (and Bus 3B to 4A) for battery testing. What limits are placed on the conditions under which or the length of time that the buses are to be connected?

Response to RAI 6

Cross-tieing a 125 VDC bus for testing a station battery will no longer be necessary after the addition of the spare station battery. The spare station battery, which is being installed during the upcoming dual unit outage, will be used as a substitute for any station battery scheduled for testing or maintenance. For future battery tests and maintenance, the spare battery will be connected to the appropriate 125 VDC bus before the battery to be tested is disconnected, such that the bus is always aligned to a safety-related battery and it will not be necessary to cross-connect a DC train. Since the spare battery is safety-related and is functionally equivalent to any of the existing station batteries, under all design basis conditions, no limits or compensatory measures are imposed.

RAI 7

Describe the operation of the 4160 volt ties between buses 4B and 4C, 4A and 4C, 3B and 3C, 3A and 3C, 3A and 4A (Auxiliary Transformer connection), and 4A and 3A (Auxiliary Transformer connection). What interlocks, keylocks or administrative procedures ensure electrical separation between unit divisions (A and B), between units (3 and 4), and between safety and non-safety buses.

Response to RAI 7

The operation of the 4160 volt ties between the identified buses is defined by existing plant procedures and will not be impacted by the EPS Enhancement Project. Please note that the ties between 3A and 4A, and 4A and 3A are at the startup transformers and not the auxiliary transformers.

RAI 8

After the system enhancement, what major systems/equipment important to safety will be shared by the two units? What are the alternative power supply sources (buses) for these systems/equipment?

Response to RAI 8

Major equipment shared by both units includes:

COMPONENT/NO. AVAILABLE

- High Head SI Pumps/4
- Auxiliary Feedwater Pumps/3 (See Note)
- Battery Chargers (in existing)/6
  (in enhanced)/8
- 125 V DC Batteries/4 plus 1 spare battery
- Control Room AC Units/3
- Boric Acid Heat Trace/2
- Boric Acid Tank Heaters/3
- Boric Acid Pumps/4
- Miscellaneous HVAC

Note: AFW System not affected by scope of Enhancement Project.

In the enhanced design, each High Head Safety Injection Pump is still powered from its own 4.16 kV bus, which now has a single EDG associated with it. Thus the single failure of an EDG does not result in the loss of more than one HHSI pump.

Two new battery chargers are provided in the enhanced design, each dedicated to a single 125V battery, and the existing swing battery chargers are each rededicated to a single 125V battery. Thus, each battery has two battery chargers associated with it in the enhanced design. A spare battery is also being added. This spare battery can be used as a substitute for any one of the existing station batteries. Note that below the 125V DC bus level, the existing DC distribution systems are not affected by the Enhancement Project.

As shown in Figure 1-2 (see response to RAI 1) the remaining shared safety related equipment is no longer powered from either unit, but rather, swing load centers have been provided on each unit, and their loads apportioned appropriately, such that a single failure on a unit does not result in loss of the minimum required equipment. Even though the equipment is powered from either bus of a given unit, the equipment function can be shared between units.

RAI 9

For the "Loss of Normal Power Supply Followed by Actuation of SIS" scenario, it is stated that those loads that have already been connected to the 4.16kV bus by the sequencer action, in response to the LOOP, will remain connected if they are required in response to an SIS. Are those loads not required by the SIS stripped from the buses? If so, how is this accomplished? If not, what prevents

a possible overload on the diesel generators?

Response to RAI 9

All loads are stripped by either bus undervoltage, relays 127X1 (Z1), or bus undervoltage in conjunction with the Startup transformer breaker open, relays 127X2 (Z2), or by loss of voltage at connected buses.

Upon restoration of the emergency bus voltage by the EDG, the 127X1 relays cited above are reset. 127X2 relays remain actuated until the offsite power source is returned to the bus via the startup transformer. Loads required to run in response to the LOOP are sequenced to their buses by the emergency bus loading sequencers. Certain plant investment loads, having been tripped previously by a 127X1 relay, are capable of being manually loaded by the operator within the generator loading capacity. Equipment which cannot be energized are those loads or supplies blocked or inhibited from starting by 127X2 relay signals (LOOP).

Actuation of SIS during LOOP resets the emergency bus loading sequencers and will shed all loads from the EDG. This is accomplished by reactuation of the 127X1 relays and restarting the sequencer in the LOCA/LOOP mode, sequentially loading equipment onto the EDG for mitigation of the DBA. Not tripping the EDG breaker for the subject scenario reduces the challenges to the breaker to successfully reclose.

RAI 10

For the "Actuation of SIS with Normal Power Supply Available" scenario, are the non-safety related loads stripped from the safety related buses?

Response to RAI 10

The non-safety related loads are not stripped from the safety related buses for the "Actuation of SIS with Normal Power Supply Available" scenario. Voltage on the 4.16 kV busses will be maintained by transferring to the associated startup transformers.

RAI 11

We understand that the enhancement project will involve the following locations:

1) New diesel generator building
2) Existing diesel generator building
3) Unit 4 auxiliary building, hot machine shop
4) Unit 4 auxiliary building, mezzanine floor
5) Control room

Identify any other general areas that will be impacted by the enhancement project due to equipment installation, relocation or other changes, including cable routing. Identify those safety related circuits (power, control, indication, alarm, etc.) that will pass between or through these general areas. Identify these circuits as to function, end points and intermediate points. Identify those circuits and areas for which divisional separation or isolation consistent with applicable standards is required, and indicate how such separation or isolation will be accomplished:

Response to RAI 11

The EPS Enhancement will impact virtually all power block areas with the exception of the Units 3 & 4 Reactor Buildings.

Interconnecting raceway containing safety related power, control, indication and alarm circuits will be routed between areas, through the existing plant. Identification of these circuits with reference to function, end points and intermediate points is provided in the detailed Plant Change/Modification Packages which are available for NRC review. Divisional separation/isolation will be provided in accordance with the Turkey Point Units 3 & 4 Updated Final Safety Analysis Report, Amendment 6, i.e., circuits to duplicate equipment are routed in separately located raceway, ensuring that any physical damage affecting one circuit will not affect its duplicate.

Additional information concerning separation and isolation criteria for electrical design in the new EDG building is provided in our responses to RAI 1 and 2.

RAI 12

Consistent with Regulatory Guide 1.6, staff believes that an interlock should be provided on the breakers between 480 volt load center buses 4A and 4B, 4C and 4D, 3A and 3B, and 3C and 3D to prevent an operator error that would parallel these power sources. Provide these interlocks or justify non-conformance.

Response to RAI 12

Normally, these breakers are racked out. When required, they are controlled by existing plant procedures. This aspect of the electrical power distribution system is not changed within the scope of the EPS Enhancement Project.

RAI 13

Include an analysis to illustrate that the 125 VDC batteries are adequate for the worst single failure and accident loading condition.

Response to RAI 13

Other than the addition of two battery chargers, the spare battery and its associated isolation switches and extending the four DC Buses to provide additional distribution circuit breakers, no modifications are being made to the existing 125 VDC distribution system. These modifications have been evaluated and determined not to introduce any unacceptable failure modes. The battery sizing calculations have been revised to include the additional dc loads associated with the EPS enhancement. The results of these calculations demonstrate that the existing batteries are adequately sized to meet the worst accident loading condition. Calculations have also been performed which demonstrate the adequacy of the spare battery as a replacement for any of the existing batteries.

RAI 14

Describe the changes to be made in the Control Room (control, indication, alarms, etc.) for the enhancement project. Discuss how these changes will be scheduled and controlled to limit possible installation induced operational transients.

Response to RAI 14

The existing configuration of EDG controls in the Turkey Point Units 3 and 4 Control Room provides for both EDG A and EDG B control/indication from each of Control Consoles 3C02 and 4C02. On the vertical panels (3C04 and 4C04), EDG controls are not combined; EDG A instrumentation and controls are installed on 3C04 and EDG B instrumentation and controls are installed on 4C04.

As part of the EPS Enhancement Project, the EDG A and EDG B instrumentation and controls on Control Console 3C02 will be modified, relabeled and rewired, as required, for EDG 3A (existing EDG A) and EDG 3B (existing EDG B) while the instrumentation and controls on Console 4C02 will be modified, relabeled and rewired for EDG 4A (new) and EDG 4B (new). The existing start pushbuttons on vertical panels 3C06 and 4C06 will be relabeled and rewired for EDGs 3A/3B on panel 3C06 and EDGs 4A/4B on panel 4C06. All new safety related instrumentation and controls installed in the Control Room are qualified Class 1E; all Control Room modifications comply with NUREG 0700, "Guidelines for Control Room Design Review."

Annunciator alarms in the control room are modified and rewired to include changes required for the existing diesel generators upgrade, as well as the new diesel generators.

The 4160 volt tie breaker control switches, a station blackout key operated breaker control switch, a lockout relay reset pushbutton, indicating lights and name plates are installed in vertical panels 3C04 and 4C04 for 4160 volt swing switchgears 3D and 4D respectively. Annunciator alarms in the control room are modified and rewired to include inputs from 4160 volt 3D/4D bus tie breakers overcurrent, isolation switches and 3D/4D lockout relays.

For 480 volt load centers 3H and 4H, new three position control switches will be installed in vertical panels 3C04 and 4C04, respectively, to allow manual or auto transfer of power from load centers 3C-3D/4C-4D to 3H/4H. Adjacent to the switch, green and red indicating lights will be installed for each of the feeder and supply breakers that tie load center 3H/4H to load centers 3C-3D/4C-4D. Alarms in the control room will be modified and rewired to include 480 volt swing load center undervoltage/trouble.

The control room modifications will be performed during a dual unit outage, thereby avoiding operational transients which might otherwise occur.

RAI 15

Review and evaluate the alarm and control circuitry for the diesel generators for any condition that renders a diesel generator unable to respond to an automatic emergency start signal. These conditions include not only the trips

that lock out the diesel generator start and require manual reset, but the control switch or mode switch positions that block automatic start, loss of control voltage, insufficient starting air pressure or battery voltage, etc. This review should consider all aspects of possible diesel generator operational conditions, for example test conditions and operation from local control stations. One area of particular concern is the unreset condition following a manual stop at the local station which terminates a diesel generator test and prior to resetting the diesel generator controls for enabling subsequent automatic operation.

Provide the details of your review including the following information:

a) all conditions that render the diesel generator incapable of responding to an automatic emergency start signal for each operating mode as discussed above:

b) the wording on the annunciator window in the control room that is alarmed for each of the conditions identified in (a);

c) any other alarm signals not included in (a) above that also cause the same annunciator to alarm;

d) any condition that renders the diesel generator incapable of responding to an automatic emergency start signal which is not alarmed in the control room; and

e) any proposed modifications resulting from this evaluation.

<u>Response to RAI 15</u>

a) (Part 1)

The following are the conditions under which the new diesel generators will not respond to an emergency start signal:

1) Master control switch in 'off' or 'local' position
2) Key operated local switch (rapid start - neutral - auto bypass) in auto bypass position
3) Loss of starting air (e.g., isolation of air receivers)
4) Lockout relay 186G not reset
5) Barring device engaged. This device is used during engine maintenance. This has to be manually reset for engine start.
6) Control power not available on start control bus
7) Control power not available on emergency auto start bus
8) Control power not available on at least one air start motor circuit
9) Mechanical engine overspeed device not reset. This device is tripped on actual engine overspeed and must be reset locally at the engine.
10) Any shutdown or lockouts not reset

[illegible]

(Part 2)

The following are the conditions under which the New Diesel Generators will start in response to an emergency auto start signal, but may not function properly:

1) Governor selector switch not in electrical position
2) The voltage regulator switch not in auto position
3) The engine immersion heater control is not in auto position
4) The engine turbocharger oil pump control switch not in auto position
5) The speed switch power not available or fuses blown
6) The voltage regulator control power not available
7) The electric governor control power not available
8) Generator field flashing power not available

b) The wording of the annunciator windows in the control room that are alarmed for the conditions in (a) Parts 1 and 2 are given in (1) and (2) below:

1) "DIESEL GEN 4A MASTER CONTROL SWITCH IN OFF OR LOCAL POSITION" for EDG 4A and "DIESEL GEN 4B MASTER CONTROL SWITCH IN OFF OR LOCAL POSITION" for EDG 4B. Input to this window is directly from master control switch contacts.

2) For all conditions in (a) Part 1 and conditions 5 thru 8 of (a) Part 2 there is a common window in the control room.

"DIESEL GEN 4A TROUBLE" for EDG 4A and "DIESEL GEN 4B TROUBLE" for EDG 4B. Input to this window is from all the groups 1 through 5 of the local annunciator panel. The listing of local alarms is given in Tables 15-1 and 15-2

3) Conditions 1 through 4 of (a) Part 2 are not annunciated in the local panel or control room, but indicating lights are provided in the diesel generator, local panel and control room. These lights are on when the conditions listed in (a) Part 2 and conditions (1), (2), (4), (6) through (8) and (10) of (a) Part 1 do not exist. These lights indicate that the Diesel Generator is available for auto start. Administrative procedures will ensure that these lights are on and the Diesel Generators are available for auto start.

c) The signals to the EDG trouble alarm are from all the groups 1 through 5 listed in Tables 15-1 & 15-2. These tables also list the additional signals not included in (a) Part 1 and conditions 5 through 8 of (a) Part 2.

d) Item b (3) above shows conditions that are not annunciated in the control room. In addition, the EDG breaker control power failure alarm is not annunciated locally or in the control room. However, EDG breaker position indicating lights are provided, and during loss of control power these indicating lights will be extinguished. There may be some changes to the conditions listed in Part 1 and 2, as the detailed design progresses.

e) Minor modifications may be required as the detailed design progresses.

Note: 1

Conditions (6) through (8) of (a) Part 1 and conditions (5) through (8) of (a) Part 2 are input to one common window at the local panel as 'control power not available' and is shown in group 1 of Table 15-1.

Note: 2

The wording on the local alarms as well as the control room alarms may change as detailed design progresses.

TABLE 15-1

INPUTS INTO ANNUNCIATOR FOR EDG TROUBLE ALARM

GROUP 1-EDG NOT READY FOR EMERGENCY START	GROUP 2-EDG EMERGENCY TRIP (SIS/LOOP)
STARTING AIR LINE-1 LOW PRESSURE	ENGINE OVERSPEED TRIP
STARTING AIR LINE-2 LOW PRESSURE	GENERATOR DIFFERENTIAL PHASE A TRIP
186G LOCKOUT RELAY NOT RESET	GENERATOR DIFFERENTIAL PHASE B TRIP
EDG CONTROL POWER FAILURE	GENERATOR DIFFERENTIAL PHASE C TRIP
EDG CONTROL SWITCH IN OFF	
AUTO START BYPASS	
FUEL PRIMING PUMP NO POWER / OVERLOAD	
BARRING DEVICE ENGAGED	
DAY TANK LEVEL CRITICALLY LOW	
EXCITER FIELD FLASHING POWER NOT AVAILABLE	
GENERATOR BREAKER PULLED OUT	

TABLE 15-2

INPUT INTO ANNUNCIATOR FOR EDG TROUBLE ALARM

GROUP 3 - EDG TRIP (NO SIS/LOOP)

- LUBE OIL HIGH TEMPERATURE TRIP
- GENERATOR REVERSE POWER
- EXHAUST HIGH TEMP TRIP
- COOLING WATER HIGH TEMP TRIP
- GEN OVERCURRENT PHASE A
- MAIN MANIFOLD LUBE OIL LOW PRESSURE TRIP
- GENERATOR LOSS OF EXCITATION
- GEN UNDERFREQUENCY
- COOLING WATER LOW PRESSURE TRIP
- GEN OVERCURRENT PHASE B
- ENGINE HIGH VIBRATION TRIP
- PISTON COOLING OIL LOW PRESSURE TRIP
- CRANKCASE HIGH PRESSURE TRIP
- GEN OVERCURRENT PHASE C

GROUP 4 - EDG DEGRADED

- LUBE OIL PRESSURE LOW
- LUBE OIL METAL PARTICLE DETECTED
- EXHAUST HIGH TEMP PRE-TRIP
- COOLING WATER LEVEL LOW
- ENGINE HIGH VIBRATION PRE-TRIP
- LUBE OIL LEVEL LOW
- SOAKBACK PUMPS NO POWER/OFF
- EXHAUST HIGH PRESSURE
- COOLING WATER HIGH TEMPERATURE PRE-TRIP
- FIELD FLASHING BACKUP TIMER TIMED OUT
- LUBE OIL HIGH TEMP PRE-TRIP
- COMBUSTION AIR HIGH TEMP
- EDG START FAILURE
- COOLING WATER LOW PRESSURE PRE-TRIP
- RADIATOR FAN #1 TRIPPED/OFF
- RADIATOR FAN #2 TRIPPED/OFF
- LUBE OIL STRAINER DIFF PRESSURE HIGH
- TURBOCHARGER HIGH DIFF TEMPERATURE PRE-TRIP
- FUEL OIL LOW PRESSURE
- FUEL OIL FILTER DIFF PRESSURE HIGH
- PT/TRANS FUSE FAILURE
- RADIATOR FAN #3 TRIPPED/OFF
- LUBE OIL COOLER DIFFERENTIAL PRESSURE HIGH
- STARTING AIR TANKS PRESSURE LOW
- FUEL OIL PRIMING PUMP TIMER TIMED OUT
- FUEL STRAINER DIFFERENTIAL PRESSURE HIGH
- GENERATOR STATOR TEMPERATURE HIGH
- EDG OVER/UNDER VOLTAGE
- 186G LOCKOUT RELAY COIL OPEN
- ISOLATION SWITCHES IN "ISOLATE" POSITION

GROUP 5 - EDG AUXILIARIES FAILURE

- COOLING WATER IMMERSION HEATER TRIPPED/OFF
- AIR COMPRESSOR TRIPPED/OFF
- DAY TANK LEVEL HIGH
- BACKUP DC OIL PUMPS RUNNING
- EDG CONTROL PANEL FAN FAILURE
- COOLING WATER TEMPERATURE LOW
- FUEL TRANSFER PUMP TRIPPED/OFF
- STORAGE TANK HIGH LEVEL
- BACKUP DC OIL PUMPS NO POWER/OVERLOAD
- EDG BUILDING VENTILATION FAILURE
- STARTING AIR TANKS HIGH PRESSURE
- STORAGE TANK LOW LEVEL
- WATER DETECTED IN AIR RECEIVER DRAIN
- EDG CONTROL PANEL FAN FAILURE

TABLE 15-2 (Cont'd)

INPUT INTO ANNUNCIATOR FOR EDG TROUBLE ALARM

GROUP 4 - EDG DEGRADED (CONTINUED)

COMBUSTION AIR
LOW PRESS

DAY TANK LEVEL
LOW

ENGINE SPEED
HIGH

RAI 16

Concerning the Class 1E Direct Current Power System, address the following:

As a result of recent reviews on the adequacy of safety-related direct current power systems of operating plants, the following recommendations applicable to those plants undergoing operating license and construction permit reviews have been proposed. In this regard, state if your design conforms to these recommendations and explicitly identify any exception.

a) The position of circuit breakers or fused disconnect switches associated with the battery charger, battery and direct current bus supply should be monitored to conform to the recommendations of Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems," (May 1973).

b) The technical specifications should include periodic testing of battery chargers to verify that the current limiting characteristics have not been compromised or lost.

c) The technical specifications should require that cell-to-cell and terminal connection resistance measurements be made as recommended in IEEE Standard 450-1972, "Recommended Practice for Maintenance, Testing and Replacement of Large Stationary Type Power Plant and Substation Lead Storage Batteries".

d) The direct current power system design should include the following monitors and alarms.

   1) An ammeter (directional and dual range) in the battery output to monitor the battery input current while the battery is on floating and equalizing charge and to monitor the battery output current when it is supplying power.

   2) An annunciator to alarm whenever the charger goes into a current limiting condition.

   3) A temperature indicator to measure the battery room ambient temperature.

Response to RAI 16

a) Turkey Point Plant Units 3 and 4 are not committed to comply with Regulatory Guide 1.47. The new battery chargers will be connected to existing or new circuit breakers, which do not have monitoring provisions. The existing battery breakers are provided with an auxiliary switch which will alarm in the control room when the breaker is open. A new spare battery is also being provided. Breaker positions will be monitored by the installation (subject to availability of appropriate hardware) of a control room alarm that annunciates if, both a vital battery breaker feeding the associated vital DC bus and the breaker in the spare battery feeder circuit to the same vital DC bus, is open.

b) Battery chargers are equipped with a completely automatic load limiting feature which prevents the output from exceeding 115 percent of rated output amperes regardless of the total dc load or the state of charge of the battery. In the event of failure of the load limiting feature, backup protection has been provided which will trip the unit off the line and provide annunciation of this condition.

However, neither the existing nor proposed Technical Specifications require periodic testing to verify that the current limiting characteristics have not been compromised or lost, and, in light of the backup protection provided, it is not intended to add this new technical specification.

c) The proposed Technical Specifications require that, at least once per 18 months, the cell-to-cell and terminal connection resistance be measured.

d) 1) The existing ammeter is a bi-directional, single range ammeter. This function is not being modified by the EPS Enhancement.

2) An alarm is provided whenever the charger goes into a current limiting condition.

3) This aspect of the existing battery rooms is not being modified via the EPS Enhancement Project. A spare battery is being added and will be housed in the new Battery Room located in the new Electrical Equipment Room. A temperature indicator has not been provided; however, a non-safety related, thermostatically controlled HVAC system is provided to maintain the Battery Room's temperature within acceptable limits. A safety-related HVAC system is provided to maintain the room's temperature during a design basis event.

RAI 17

State if the battery charger has sufficient capacity to meet the requirements of position c.1.b of Regulatory Guide 1.32. Also, state if the stability of the battery charger output is load dependent and if so, describe.

Response to RAI 17

The new battery chargers have been sized to meet the requirements of position c.1.b of Regulatory Guide 1.32, i.e., the supply is based on the largest combined demands of the various steady-state loads and the charging capacity to restore the battery from the design minimum charge state to the fully charged state within the FSAR design basis 24 hour time period, irrespective of the status of the plant during which these demands occur. The stability of the battery charger output is not load dependent, but is self-regulating, automatically holding output voltage within +/-0.5 percent over the working range from no load to full load.

RAI 18

Provide a description of the capability of the emergency power system battery chargers to properly function and remain stable upon the disconnection of the battery. Include in the description any foreseen modes of operation that would require battery disconnection such as when applying an equalizing charge.

Response to RAI 18

The new battery chargers are capable of operating and remaining stable with the battery disconnected. The new battery chargers have been designed to maintain an acceptable DC output (i.e., minimal "ripple") if the battery were disconnected from the bus. With the addition of the spare battery, a battery can be connected to the DC bus at all times. If a battery is taken out of service to perform corrective actions based on surveillance inspections or to perform a battery service or performance test, the spare battery will be connected to the bus before the normal battery is disconnected.

RAI 19

Provide the details of your design of the DC power system that assures equipment will be protected from damaging overvoltages from the battery chargers that may occur due to normal equalize charging, faulty regulation or operator error.

Response to RAI 19

To protect the dc system against overvoltages from the new battery chargers, an overvoltage relay is connected internally, across the output terminals of each charger. Actuation of this relay will trip the charger off the line and provide an alarm.

RAI 20

For the diesel engine fuel oil storage and transfer system, discuss the testing necessary to maintain and assure a highly reliable instrumentation, control, sensor, 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 what operator actions are required during alarm conditions to prevent harmful effects to the diesel engine. Discuss the system interlocks provided.

Response to RAI 20

Each engine has its own fuel system consisting of a storage tank, a day tank, duplex strainer, engine driven pump, DC motor driven priming pump, duplex filters, fuel injector filters, fuel injectors, and various check and relief valves. Pressure switches, level switches, pressure gauges, and level gauges are also included for alarm, control and indication. Instrumentation associated with the EDG fuel oil storage and transfer systems includes the components shown on Table 20-1.

The operator action required following alarm actuation will be specified in applicable off normal operating procedures. These actions will be consistent with the manufacturer's guidelines.

The only interlock in the diesel oil storage and transfer systems is between a given diesel oil day tank and its associated diesel oil transfer pump.

System components are inspected and tested by the manufacturer. After installation and before plant startup, the diesel oil storage and transfer systems are inspected, tested, and operated. Testing will be performed to verify system operability per Technical Specification requirements in accordance with manufacturer recommendations and applicable codes and standards.

TABLE 20-1

FUEL OIL SYSTEM COMPONENTS

'AG*	DESCRIPTION	LOCATION	SETPOINT/ RANGE**	INDIC.	CONTROL	ALARM	SHUTDOWN
'S61	FPS1-Fuel Pressure Low Alarm	Local	15 psig ↑ 10 psig ↓			X	
'S62	BFCS - Backup DC Fuel Pump Control	Local	15 psig ↑ 10 psig ↓		X		
'PS61	FSDP - Fuel Strainer Differential High	Local	5 psi ↑ 2 psi ↓			X	
'PS62	FFDP - Fuel Filter Differential High	Local	35 psi ↑ 30 psi ↓		X	X	
I61	Fuel Manifold Pressure	Local	0-100 psig	X			
I62	Fuel Manifold Pressure (4-20 MADC)	Local	0-100 psig	X			
[illegible]	Pump Manifold Pressure	Local	0-100 psig	X			
V61	1 Hour Fuel Day Tank Level Low Alarm	Local	17" (246 gal)			X	
V62	Fuel Day Tank Level Low Alarm	Local	20" (303 gal)			X	
V63	Fuel Transfer Pump On	Local	21½" (332 gal)		X		
V64	Fuel Transfer Pump Off	Local	39½" (626 gal)		X		
V65	Fuel Day Tank Level High Alarm	Local	41" (638 gal)			X	
I61	Fuel Day Tank Level (4-20 MADC)	Local	0-100%	X			
T4-587A	DOST 4A Level (Narrow Range)	Local	30,670-40,770 gal				
I4-587A	DOST 4A Level Indication (Narrow Range)	Local	30,670-40,770 gal	X			

TABLE 20-1 (Cont'd)

TAG*	DESCRIPTION	LOCATION	SETPOINT/ RANGE**	INDIC.	CONTROL	ALARM	SHUTDOWN
LT4-6586A	DOST 4A Level (Wide Range)	Local	750-41,000 gal				
LI4-6586A-1	DOST 4A Level Indication (Wide Range)	Fill Station	750-41,000 gal	X			
LI4-6586A	DOST 4A Level Indication (Wide Range)	Local	750-41,000 gal	X			
LSH4-6587A	DOST 4A High Level Alarm	Control Room	39,487 gal			X	
LSL4-6587A	DOST 4A Low Level Alarm	Control Room	35,972 gal			X	
PDIS4-6332A	Differential Pressure Across Pump Suction Strainer	Local	41.56" H_2O	X		X	
PI4-6722A	Diesel Oil Transfer Pump A Discharge Pressure	Local	0-50 psig	X			
PDIS4-6333	Fill Line Filter Differential Pressure	Local	41.56" H_2O			X	
TI4-6388A	DOST 4A Temp Indicator	Local	50°-100°F	X			
TI4-6388B	DOST 4B Temp Indicator	Local	50°-100°F	X			
LT4-6587B	DOST 4B Level (Narrow Range)	Local	30,670-40,770 gal				
LI4-6587B	DOST 4B Level Indication (Narrow Range)	Local	30,670-40,770 gal	X			
LT4-6586B	DOST 4B Level (Wide Range)	Local	750-41,000 gal				
LI4-6586B-1	DOST 4B Level Indication (Wide Range)	Fill Station	750-41,000 gal	X			

TABLE 20-1 (Cont'd)

TAG*	DESCRIPTION	LOCATION	SETPOINT/ RANGE**	INDIC.	CONTROL	ALARM	SHUTDOWN
LI4-6586B	DOST 4B Level Indication (Wide Range)	Local	750-41,000 gal	X			
LSH4-6587B	DOST 4B High Level Alarm	Control Room	39,487 gal			X	
LSL4-6587B	DOST 4B Low Level Alarm	Control Room	35,972 gal			X	
PDIS4-6332B	Differential Pressure Across Pump Suction Strainer	Local	41.56" H_2O	X		X	
PI4-6722B	Diesel Oil Transfer Pump B Discharge Pressure	Local	0-50psig	X			
PDIS4-6334	Differential Pressure Dost T-36 Inlet filter	Local	41.56" H_2O			X	

* Manufacturer tag number

** All values are approximate and may change as detailed design is finalized.

[illegible]

RAI 21

Describe your design provisions made to protect the fuel oil storage tank fill and vent lines from damage by tornado missiles.

Response to RAI 21

The fill lines enter the storage tanks near the top of the tanks. Therefore, if one of the lines were to be impacted by a tornado missile, there would be no effect on the fuel inventory in the tank. In addition, in the event that a fill line were to be impacted by a tornado missile, alternate methods exist to resupply the storage tanks.

Either of the following methods could be used:

1. Cross connects between the new fuel oil storage tanks and the existing fuel oil storage tanks will be installed under the Enhancement Project. Manual alignment of these cross connects would allow resupply of the affected tank.

2. Available fuel oil system piping connections exist for each EDG storage tank room. Use of these connections would allow the affected storage tank to be resupplied by a fuel oil delivery truck.

The impact of a tornado missile causing the complete loss of function of a vent line is not considered credible since almost complete crimping of the vent line would be required to cause a vacuum to be formed in the tank.

RAI 22

Discuss the means for detecting or preventing growth of algae in the diesel fuel storage tank. If it were detected, describe the methods to be provided for cleaning the affected storage tank.

Response to RAI 22

In accordance with existing procedures, a program of detection and prevention based upon current practices is utilized to prevent the deleterious effects of biological activity upon diesel fuel oil quality. Upon receipt, each oil delivery truck is subject to testing for microbial activity prior to transferring the diesel fuel oil from the oil delivery truck to the diesel fuel oil storage tank. Prior to transfer of the fuel oil from the truck to the tank, Kathon (a biocide), or an approved equivalent, is added to the fuel oil at the appropriate concentration. In addition, all diesel oil tanks including day tanks are subjected to microbial testing on a periodic basis.

Should microbial activity be detected in the diesel oil storage tank, tie in points are available in the suction and fill lines to allow the use of portable filtering equipment to clean and filter the fuel oil. Should microbial activity be detected in a day tank, the tank is drained and refilled with clean oil.

RAI 23

For the diesel fuel oil system, include a more explicit description of proposed protection of underground piping. Where corrosion protective coatings are being considered (piping and tanks) include the industry standards which will be used

in their application. Also discuss what provisions will be made in the design of the fuel oil storage and transfer system in the use of a impressed current type cathodic protection system, in addition to waterproof protective coatings, to minimize corrosion of buried piping or equipment. If cathodic protection is not being considered, provide your justification.

Response to RAI 23

To protect against corrosion, all fuel oil transfer piping that is underground will be 304 stainless steel and will be covered with Koppers Super Service Black (or equal), 3 to 4 mils, and then wrapped with Polyken Pipeline Coating (or equal) with a 2 inch overlap. Pipes exiting or entering the ground will be wrapped to a minimum of 3 inches above ground level and encased in a concrete collar.

The diesel oil storage tanks (DOSTs) are above ground reinforced concrete and steel lined structures and are part of the diesel generator building. The diesel oil day tanks are horizontal steel tanks located on the ground floor of the diesel generator building. Therefore, the tanks are considered as being enclosed within the building and not subjected to environmental conditions.

The liner plate and embedments for the DOSTs will be shop coated with a weldable inorganic zinc primer for protection during shipment and installation. Upon completion of the DOST liner installation, the interior surface of the DOST will be blasted clean and field coated with an epoxy coating system. This work will be performed in accordance with the coating manufacturer's and Structural Steel Painting Council requirements.

Interior and exterior surfaces of the diesel oil day tanks will also be provided with a suitable protective coating.

RAI 24

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 to RAI 24

The fuel oil day tank is located 9 feet away from the EDG engine. It is at elevation 21 feet. The EDG exhaust piping, which is completely insulated, is at elevation 34.5 feet (13.5 feet above the fuel oil day tank). Since there are no open ignition sources in the EDG room and since the day tank is located in one of the cooler areas of the EDG room, the possibility of the fuel oil day tank being overheated or being in the area of an open flame is minimal. Also, when the engine is running, the radiator fan system moves air through the engine room at such a rate to prevent any heat buildup in the area where fuel oil is located.

The piping from the fuel oil day tank to the engine skid is at a low elevation in a trench below floor level and then it rises to the skid piping. The remaining piping is per the manufacturers design on the engine skid. The engine room is also protected by a complete fire detection/fire protection system.

1) Fire/heat detectors are located in the ceiling in the EDG engine room.

[illegible]

2) Water sprinklers are located throughout the room to protect the equipment should a fire start for any reason.

3) The building walls are three hour rated fire barriers and the entrance between the EDG rooms is equipped with a three hour rated fire door to preclude a fire from spreading outside of the engine room.

4) The fuel oil day tank is vented outside and protected by a flame arrestor to ensure the fuel oil day tank is protected.

5) All off-skid fuel oil piping and the day tank that could contain fuel oil is designed to ASME Section III, Class 3 and Seismic Category I.

RAI 25

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 to RAI 25

There are no high or moderate energy lines in the EDG building.

RAI 26

The discussion of your diesel engine fuel oil storage and transfer system (EDEFSS) does not specifically reference ANSI Standard N195 "Fuel Oil Systems for Standby Diesel Generators". Indicate if you intend to comply with this standard in your design of the EDEFSS; otherwise, provide justification for non-compliance.

Response to RAI 26

The fuel oil storage and transfer system complies with ANSI Standard N195-1976, "Fuel Oil Systems for Standby Diesel Generators."

RAI 27

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 to RAI 27

Should this unlikely event occur, the following provisions have been made to eliminate fouling of the fuel oil to the EDG.

1) The fuel oil transfer pump takes suction from an elevation 19.5 feet, 6 inches from the local bottom of the fuel oil storage tank. The 12 gpm

through the 3 inch suction line has a flow velocity of approximately 0.55 feet/second, which is very low, therefore, it will not cause turbulence of any sediment at the intake to the suction line.

2) The fill line to the fuel oil storage tank enters the tank at the 45 feet elevation and terminates inside the tank at the 42.5 feet elevation. Technical Specification requires a minimum seven day supply and the level for this quantity of fuel oil is the 42.2 feet elevation. The EDG at full load will use approximately 3 feet of fuel oil per 24 hours. When the fuel oil level decreases below 42.2 feet elevation, arrangements will be made to obtain more fuel oil. Assuming it takes four days to obtain more fuel oil, the fuel oil elevation at that point will be 29.2 feet, which is approximately 10 feet above the suction line and greater than 10 feet above the bottom of the tank. Since the fill line is oversized (three inch line) to assure low velocity flow and with multiple one inch holes on the discharge end to diffuse the flow, the dynamic effects of the new fuel oil entering the storage tank will be insignificant with respect to stirring up the fuel oil at the bottom of the storage tank.

3) The fuel oil transfer pumps also have duplex suction strainers to further assure that no debris is transferred from the fuel oil storage tank to the fuel oil day tank. The suction strainers can be shifted while the transfer pumps are in operation, and the strainer that is out of service can be cleaned and made ready for service while the transfer pump is operating. The suction strainers also have a differential pressure gauge across them so the operator can determine if the strainer needs to be cleaned.

4) The fuel oil entering the fuel oil storage tank must pass through a one micron filter. This will assure that no particles larger than one micron will enter the fuel oil storage tank.

5) In addition to the above, fuel oil exiting the day tank first passes through a duplex suction strainer, then the fuel oil pump and finally, just before it enters the engine fuel racks, the fuel oil must pass through a one micron duplex filter. Both the strainer and the filter can be changed and cleaned while the EDG is in operation and both have differential pressure indication/switches to alert the operator that the strainer/filter in service needs cleaning long before fuel oil would be restricted from the EDG.

<u>RAI 28</u>

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 limitations as well as diesel index number of its equivalent, cloud point, entrained moisture, sulfur, particulates and other deleterious 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.

<u>Response to RAI 28</u>

The quality and reliability of the fuel oil supply is assured per existing procedure. For particulate testing, the program follows the requirements of ASTM-2276. The remainder of the fuel oil testing follows the requirements of

ASTM-D975-1981. All monthly tests are completed every 31 days and all quarterly tests are performed on a bi-monthly basis. Every eighteen months, the fuel oil is also tested per manufacturer standards which includes all requirements of ASTM-D975-1981 plus testing for chlorides. These same or equivalent requirements will apply to the new fuel oil supply system.

RAI 29

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

Response to RAI 29

The fuel oil day tank has a total capacity of 650 gallons. The tank has a one hour low level alarm, a low level alarm, and a high level alarm. The internal diameter of the tank is 42 inches. The tank is mounted horizontally; its overall length is approximately 117.5 inches.

The fuel oil day tank normally has between 21.5 and 39.5 inches of fuel oil in it, the fuel oil transfer pump auto-start and auto-stop levels, respectively. Therefore, there is usually enough fuel oil in the day tank to support about three hours of EDG operation.

The physical location of the fuel oil day tank was selected taking into account the following considerations.

1) For fire safety, the tank could not be located near hot surfaces such as the engine or an exposed section of the exhaust piping.

2) The tank must be accessible to be able to perform maintenance on the level switches.

3) The elevation of the tank could not be too high because its head pressure would overcome the ten psi check valves in the EDG fuel oil piping system to the engine. These valves must open only when the EDG fuel oil pumps are running.

4) The elevation could not be too low because the EDG fuel oil pumps would not have sufficient NPSH to supply fuel oil to the engine. The tank location meets the requirements of the diesel engine manufacturer.

5) The tank has been located where it can be seismically supported to assure it can withstand earthquake loadings.

6) The tank has been located where it is protected from tornado missiles or other natural phenomena.

7) The tank has been located where it is safe from sabotage, that is, within the vital security area.

8) The tank has been located such that it will not interfere with normal EDG maintenance. The engine room requires access for monorails and equipment dollies for engine maintenance.

9) The tank has been located in a fire protected area because of the fuel oil the tank contains.

RAI 30

Will the diesel generator fuel oil storage tank be provided with an individual fill and vent line. Indicate where these lines are located (indoor or outdoor) and the height these lines are terminated above finished ground grade. If these lines are located outdoors, discuss the provisions made in your design to prevent entrance of water into the storage tank during adverse environmental conditions.

Response to RAI 30

The fuel oil storage tanks have individual vent lines. There is a common truck fill connection which goes to a valve header. Depending on the valve line-up in each pump room, oil may be transferred to either storage tank. The fill lines enter the tanks at the 45 foot elevation and terminate inside the tank at the 42.5 foot elevation. The ground elevation is 18 feet. The truck fill connection to the fuel oil transfer piping is located outside the EDG building at elevation 22.5 feet (4.5 feet above ground level), with a normally closed valve. It also has a quick-disconnect female coupler with an end plug.

In addition, there is a truck fill connection for the existing EDG located at the northwest corner of the new EDG Building at the 22.5 foot elevation. This line is connected to the new Unit 3 - Unit 4 cross-tie and may be used to fill either Unit's EDG storage tanks. This line also has a quick-disconnect female coupler with an end plug.

The vent on the roof of the building has a flame arrestor and a 180 degree elbow, both of which will prevent water from entering the fuel oil storage tank during inclement weather. The vent lines flame arrestors are located at approximately the 52 feet elevation on the roof of the EDG building.

RAI 31

We require the vent line from each diesel day tank to be designed to seismic Category 1, Class C requirements. Also, the portion of the vent line and flame arrestor exposed above the diesel generator building roof should be protected from damage by tornado missiles. Your design should meet these requirements.

Response to RAI 31

As stated in Response to RAI 26, the fuel oil system is designed in accordance with ANSI Standard N195-1976. The above standard requires the materials and design for pressure containing components to be designed to ASME Section III, Subsections ND. Since vent lines are not pressure containing components (they are open to the atmosphere) and since they are located at an elevation above any fuel oil level, they were designed to ANSI Standard B31.1. However, each vent line from its day tank to the building roof has been seismically analyzed and shown to be acceptable.

The vent line flame arrestor and all piping exposed above the roof are made from extra heavy steel. The impact of a tornado missile causing the complete loss of function of the vent line and flame arrestor is not considered credible since almost complete crimping would be required to cause a vacuum to be formed in the tank.

RAI 32

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 to RAI 32

The attached Figure 32-1 identifies the total and individual heat removal rates for the diesel generator cooling water system at 110 percent rated load. The cooling system is designed to maintain a top tank (water leaving the engine) temperature of 190°F at 110 percent rated load and radiator cooling air entering the radiator coils at 122°F. Since the engine is typically not operated at 110 percent rated load, the actual heat removal requirements are lower. The lower actual heat load constitutes design margin for the system.

RAI 33

Provide the results of a failure mode and effects analysis to show that failure of a piping connection between subsystems (engine water jacket, lube oil cooler, governor lube oil cooler, and engine air inter-cooler) does not cause total degradation of the diesel generator cooling water system.

Response to RAI 33

In the event of a cooling system piping connection failure, the resultant loss of cooling system fluid would eventually force the affected EDG out of service. However, the possibility for this event is considered highly unlikely for the following reasons:

1) The cooling system normally operates at relatively low pressure and temperature (less than 30 psig and 190°F) respectively and meets the criteria for a low energy system per SRP 3.6.1.

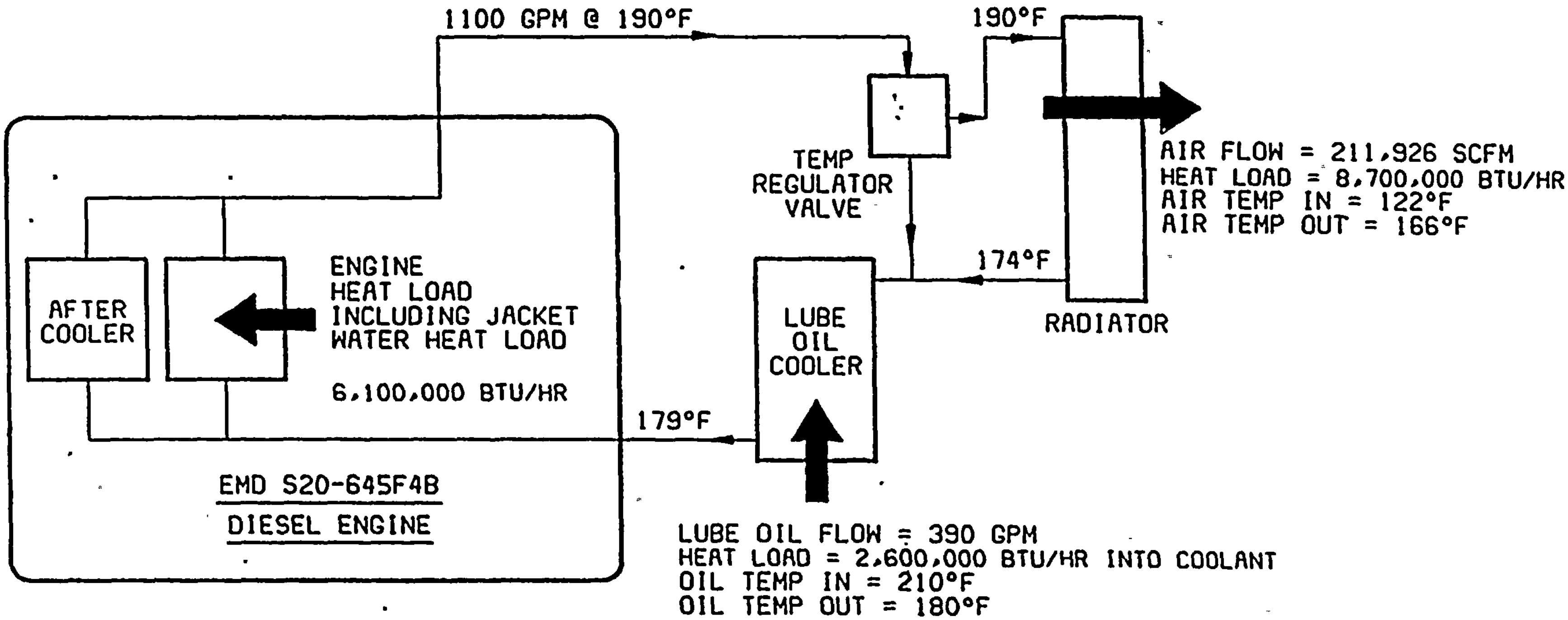
2) The entire cooling system is analyzed for all normal and postulated loads including dead weight, thermal and seismic conditions and designed accordingly.

3) The cooling system design is consistent with the manufacturers standard practice which historically has proven to be very reliable with respect to cooling system piping failures.

Although considered highly unlikely, should such a failure occur, available alarms and indication (see response to RAI 36) would alert plant operators of possible degradation in cooling system performance so that appropriate action could be taken. In addition, as stated in response to RAI 36, during non-emergency use, automatic EDG shutdown would occur when cooling temperatures reached 215°F.

In the event that a cooling system piping connection failure would lead to shutdown of the affected EDG, safe plant operation would not be affected since the redundant EDG with completely independent cooling water system would still be available.

FIGURE 32-1
COOLING SYSTEM HEAT TRANSFER CAPABILITY
(AT 110% RATED LOAD)



RAI 34

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.

Response to RAI 34

Control of corrosion and organic fouling for the existing Turkey Point diesels is assured per procedure based upon the use of a borate-nitrate type inhibitor and treated water.

For the new EDG's, EMD has identified four basic requirements for the coolant solution.

1) It must adequately transfer heat energy through the cooling system.

2) It must not form scale or sludge deposits in the cooling system.

3) It must not cause corrosion within the cooling system.

4) It must not deteriorate any of the cooling system seal materials.

In addition, specific requirements for water quality and the use of various inhibitors are also included in the EMD Maintenance Instruction. For the new EDG's, the above requirements of EMD Maintenance Instruction for engine coolant will be considered and incorporated into plant procedures as appropriate.

RAI 35

Provide details of your proposed diesel engine cooling water system chemical treatment, and discuss how your proposed treatment complies with the engine manufacturer's recommendations.

Response to RAI 35

See Response to RAI 34.

RAI 36

For the diesel engine cooling water system discuss the testing necessary to maintain and assure a highly reliable instrumentation, control, sensor, and alarm system. Identify the temperature, pressure, level, and flow (where applicable) sensors which alert the operator when these parameters exceed the range 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.

Response to RAI 36

The diesel engine cooling water system has instruments, controls and alarms either local or on the local control panels for EDG-4A or EDG-4B. Any abnormal condition in the cooling water system is annunciated locally at the local control panels of EDG-4A or EDG-4B and in the main control room through a common trouble annunciator. For listing of instrumentation, see Table 36-1.

The necessary controls are provided with each cooling system to maintain the engine jacket at the proper temperature for all modes of operation. Alarms are provided at the local control panel, with a common EDG trouble alarm in the main control room, for low expansion water tank level, abnormal cooling water temperature, and low cooling water pressure at the inlet to the engine. The operator action required following alarm actuation will be specified in off-normal operating procedures. These actions will be consistent with the manufacturer's guidelines.

If the cooling water pressure and temperature go beyond their shutdown limits, the diesel generators are interlocked to shutdown under non-emergency conditions.

System components are inspected and tested by the manufacturer. After installation and before plant startup, the cooling water systems are inspected, tested and operated. Testing will be performed to verify system operability per Technical Specification requirements in accordance with manufacturer recommendations and applicable codes and standards.

TABLE 36-1

COOLING WATER SYSTEM INSTRUMENTS

'AG*	DESCRIPTION	LOCATION	SETPOINT/ RANGE**	INDIC.	CONTROL	ALARM	SHUTDOWN
'S-41	Cooling Water Pressure Low	Local	30 psig ↑ 20 psig ↓			X	X
'S-42	Cooling Water Pressure Low	Local	35 psig ↑ 25 psig ↓			X	
'S-43	Cooling Water Pressure Low - Idle	Local	8 psig ↑ 6 psig ↓			X	X
'S-41	Cooling Water Temp High	Local	215°F ↑ 205°F ↓			X	X
'S-42	Cooling Water Temp High	Local	208°F ↑ 198°F ↓			X	
S-43	Cooling Water Temp Low	Local	105°F ↑ 95°F ↓			X	
S-44	Immersion Htr Temp Control	Local	155°F ↑ 125°F ↓		X		
S	Lube Oil Temp. Enable for Diff. Press. Across Lube Oil Cooler	Local	160°F ↑ 150°F ↓		X (1)		
I-41	Cooling Water Temp Engine Out	Local	50°F-300°F	X			
I-42	Cooling Water Temp Radiator Out	Local	50°F-300°F	X			
I-43	Cooling Water Temp Engine In	Local	50°F-300°F	X			
I-44	Cooling Water Temp Engine Out	Local	50°F-300°F	X			
I-45	Cooling Water Temp Radiator Out	Local	50°F-300°F	X			
I-46	Cooling Water Temp Engine In	Local	50°F-300°F	X			
I-47	Cooling Water Temp Radiator In	Local	50°F-300°F	X			
/-41	Expansion Tank Level Low	Local	7.2" from tank bottom	X			

Manufacturer tag number

* All values are approximate and may change as detailed design is finalized.

1) - Enables annunciator circuit for high differential pressure across lube oil cooler.

RAI 37

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 to RAI 37

General Motors Electro-Motive Division (EMD) has established requirements for cooling water systems to ensure proper performance of the engine mounted cooling water pumps and other system components. These requirements include the following:

1) The minimum height of the expansion tank and radiator relative to the water inlet connection to the lube oil cooler should be 15 feet. Any less height would require the use of aspirators (see Figure 37-1).

2) The maximum height of the expansion tank and radiator relative to the water inlet connection to the lube oil cooler should be 25 feet.

3) The total pressure loss of pipe and cooling equipment external to the engine accessory rack should be limited to 8 psi.

4) To assure that the cooling system is kept completely full of water, the high points of any pipe or component shall be vented to the top of the expansion tank (see Figure 37-1).

The new EDG's comply with each of the above requirements.

RAI 38

The diesel generators are required to start automatically on loss of all offsite power and in the event of a LOCA. The diesel generator sets should be capable of operation at less than full load for extended periods without degradation of performance or reliability. Should a LOCA 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. Explicitly define the capability of your design with regard to this requirement.

Response to RAI 38

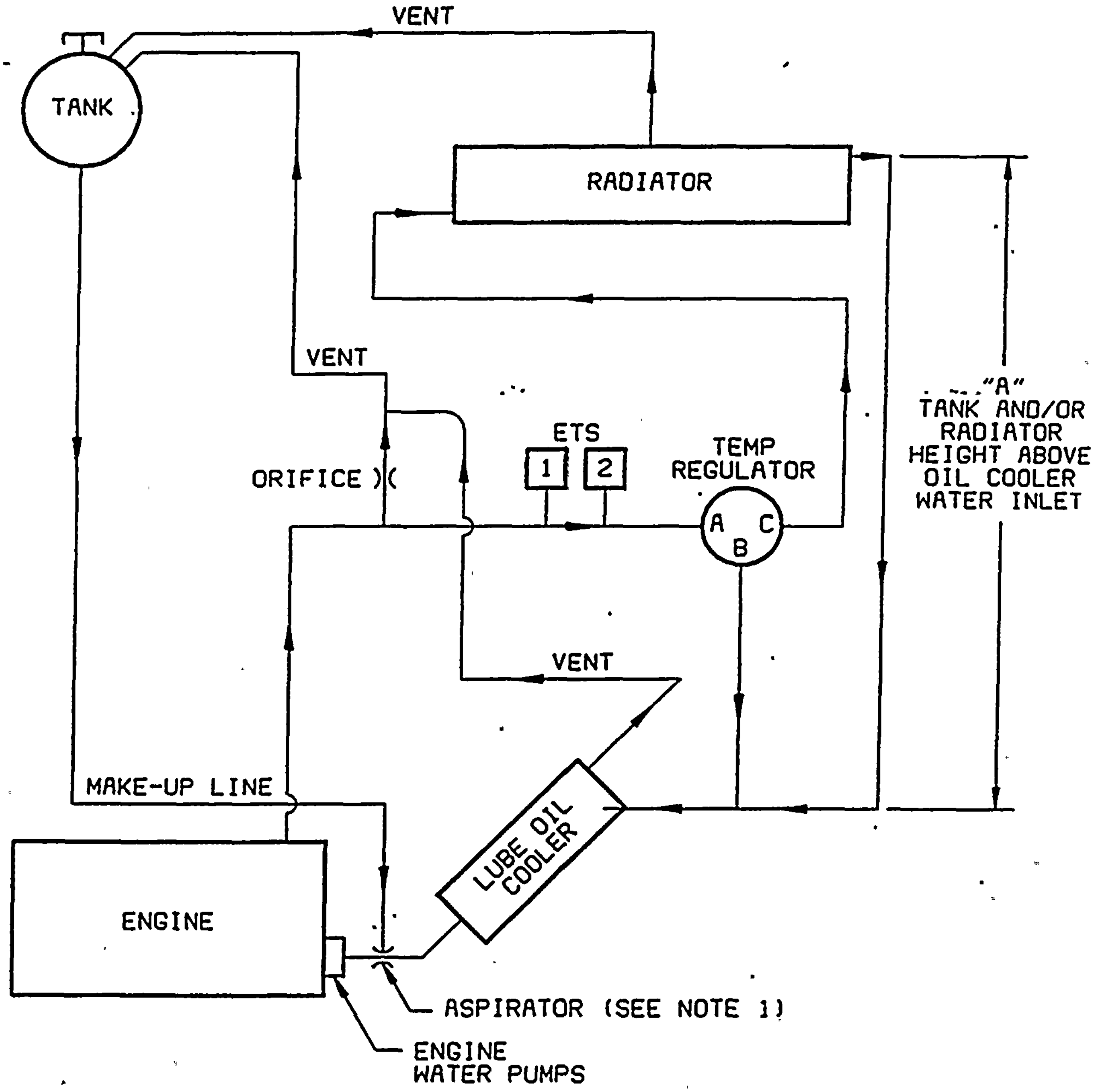
Internal combustion engines including diesel engines operate most reliably at the rating for which they are designed. At extended light load operation, "souping" can be expected to occur with a diesel engine. The term "souping" refers to an accumulation of lube oil in the exhaust system due to light load operation. Depending upon the amount of "souping" that has taken place, an exhaust fire could result when the engine is suddenly loaded.

If long periods of no load operation are required, operation at idle speed (440-560 rpm) is recommended by the manufacturer. Each new EDG has an idle start feature which allows the emergency signal to release the EDG to go to rated speed and frequency and accept load.

In addition, if an engine has been running lightly loaded, the manufacturer has provided the following recommendations for ensuring proper EDG performance:

1) Operation at synchronous speed at loads between 0 and 20 percent: after 4-1/2 hours of operation, the engine should be run at a minimum of 40 percent load for a minimum of 30 minutes to clean out the exhaust stacks.

FIGURE 37-1
TYPICAL COOLING SYSTEM SCHEMATIC WITH RADIATOR



NOTES

1. THIS ARRANGEMENT IS USED IF HEAD "A" AT OIL COOLER INLET EXCEEDS 15 FEET. MAXIMUM ALLOWABLE HEAD "A" IS 25 FEET. (ASPIRATOR MAY ALSO BE USED IF DESIRED.)

2. VENT AND MAKE-UP LINES SHOWN IN SCHEMATIC FOR ILLUSTRATIVE PURPOSES ONLY. ACTUAL VENTING AND MAKE-UP TO SUIT INSTALLATION SO AS TO PROVIDE SMALL VENT FLOW TO TANK FOR REMOVAL OF AIR FROM SYSTEM. FLOW LOSS IN MAKE-UP LINE IS KEPT TO A MINIMUM.

2) Operation at idle speed (440-560 rpm): After 5 days of operation at a minimum oil temperature into the engine of 170°F, the engine should be run at a minimum of 40 percent load for a minimum of 30 minutes to clean out exhaust stacks. In addition, during an extended idle period, the air box drains should be continually drained or opened periodically to purge oil accumulated in the engine air box.

For the new EDG's, the above manufacturer recommendations will be considered in the event that the EDG's are required to operate at light load for extended periods.

RAI 39

You state in Section 5.2.7 of the June 23, 1988 submittal that each diesel engine cooling water system is provided with an expansion tank to provide for system expansion and water makeup. The expansion tank should provide for minor system leaks at pump shafts seals, valve stems and other components, and to maintain required NPSH on the system circulating pump. Provide the size of the expansion tank and location. Demonstrate by analysis that the expansion tank size will be adequate to maintain required pump NPSH and make up 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 make up water supply to the expansion tank.

Response to RAI 39

The total cooling water system inventory is approximately as follows:

1)	Engine and accessory rack		- 318 gallons
2)	Radiator		- 365 gallons
3)	6" piping - 1.5 gal/ft - 50 ft		- 75 gallons
		TOTAL	758 gallons

The expansion of water from 40°F to 200°F is approximately 4 percent of total volume therefore, .04 x 758 gal = 30.3 gallons.

The expansion of water from standby temperature 120°F to 200°F is approximately 2.75 percent, therefore, .0275 x 758 gal. = 20.8 gallons.

The expansion tank has a total volume of 100 gallons. It is located at the highest point in the system but not higher than 25 feet above the inlet connection to the lube oil cooler. The equivalent dimension from the bottom of the engine base is 33 feet. The minimum height of the bottom of the expansion tank in conjunction with aspirators is 7 feet from the bottom of the base. To assure that the system is kept completely full of water, the high points of any pipe or component are vented to the top of the expansion tank.

The tank is filled with approximately 60 gallons of water at standby conditions to allow for the 21 gallon expansion when the water is hot.

The water inlet connection to the engine (pump inlet) has a device called an aspirator to assure NPSH at the pump inlet. The bottom expansion tank connection is piped directly to the aspirator.

The jacket water system is a closed system designed to operate at 7 psig pressure. The pumps have mechanical seals and do not leak until they have been worn. Leakage past seals and gaskets at pipe connections should also be non-existent. When properly maintained, there should be no leakage that would require the addition of water during the seven day continuous operation. There is however, a fill connection on the expansion tank to which plant fill piping can be connected to replenish the water level if required.

RAI 40

Provide the source of power for the standby immersion heater in the diesel engine cooling water systems.

Response to RAI 40

The standby immersion heaters in the diesel engines' cooling water systems are provided power via Class 1E Motor Control Centers, 4J and 4K for EDG's 4A and 4B, respectively.

RAI 41

What is the source of power for the electric motor driven (AC and DC) external lube oil pumps.

Response to RAI 41

The ac motor driven external lube oil pumps are provided power via Class 1E Motor Control Centers, 4J and 4K for EDGs 4A and 4B, respectively. The dc motor driven external lube oil pumps are provided power via Class 1E 125V DC buses, 4D23 and 4D01 for EDGs 4A and 4B, respectively.

RAI 42

Provide a discussion of the measures that have been taken in the design of the standby diesel generator air starting system to preclude the fouling of the air start valve or filter with moisture and contaminants such as oil carryover and rust.

Response to RAI 42

The air start systems to be used for the new EDGs will essentially eliminate moisture carryover into the starting air receivers because a deliquescent type air dryer will be installed between the air compressors and the air receivers. Therefore, the air entering the air receivers will have a very low dewpoint. As an additional precaution, the air receivers and all system piping, valves and instruments are to be made from stainless steel to further prevent rusting. The air receivers will be monitored for moisture buildup with water detection devices which will alarm should moisture accumulate in the air receivers. As an administrative control, the air receivers will also be checked monthly for water/moisture buildup. A wye-type strainer is also installed in the air start piping just as the air enters the skid piping to further control the possibility of foreign matter entering the air start motors.

Oil carryover is not a concern because of the design of the system (i.e., use of prefilters, dryers, receiver piping arrangement, etc.). It should also be noted that a small amount of oil is actually injected into the air start piping just upstream of the air start motors to assure they are properly lubricated. This is the manufacturer's normal design.

RAI 43

For the diesel engine air starting system, describe the testing necessary to maintain a highly reliable instrumentation, control, sensor 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.

Response to RAI 43

The diesel engine air starting system is equipped with controls and alarms for:

1) Independently starting and stopping the compressor.

2) Operating each set or both sets air motors.

3) Alarming low starting air pressure with a common EDG alarm in the control room.

Indication of starting air pressure upstream of the starting air valves is provided in the EDG control room and locally. The EDG starting air system indications and alarms are summarized in Table 43-1.

The operator action required following alarm actuation will be specified in the off-normal operating procedures. These actions will be consistent with the manufacturer's guidelines.

This system has no interlocks to shutdown the diesel generators.

System components are inspected and tested by the manufacturer. After installation and before plant startup, the air start systems are inspected, tested and operated. Testing will be performed to verify system operability per Technical Specification requirements in accordance with manufacturer recommendations and applicable codes and standards.

TABLE 43-1

STARTING AIR INSTRUMENTS

AG*	DESCRIPTION	LOCATION	SETPOINT/ RANGE**	INDIC.	CONTROL	ALARM	SHUTDOWN
5-71 1,2	Starting Air Tank Pressure Low	Local	197 psig ↑ 188 psig ↓			X	
5-72 1,2	Starting Air Tank Pressure High	Local	215 psig ↑ 205 psig ↓			X	
I-71	Air Receiver Press	Local	0-300 psig	X			
I-72	Air Receiver Press	Local	0-300 psig	X			
I-73	Engine Start Air Pressure - Left	Local	0-300 psig	X			
I-74	Engine Start Air Pressure - Right	Local	0-300 psig	X			
I-75	Engine Start Air Pressure - Left	Local	0-300 psig	X			
I-76	Engine Start Air Pressure - Right	Local	0-300 psig	X			
5-[illegible] ,2	Start Air Line Pressure Low	Local	197 psig ↑ 188 psig ↓			X	
5-74 ,2	Start Pinion - Fail to Engage/Recycle Control	Local	10 psig ↑ 6 psig ↓			X	
5-75 ,2	Air Compress Motor Control	Local	202 psig(stops) 193 psig(starts)		X		
071 ,2	Air Receiver Drain Water Detector	Local	N/A			X	
171	Engine Air Barring Devise Engaged	Local	N/A			X	

Manufacturer tag number
All values are approximate and may change as detailed design is finalized.

[illegible]

RAI 44

Expand your description of the diesel engine starting system. Describe the diesel engine starting sequence including the number of air start valves used and whether one or both air motors are used.

Response to RAI 44

Each engine has four air start motors. For a normal start, all four air motors are used to roll over the engine. If two air start motors are inoperable, the other two have sufficient torque to start the EDG in the required time interval. If one set of air start motors do not engage to roll over the engine during a start attempt, an alarm will alert the operator that these air start motors are not functional even though the EDG has started. This provides an added safety feature which will allow maintenance to correct any problem with the inoperable set of air start motors prior to the next start attempt.

When the air start system is in normal standby, there is approximately 200 psig air pressure in the piping up to the two redundant air start solenoid valves. The electrical start signal will open both of the air start solenoid valves and admit starting air to engage the pinions of the air start motors. When both pinions are engaged, the control valve is then actuated which admits the starting air to the air start motors. When the starting air enters the air start motor assemblies, it first pressurizes the pinion which engages the air start motor to the engine flywheel; then the air starts to turn the air start motor internals and the engine flywheel together.

When the air pressure downstream of the air start motors builds to a preset value due to the air start motors rotational velocity, a pneumatic pressure sensing line sends air to the governor servo-booster pump and simultaneously to the top side of the air start solenoid valve. This allows the governor to obtain control of the EDG faster and it also shuts the air start solenoid valve when the EDG has reached the necessary starting speed so the fuel racks can maintain and accelerate the engine to the desired rpm.

RAI 45

A study by the University of Dayton has shown that accumulation of water in the starting air system has been one of the most frequent causes of diesel engine failure to start on demand. Condensation of entrained moisture in compressed air lines leading to control and starting air valves, air start motors, and condensation of moisture on the working surfaces of these components has caused rust, scale and water itself to build up and score and jam the internal working parts of these vital components thereby preventing starting of the diesel generators.

In the event of loss of offsite power the diesel generators must function since they are vital to the safe shutdown of the reactor(s). Failure of the diesel engines to start from the effects of moisture condensation in air starting systems and from other causes have lowered their operational reliability substantially. In an effort toward improving diesel engine starting reliability we require that compressed air starting system designs include air dryers for the removal of entrained moisture. Starting air should be dried to a dew point of not less than 50°F when installed in a normally controlled 70°F environment, otherwise the starting air dew point should be controlled to at least 10°F less than the lowest expected ambient temperature.

Describe the design of the diesel engine air starting system with respect to this concern.

Response to RAI 45

A deliquescent air dryer and filter is incorporated into the air start systems for both the diesel and electric driven air compressors. A dew point of less than 40°F and a maximum particulate size of 1 micron has been specified as the minimum air quality requirements for the air dryer package. (Note the equipment has not been selected at this time.) Additionally, the air receivers, system piping up to the skid, valves and instruments are made of stainless steel to prevent the generation of rust particles. The air receivers will be monitored for moisture buildup with water detection devices which will alarm should the air dryer fail and moisture accumulate in the air receivers. (Also see response to RAI 42.)

RAI 46

Provide the source of power for the motor driven air stating system compressor and the motor characteristics, i.e., motor hp, operating voltage.

Response to RAI 46

The motor driven air starting system compressors are provided power via Class 1E Motor Control Centers, 4J and 4K for EDG's 4A and 4B, respectively. Motors are rated 10 hp for use on a 480 V AC, 3-phase 60 Hz system.

RAI 47

For the diesel engine lubrication system, provide the following information: 1) 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; 2) describe the protective features (such as blowout panels) provided to prevent an unacceptable crankcase explosion and to mitigate the consequences of such an event; and 3) describe the capability for detection and control of system leakage.

Response to RAI 47

1) EMD's Maintenance Instruction for lubricating oil includes a requirement for monthly lube oil analysis with the results to be trended. In addition, guidance on the interpretation of the lube oil analysis, acceptance criteria and replacement schedule are also specified. For the new EDG's, these requirements will be considered and incorporated into plant procedures as appropriate.

2) Each engine is equipped with a crankcase pressure detector designed to shutdown the engine when operating in the normal mode, or to alarm a high pressure condition when operating in the emergency mode. (See RAI 48, Table 48-1). In addition, the engines are equipped with handhole covers which would blowout in the event of excessive crankcase pressure.

3) Detection and control of oil leakage is accomplished in accordance with EMD's recommended maintenance program which calls for periodic visual inspections. During engine operating conditions, excessive leakage would be detected via the installed low oil level/pressure alarms (see RAI 48, Table 48-1).

RAI 48

For the diesel engine lubrication oil system, describe the testing necessary to maintain a highly reliable instrumentation, control, sensor, 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 action required during alarm conditions to prevent harmful effects to the diesel engine. Discuss systems interlocks provided.

Response to RAI 48

The diesel engine lubrication oil system has instruments, controls and alarms either local or on the local panels for EDG-4A and EDG-4B. Abnormal conditions in the lube oil system are annunciated locally at the local control panels of EDG-4A or EDG-4B and in the main control room through a common trouble annunciator. For listing of instrumentation, see Table 48-1.

The necessary controls are provided with each lube oil system to maintain the proper engine lubrication for all modes of operation. Operator action required following alarm actuation will be specified in off-normal operating procedures. These actions will be consistent with the manufacturer's guidelines.

Interlocks which result in shutdown of the EDG are shown on Table 48-1.

System components are inspected and tested by the manufacturer. After installation and before plant startup, the lubrication oil systems are inspected, tested and operated. Testing will be performed to verify system operability per Technical Specification requirements in accordance with manufacturer recommendations and applicable codes and standards.

TABLE. 48-1

LUBE OIL SYSTEM INSTRUMENTS

AG*	DESCRIPTION	LOCATION	SETPOINT/ RANGE**	INDIC.	CONTROL	ALARM	SHUTDOWN
S21	Crankcase Pressure HIGH	Local	0.8-1.8" H_2O			X	
S31	Oil Pressure Low	Local	20 psig ↑ 17 psig ↓			X	X
S32	Low Oil Pressure Control-Idle	Local	30 psig ↑ 25 psig ↓		X	X	
S33	Low Oil Pressure Alarm-Running	Local	45 psig ↑ 40 psig ↓			X	
S34	Low Turbo Oil Pressure Alarm	Local	10 psig ↑ 6 psig ↓			X	
S35	Low Circ Oil Pressure Alarm	Local	10 psig ↑ 6 psig ↓			X	
S36	Low Piston Cooling Oil Pressure Shutdown	Local	22 psig ↑ 17 psig ↓			X	X
[illegible]	Backup DC Turbo Oil Pump Control	Local	20 psig ↑ 15 psig ↓		X		
S38	Backup DC Circ Oil Pump Control	Local	20 psig ↑ 15 psig ↓		X		
'S31	Engine Oil Strainer Differential High Alarm	Local	5 psig ↑ 2 psig ↓			X	
'S32	Oil Filter Differential High Alarm	Local	20 psi ↑ 10 psi ↓			X	
'S33	Oil Cooler Differential High Alarm	Local	30 psi ↑ 20 psi ↓			X	
'S35	Aux Turbo Oil Filter Differential High Alarm	Local	20 psi ↑ 15 psi ↓			X	
'S36	Turbo Oil Filter Differential High Alarm	Local	20 psi ↑ 15 psi ↓			X	
31	Engine Oil Pressure	Local	0-160psig	X			
32	Turbo Standby Oil Pressure	Local	0-100psig	X			
[illegible]	Engine Oil Pressure	Local	0-160psig	X			

TABLE 48-1 (Cont'd)

[illegible]	DESCRIPTION	LOCATION	SETPOINT/ RANGE**	INDIC.	CONTROL	ALARM	SHUTDOWN
S31	High Oil Temperature Shutdown/Alarm	Local	230°F↑ 220°F↓			X	X
S32	Low Oil Temperature Alarm	Local	95°F↑ 85°F↓			X	
S33	High Oil Temperature Alarm	Local	220°F↑ 210°F↓			X	
I31	Engine Oil Out	Local	50-300°F	X			
I32	Engine Oil In	Local	50-300°F	X			
V31	Engine Oil Sump Level Low	Local	7 1/4" from bottom of oil pan			X	
D31	Metal Particles in Oil Alarm	Local	Fixed			X	
PI31	Oil Filter Differential Pressure	Local	0-30psi	X			
P[illegible]	Oil Strainer Differential Pressure	Local	0-30psi	X			

* Manufacturer tag number

** All values are approximate and may change as detailed design is finalized.

[illegible]

RAI 49

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.

Response to RAI 49

The diesel engine combustion air intake and exhaust system has instruments, controls and alarms on the local panels for EDG-4A and EDG-4B. For listing of instrumentation, see Table 49-1. Indication, alarm and shutdown functions associated with different instruments are also found in Table 49-1.

Operator action required following alarm actuation will be specified in off-normal operating procedures. These actions will be consistent with the manufacturer's guidelines.

System components are inspected and tested by the manufacturer. After installation and before plant startup, the combustion air intake and exhaust systems are inspected, tested and operated. Testing will be perform to verify system operability per Technical Specification requirements in accordance with manufacturer recommendations and applicable codes and standards.

TABLE 49-1

COMBUSTION AIR INSTRUMENTS

TAG*	DESCRIPTION	LOCATION	SETPOINT/ RANGE**	INDIC.	CONTROL	ALARM	SHUTDOWN
PI-81	Air Box Pressure	Local	0-30 psig	X			
PS-81	Combust Air Press Low	Local	10 psig ↑ (1% Deadband)			X	
TS-82	Combust Air Temp High	Local	300°F ↑ (2% Deadband)			X	
PS-91	Exhaust Air Press High	Local	5" H_2O ↑ (1% Deadband)			X	
TM-91	Exhaust Temp High	Local	1200°F ↑ (2% Deadband)			X	
			1300°F ↑ (2% Deadband)			X	X
TI-91	Engine Exhaust Pyrometer (1 sensor per cylinder)	Local	0-1400°F	X			
PI-91	Exhaust Back Pressure	Local	0-10" H_2O	X			
TM-93	Turbocharger Temp Differential High	Local	500°F ↑ (2% Deadband)			X	

* Manufacturer tag number
** All values are approximate and may change as detailed design is finalized.

RAI 50

Show by analysis 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 to RAI 50

With a fire in one engine room, it is also assumed that the engine room in question has had a failure of its fire protection system. It is required that the other EDG can operate at 100 percent load if it is called upon to do so.

Between the two engine rooms is a three hour rated fire wall and a fire rated door. Therefore, a fire in one engine room would not cause overheating of the other engine room.

The smoke from this fire will exit the engine room via the south side and the north side of the building. The smoke exiting through the radiator fans in the south wall will not interfere with the operation of the other EDG in any way since a fire barrier separates the south walls of the two EDGs.

It is possible for smoke to exit the north wall if the engine is not running, or more precisely, the radiator and room exhaust fans for that engine are not running. The smoke would have to ascend up into the air compressor room through the 22 by 25 foot grating, and migrate north to the normal air intake opening. The smoke would then be required to descend to below the 50 foot elevation through the security barriers (grating) that are 8.0 by 25 feet. At this point, the smoke would be falling down along the north wall of the building and therefore, could not go directly to the air intake of the other EDG room because there is a divider wall separating the two air intakes. The smoke would have to travel north approximately four feet and then travel east (or west) to the intake of the other EDG room. During this time, when the smoke is outside in the atmosphere, most of it will rise to a height above the air intake of the other EDG room. Although it may be possible for some smoke to find its way to the intake of the other EDG room, the amount will be reduced because of the torturous path it must follow. Also, when the smoke leaves the north wall of the burning EDG, it will be mixing with fresh air before traveling to the intake of the other EDG room. It must also be considered that the main stream of air entering the operating EDG room will be coming from the north side, well below the 50 feet elevation. Therefore, the amount of smoke that could be entrained in the air intake of the operating EDG would be minimal and for a relatively short duration of time.

Since the EDG operates at a relatively high excess of oxygen, some amount of smoke in the combustion air system could be accommodated by the EDG simply taking in more combustion air to make up the difference in order to obtain 100 percent power.

RAI 51

Experience at some operating plants has shown that diesel engines have failed to start due to accumulation of dust and other deleterious 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 this 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.

Response to RAI 51

Combustion air and cooling intake air enters the EDG building on the north side at the 51 feet elevation. Since the ground elevation is 18 feet, there is a minimum amount of dust or other deleterious materials in the air at an elevation of 33 feet above ground level. This air travels through the air compressor room at the 42 feet elevation, down through the grating and into the engine room. Some of the air goes into the engine as combustion air, and the remainder is exhausted out the south wall through the cooling water radiators. Although this air should be reasonably clean, there will be some dust, etc. entrained in it, and therefore, all switches in these rooms will be enclosed to protect them from dust and moisture.

The greater quantity of switches, relays and other electrical contacts will be located in the local control rooms located directly above the EDGs. These rooms are separate from the engine rooms and will be climate controlled, i.e., air entering these rooms will be filtered and cooled via the air conditioning units on the roof. Not only will this arrangement prevent dust and other deleterious material from fouling the electrical equipment, it will also prevent excess moisture from accumulating in the room that could cause rusting or corroding of electrical contacts or the drifting of setpoints of instruments and meters due to temperature variations.

Concrete walls and floors in the EDG building will also be sealed and/or painted to preclude any dust, especially concrete dust, from being generated internally. Smooth, clean and sealed surfaces are necessary for general good housekeeping, but especially in the engine room where lube oil, cooling water with inhibitors and fuel oil fumes are likely to be present.

In addition, housekeeping and cleanliness control procedures applicable to existing plant areas will be applied to the new EDG building.

RAI 52

Provide information which illustrates how the stress margins of the 20 cylinder, single prime mover, F4B model compare to the 20 cylinder, E4 model that has undergone the 300 start and run tests.

Response to RAI 52

The single prime mover configuration does not result in higher crankshaft stresses than the tandem arrangement.

Consider a tandem diesel generator rated 2000 KW. Each engine must furnish 1000 KW. The Woodward 2301A control system positions the governor actuator such that each engine operates at the same fuel rack setting and therefore, each delivers the same amount of power. The inertia of the generator is quite large compared to the inertia of the engine and acts like a single generator looking back to the end connected to its respective end. This shafting between each engine and generator will deliver torque equivalent to one half the total torque. If the shaft on either side of the generator is of equal size, the stresses will be equal. Remove one engine and reduce the size of the generator and the result is the single drive. There is no change in torque between the engine and generator.

A torsional analysis was performed by EMD to verify that stress levels for the Turkey Point model F4B engines are within acceptable limits. However, the torsional analysis is considered proprietary by EMD and was not available for our submittal in this response.

RAI 53

With respect to BMEP and BHP, what tests or other measures are proposed to assure that the F4B series can withstand the additional forces without experiencing fatigue failures over its life?

Response to RAI 53

It is our understanding that the TDI EDG utilized a custom made crankshaft to suit the torsional requirements for the installation. From a statistical point of view, the failure rate of a given component typically follows a "bathtub" curve as shown in Figure 53-1. Therefore, for a customized component, the likelihood of an early failure is greater than for a standard component with significant operating experience.

The EMD Model F4B does not utilize a customized crankshaft to satisfy torsional requirements.

The torsional analysis, combined with significant operating experience as described below, provide a high degree of assurance that the additional forces resulting from the increased BMEP and BHP will not result in fatigue failure.

Operating Experience of Model "F" Engine:

The EMD model "F" engine is produced for stationary, railroad, drill rig and marine service. EMD has produced a total of approximately 861 "F" units.

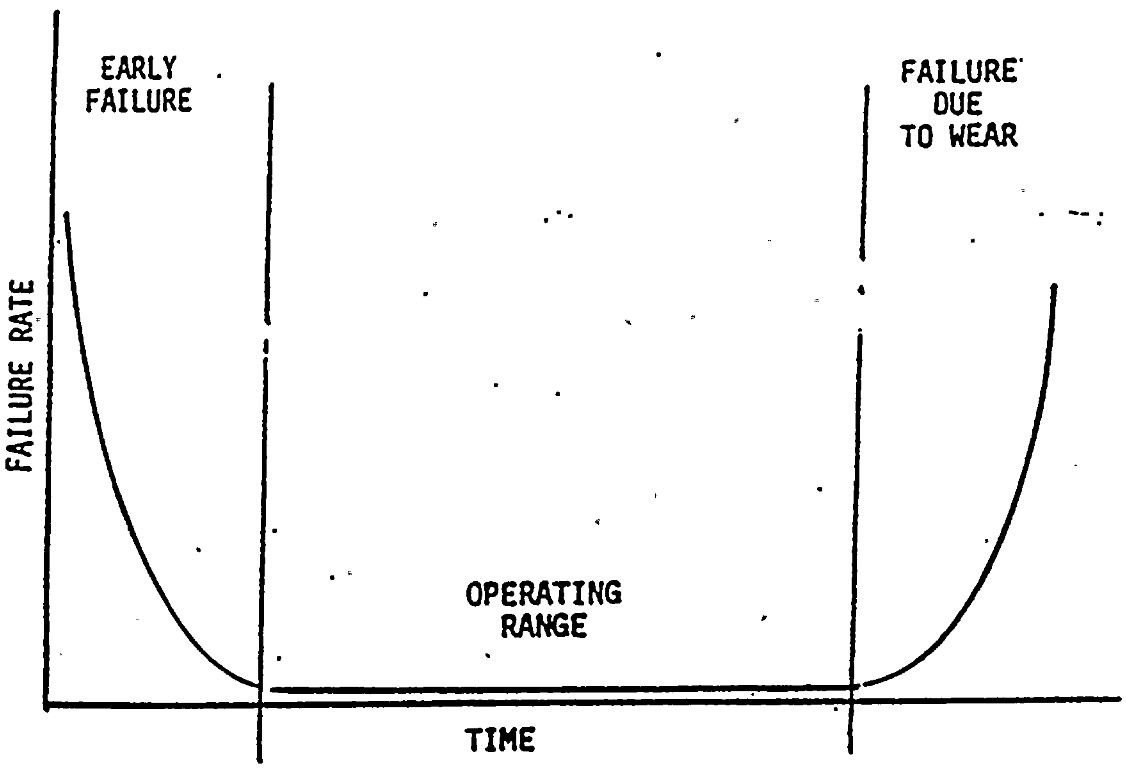
Those produced for stationary service are used both as standby and base power.

From data provided by EMD, approximately 46 "F" engines were produced for stationary service, but there were also evolutionary engines produced identified as models EB and EC. Figure 53-2 indicates the engine improvements made in each model related to the number of units for that improvement. Only the "F" engines are included for the railroad engines even though the evolutionary models apply to that service also. Marine and Drill Rig applications are not included in the totals.

Stationary service is a constant speed application, whereas railroad service is a variable speed application. Railroad engines once started are seldom stopped but run at idle speed when waiting for an assignment. While the engine is operated at idle when not in use, there are periods of time when the railroad engine is run "full bore" with a BMEP of 153 psi as compared to the rated BMEP of 136 psi for the stationary engine. Locomotive engines typically accumulate 100,000 to 250,000 miles per year. The useful life is 15 to 25 years during which 2 to 5 million miles have been accumulated. In heavy duty mainline freight service, mean time between overhaul is typically 3 to 4 years.

Percent	Duty
17	Full bore
4	Low Load to Full Load
46	Idle
9	Dynamic Brake

FIGURE 53-1



BATH TUB CURVE

FIGURE 53-2

FB IMPROVEMENTS IMPLEMENTED IN PRIOR MODELS

IMPROVEMENTS		MODEL			UNITS IN SERVICE W/IMPROVEMENTS		
	FB	EB	EC	FB	STAT.	RR	TOTAL
Compression ratio	16:1		—	—	77	714	791
Crankcase	F			—	46	714	760
Liner	Laser Hardened Upper Bore		—	—	77	714	791
Lower Liner Water Seal	Viton		—	—	77	714	791
Water Outlet Seal	Viton	—	—	—	162	714	876
Lower Liner Insert	Nickel			—	46	714	760
Cylinder Head	Thin Deck	—	—	—	162	714	876
Cylinder Head Seat Ring	Aluminum Bronze	—	—	—	162	714	876
Cyl. Crab Retention Sys.	Plate Crab		—	—	77	714	791
Top Piston Ring Location	Fire Ring	—	—	—	162	714	876
Piston Pin Bearing	Bronze	—	—	—	162	714	876
	Rocking Pin	—	—	—	162	714	876
Camshaft Material	1080	—	—	—	162	714	876
Injector Plunger	.500"	—	—	—	162	714	876
Rocker Arm Rollers	Crowned	—	—	—	162	714	876
Exhaust Valve	Heavy Head		—	—	77	714	791
Blade Connecting Rod Matl.	4140		—	—	77	714	791
Turbocharger	FA			—	46	*	46
Turbocharger After Cooler	12 Row			—	46	*	46
Turbocharger Screen	(Reduced - Gradient)				162	714	876
	With Trap	—	—				
	W/Rev.Trap			—			

* A different turbocharger is utilized for locomotive diesel.

Therefore, it is useful to include the engines in railroad service to evaluate the reliability of the improvements to the E4 engine design that finally evolved into the "F" engine design.

For engines in railroad service, 6000 operating hours per year is a conservative estimate. Estimates indicate that the total operating hours approximated 16,806,000 hours or an average of 23,500 hours per unit for railroad service.

The operating hours for stationary service are more difficult to estimate because of the variations between standby power and base power and the evolutionary models that are included in the totals. However, an average of 1000 hours per year appears to be conservative. The estimated total hours of operation of stationary units containing improvements initiated in a particular model are:

Model EB - 414,000 hours
Model EC - 128,000 hours
Model FB - 103,000 hours

Based upon the total number of operating hours, all improvements are on the flat operating portion of the "bathtub" curve, well away from the early failure stage ((Figure 53-1).

RAI 54

More information is desired as to the similarities and dissimilarities between the proposed Turkey Point EDGs and the "F" engines used for railroad service in order to determine the relevancy of the railroad experience.

Response to RAI 54

Both the railroad service and the "F" engine series are basically a standard 645 model design. They have the same crankcase, crankshaft, power pack (cylinder, head, piston and con rod), main and con rod bearing, accessory and camshaft drive gears, rocker arms, etc.

The differences are:

1) Governor - Railroad has variable speed control, power unit has constant speed control.

2) Turbocharger - The turbine blades and compressor nozzles differ to accommodate variable speed versus constant speed operation. Otherwise, the turbochargers are alike.

3) Injector - The injector tip is different again to accommodate variable speed versus constant speed performances.

Also, see response to RAI 53 for discussion of railroad service experience.

RAI 55

Discuss and analyze the comparative properties of the 4140 Blade Con Rod material of the F4B versus the 1050 material of the E4.

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Response to RAI 55

Our previous letter L-88-454, dated October 19, 1988, should have identified the Blade Con Rod material of the E4 as SAE 1046, not 1056.

A comparison of 4140 and 1046 is as follows:

	SAE 4140H*	SAE 1045** Similar to 1046
Tensile Strength	130,000	110,000
Yield Strength	110,000	80,000
Elongation	20%	18%
Reduction Area	58%	50%

This represents an 18% increase in tensile strength and a 37% increase in yield strength.

*Properties based upon the normal hardness range of 28-32 Rockwell "C".
**Properties based upon 3 inch round material being water quenched and tempered at 24-29 Rockwell "C".

RAI 56

Discuss and analyze the comparative properties of the 1080 Camshaft material of the F4B versus the 5046 material of the E4.

Response to RAI 56

The camshaft material was changed to SAE 1080 to provide increased strength and reliability, and to reduce cam lobe wear. Properties of the 1080 camshaft material are dependent on the type of heat treatment which was not available at the time of this response.

RAI 57

Compare the FA Turbocharger of the F4B versus the E Turbocharger of the E4.

Response to RAI 57

The turbine blade and compressor nozzle geometry of the E Turbocharger differ slightly to accommodate variable speed versus constant speed operation. Otherwise, the turbochargers are alike.

RAI 58

Discuss how the F4B obtains a higher compression ratio than the E4 considering that the piston to head clearance or the stroke has not changed.

Response to RAI 58

The increase in compression ratio is accomplished by a reduction in the volume of the piston bowl, involving a slightly narrower and shallower bowl than that of the E4 piston. Despite the higher firing pressure produced, the temperature

of the piston crown is actually lower than in previous models due to a new crown structure.

The relocation of the piston fire ring from 1-1/4" to 3/4" from the top of the piston also contributes to the increase in compression ratio.

RAI 59

Discuss and analyze the significance of the 1-1/4 Top Piston Ring Location of the E4 versus the 0.75" Fire Ring for the F4B.

Response to RAI 59

The fire ring was located for the following considerations:

1) To contribute to the increase in compression ratio

2) To decrease blow-by into the engine air box which improves performance at light load operation. The higher location of the fire ring results in less combustion gas pressure when the fire ring passes by the cylinder liner ports that open into the air box, as the piston is now further down the stroke. Therefore, less exhaust gas enters the air box. This gives a better charge of air into the combustion chamber enhancing the combustion process.

RAI 60

Provide justification for the fact that the standard EMD components are not built in accordance with ASME Section III Class 3.

Response to RAI 60

The Electro-Motive Division of General Motors (EMD) produces a commercial diesel of a standard design. The purpose of a standard design is to ferret out both design and operational problems early in the life of a model series. The varied applications for railroad, oil rig drilling, marine, off-road vehicles and stationary power service, subjects the basic standard design to all types of operational problems.

The Electro-Motive Division has produced approximately 80,000 model 645 diesels of which approximately 26,000 are in stationary power service. This provides a great depth of experience.

The manufacture of the 645 diesel is performed in compliance with the Electro-Motive Division Quality Assurance Program that includes control of the engineering, production and material control processes.

One of a kind designs sometimes lead to problems which are not discovered until a period of service has passed. Therefore, EMD will avoid producing a "one of a kind" design. Changing design and assembly practices to meet the requirements of ASME Section III, Class 3, would introduce the "one of a kind" concept, which is not recommended by EMD.