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U S Nuclear Regulatory Commission
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Prairie Island Nuclear Generating Plant Units 1 and 2
Dockets 50-282 and 50-306
Renewed License Nos. DPR-42 and DPR-60

Supplement to License Amendment Request (LAR) to Add Diesel Fuel Oil License Bases and Revise Technical Specifications (TS) 3.7.8, "Cooling Water (CL) System" and 3.8.3, "Diesel Fuel Oil" (TAC Nos. ME6849 AND ME6850)

By letter dated August 11, 2011 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML112240140), Northern States Power Company, a Minnesota corporation, doing business as Xcel Energy (hereafter "NSPM"), requested NRC review and approval of additional diesel fuel oil (DFO) license bases and amendments to TS 3.7.8, "Cooling Water (CL) System" and 3.8.3, "Diesel Fuel Oil" for the Prairie Island Nuclear Generating Plant (PINGP), Units 1 and 2. By letter dated January 19, 2012, ADAMS Accession No. ML 120060309, NRC Staff requested additional information (RAI) to support review of the LAR dated August 11, 2011 (ML112240140). The enclosure to this letter provides responses to the NRC Staff RAIs. NSPM submits this supplement in accordance with the provisions of 10 CFR 50.90.

The supplemental information provided in this letter and enclosure does not impact the conclusions of the Determination of No Significant Hazards Consideration or Environmental Assessment presented in the August 11, 2011 (ADAMS Accession No. ML112240140) submittal.

In accordance with 10 CFR 50.91, NSPM is notifying the State of Minnesota of this LAR supplement by transmitting a copy of this letter and enclosure to the designated State Official.

If there are any questions or if additional information is needed, please contact Mr. Dale Vincent, P.E., at 651-388-1121.

Summary of Commitments

This letter contains no new commitments and no revisions to existing commitments.

I declare under penalty of perjury that the foregoing is true and correct.
Executed on FEB 21 2012

Mark A. Schimmel
Site Vice President, Prairie Island Nuclear Generating Plant
Northern States Power Company - Minnesota

Enclosures (1)

cc: Administrator, Region III, USNRC
Project Manager, PINGP, USNRC
Resident Inspector, PINGP, USNRC
State of Minnesota

# ENCLOSURE

Response to Requests for Additional Information (RAIs) for License Amendment Request (LAR) to Add Diesel Fuel Oil License Bases and Revise Technical Specifications (TS) 3.7.8, "Cooling Water (CL) System" and 3.8.3, "Diesel Fuel Oil" (TAC Nos. ME6849 AND ME6850)

This enclosure provides responses from Northern States Power Company, a Minnesota corporation, doing business as Xcel Energy (hereafter "NSPM"), to Nuclear Regulatory Commission (NRC) RAIs provided by letter dated January 19, 2012, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML120060309) regarding the LAR requesting NRC review and approval of additional diesel fuel oil (DFO) license bases and amendments to TS 3.7.8, "Cooling Water (CL) System" and 3.8.3, "Diesel Fuel Oil" for the Prairie Island Nuclear Generating Plant (PINGP), Units 1 and 2.

## NRC RAI EPTB-1:

On Page 20 of the license amendment request (LAR), in the section titled "Regulatory Guide (RG) 1.137, "Fuel-Oil Systems for Standby Diesel Generators," it is stated that NSPM uses American National Standards Institute (ANSI) N195-1976 methodology in determining emergency diesel generator (EDG) fuel oil consumption rates. ANSI N195-1976 does not provide methodology to determine EDG fuel oil consumption rates.

a. Please provide the methodology that was used in determining EDG fuel consumption rates, and provide information as to how ANSI N195-1976 was used in the design of the fuel oil system.

b. If the calculation uses a load dependent method, provide a detailed discussion on how the machine efficiencies were evaluated and validated for the varying load conditions delineated in Updated Safety Analysis Report (USAR) Tables 8.4-1 and 8.4-2.

## NSPM Response to RAI EPTB-1a:

Unit 1 EDGs

The methodology used in determining EDG fuel consumption rates uses the manufacturer's and pre-operational testing records. These test records give the consumption rates (in units of pounds / [brake horsepower * hours]) at various loading conditions. Using this data, the consumption rates are converted to units of gallons-per-hour / kilowatts. The conversion of these consumption rates assumes a minimum density based on a specific gravity of 0.83. This specific gravity is the minimum allowed by ANSI/ANS 59.51-1989, Appendix C. The minimum density is used because it yields a higher consumption rate. These consumption rates are graphed as consumption rate versus load.

When calculating the fuel oil consumption, the consumption rates are chosen based on the loads delineated in USAR Table 8.4-1. The highest consumption rate shown on the graph for the load range between 0 hours to 1 hour is selected as the input into the time based loading capacity calculation for the corresponding loads of the 0 hours to 1 hour timeframe. The highest consumption rate shown on the graph for the load range between 1 hour to 14 days is selected as input into the time based loading capacity calculation for the corresponding load of timeframes greater than 1 hour.

The Unit 1 fuel oil system was designed prior to the existence of ANSI N195-1976 and therefore was not used in the design of the fuel oil system.

Unit 2 EDGs

The methodology used in determining EDG fuel consumption rates uses the manufacturer's testing records. These test records give the consumption rates (in units of grams / [kilowatt * hours]) at various loading conditions. These consumption rates are graphed as consumption rate versus load.

When calculating the fuel oil consumption, a consumption rate is chosen based on the loads delineated in USAR Table 8.4-2 for the timeframe of 1 hour to 14 days. This timeframe corresponds to the minimum loads given in this table. Using a consumption rate based on the minimum load is bounding because consumption rate increases as loading decreases due to decreased EDG operating efficiency at reduced load.

The consumption rate is converted to gallons-per-hour / kilowatts assuming a minimum density based on a specific gravity of 0.83. This specific gravity is the minimum allowed by ANSI/ANS 59.51-1989, Appendix C. The minimum density is used because it yields a higher consumption rate. This consumption rate is used as the consumption rate for all Unit 2 fuel oil capacity calculations.

Additional conservative multipliers are applied to the current Unit 2 consumption calculation. The calculation assumes that the EDGs were tested in the factory at the lowest consumption rate (highest acceptable fuel oil density), but will be assumed to be operating in the plant at the highest consumption rate (lowest acceptable fuel oil density). To account for this assumption, the consumption rate is converted to gallons-per-hour / kilowatts using both the minimum (0.83) and maximum (0.89) specific gravities allowed by ANSI/ANS 59.51-1989, Appendix C; this yields the highest and lowest consumption rates, respectively. The ratio of highest to lowest consumption rate is calculated and is multiplied to all fuel oil capacity calculations to account for potential differences in the manufacturer's tests and plant consumption rates.

Also, a conservative multiplier of 1.3% is currently added to account for potential additional consumption due to Ultra Low Sulfur Diesel as discussed in Information Notice 2006-22.

As submitted by "Prairie Island Nuclear Generating Plant Station Blackout/Electrical Safeguards Upgrade Project Response to November 29, 1991 request for additional information (TAC Nos. M80659/80660)", the Unit 2 fuel oil system was designed to comply with ANSI N195-1976, with the following exceptions:

> Subsection 6.3: There are no duplex (or simplex) fuel strainers on the engine preceding the fuel filters (to preclude clogging). However, there are fuel oil strainers in the transfer lines to the day tanks, and the on-engine filters are duplex so that routing can be switched in case of clogging.
>
> Subsection 7.3: There are no illumination, heating or ventilation provisions in the fuel oil storage tank vault. However, the vault is adequately insulated and instrumentation is provided for monitoring vault temperature.
>
> Subsection 7.4: There are exceptions to piping system compliance with ASME Section III.
>
> Subsection 7.5: There are no strainers in the fill lines for the fuel oil receiving tank. However, received fuel oil is circulated through filters prior to being transferred to the fuel oil storage tanks.
>
> Subsection 7.5: There are no provisions for detecting and removing accumulated water from each fuel oil tank.
>
> *****
>
> The main provision for detecting and removing accumulated water from fuel oil is the bell shaped appendage on the bottom of the fuel oil storage tank ... This appendage will be used for periodic checking of possible water contamination ... and any necessary draining. Each of the day tanks and the receiving tank have drain lines on the bottom of the tanks, which can be used for removing water; but principal controls for water contamination are through the fuel oil storage tanks.

**NSPM Response to RAI EPTB-1b:**

Unit 1 EDGs

The manufacturer's test data provides loads in brake horsepower and the EDG efficiencies at the tested loads. These efficiencies are used to calculate the kilowatt output at which the manufacturer's tests were performed. The pre-operational tests provide the kilowatt output from the EDGs (that is, EDG efficiency already accounted for). The EDG efficiencies given by the manufacturer's test were used in the pre-operational tests to back calculate the loading, in brake horsepower, to be used in the conversion of consumption rates.

Unit 2 EDGs

The manufacturer's test data provides loads in kilowatts (that is, EDG efficiency is already accounted for). Therefore, no efficiencies are reported in the Unit 2 calculation. Also, because the consumption rates are given in grams / [kilowatt * hours], no conversion of consumption rates is required.

For validation of both the Unit 1 and Unit 2 required capacity calculations, the consumption rates used in the calculations were compared with consumption during recent 24-hour surveillance procedure (SP) testing. The volume in gallons consumed during the SP was determined based on tank level indication which is referred to as the "actual volume." Using the consumption rates assumed in the calculations, multiplied by the kilowatt load observed during the SP, a corresponding volume in gallons was calculated which is referred to as the "theoretical volume." The actual volume should be less than the theoretical volume if the consumption rates used in the capacity calculations conservatively represent current EDG operation. This was the case for Unit 2: the theoretical volume was greater than the actual volume.

For Unit 1, the actual volume was greater than the theoretical volume. To account for this difference, the percentage difference between the actual volume and theoretical volume for each Unit 1 EDG was determined. The required fuel oil capacities for both Unit 1 EDGs were increased by a conservatively higher percentage than the largest of the percentage differences between actual and theoretical volumes. By applying the percentage increase to the required fuel oil volumes, the difference in operation of the EDGs between original manufacturer's tests and current operation is conservatively accounted for.

**NRC RAI EPTB-2:**

Please confirm that the conservative method in ANSI N195-1976 was used to calculate the required fuel oil storage capacity. Also, confirm that the fuel oil storage capacity contains an explicit allowance for fuel consumption required by periodic testing, as required by ANSI N195-1976.

**NSPM Response to RAI EPTB-2:**

EDGs

The conservative method in ANSI N195-1976 is not used to calculate the required fuel oil storage capacity for the EDGs. The time-dependent load method given by ANSI N195-1976 is used to calculate the given method.

The fuel oil storage capacity does contain explicit allowance for fuel oil consumption required by periodic testing as required by ANSI N195-1976. The performance of one monthly surveillance procedure is considered in the calculation of the required fuel oil capacity for each fuel oil supply.

Diesel Driven Cooling Water Pumps (DDCLPs)

The ANSI N195-1976 standard applies to emergency diesel generators and thus does not directly apply to the DDCLPs. For the purpose of applying the concept of Technical Specification Task Force traveler (TSTF) -501 to the DDCLP fuel oil volume, a methodology that meets the intent of the conservative calculation of ANSI N195-1976 is currently used. The consumption rate is based on the continuous load rating of the DDCLPs in conjunction with the 7-day supply requirement, but an additional volume for periodic testing of the DDCLPs was not included. In response to this RAI, the calculation for the DDCLPs will be revised to include a periodic testing volume to comply with the intent of the methodology of ANSI N195-1976.

**NRC RAI EPTB-3:**

It is stated on Page 10 of the LAR that, "The 14 day fuel oil supply (FOS) requirement was included in the original TS issued and thus has been the license basis for the FOS volume throughout the operation of the plant. The basis of the 14 day supply is derived from [Final Safety Analysis Report (FSAR)] Section 2.7, "Hydrology", sub-section 2.7.3 which states: "It was estimated that the flood stage would remain above elevation 695 feet [mean sea level (msl)] for approximately 13 days." The period of 14 days bounds the need to supply power for the 13 day duration of the maximum probable flood, after which the FOS can be replenished."

Please explain how the 14-day FOS volume requirement is derived from the flood stage described in FSAR Section 2.7.

**NSPM Response to RAI EPTB-3:**

The original TS proposed for PINGP were included as Chapter 15 of the Final Safety Analysis Report (FSAR). Proposed TS 15.3.7, "Auxiliary Electrical Systems," paragraph A.5 (page 15.3.7-1) stated, "Both diesel generators are operable, and a fuel supply of 35,000 gallons is available in the interconnected storage tanks (seven days supply for one diesel generator at full load)." The associated Bases included the statement, "A minimum of seven days fuel supply assures time to restore offsite power or to replenish fuel."

In Atomic Energy Commission (AEC) review questions dated July 15, 1971, question 2.5 asked:

> Page 2.7-6 of the FSAR indicates that the river flood level for the probable maximum flood would remain above the plant grade elevation for approximately 13 days. Page 15.3.7-1 specifies only a 7-day supply of fuel oil for the emergency diesel generators. Describe the emergency procedure for refilling the tanks during the probable maximum flood.

The AEC cover letter for the questions provided the following guidance for responding to their questions, "You may wish to amend your application by submitting revised pages for the appropriate portions of the Final Safety Analysis Report rather than by submitting separate responses to the question. If so, please provide cross references to those pages." Accordingly, Northern States Power Company (NSP) (the applicant for PINGP) provided the response to the AEC questions as revised FSAR pages. The cross-reference for question 2.5 shows that the answer was provided by FSAR Amendment 11, dated September 20, 1971, page 15.3.7-3 which revised the Bases to state, "The minimum fuel supply of 70,000 gallons will supply one diesel cooling water pump and one diesel generator (loaded per Table 8.4-1) for greater than 14 days. Additional diesel fuel can normally be obtained within a few hours. This assures an adequate supply even in the event of the probable maximum flood." FSAR Amendment 11 also revised proposed TS 15.3.7 paragraph A.5 to state, "Both diesel generators are operable, and a fuel supply of 70,000 gallons is available in the interconnected storage tanks."

The original issuance of the PINGP TS included TS 3.7.A.5 which required, "Both diesel generators are operable, and a fuel supply of 70,000 gallons is available in the interconnected storage tanks for the diesel generators and the cooling water pump diesel engines." The associated Bases provided the basis as:

> The minimum fuel supply of 70,000 gallons will supply one diesel cooling water pump and one diesel generator (loaded per FSAR Table 8.4-1) for greater than 14 days. Additional diesel fuel can normally be obtained within a few hours. This assures an adequate supply even in the event of the probably (*sic*) maximum flood.

Although the plant design was changed due to the addition of two EDGs to power Unit 2 safeguards buses and transferable loads, and the original EDGs were repurposed to supply Unit 1 safeguards buses and transferable loads, the original requirement, and the associated Bases for 70,000 gallons to provide a 14-day supply to one EDG and one cooling water diesel pump, basically remained unchanged until the TS were converted to Improved TS (ITS) format. Pre-ITS TS 3.7.A.5 paragraph (a) stated:

> Unit 1: D1 and D2 diesel generators are OPERABLE, and a fuel supply of 51,000 gallons is available for the D1 and D2 diesel generators in the Unit 1 interconnected diesel fuel oil storage tanks. A total fuel supply of 70,000 gallons is available for the D1 and D2 diesel generators and the diesel-driven cooling water pumps in the Unit 1 interconnected diesel fuel oil storage tanks.

The associated Bases stated:

> The minimum fuel supply of 51,000 gallons will supply on Unit 1 diesel generator for 14 days. Note that the 51,000 gallon requirement is included in the 70,000 gallon total requirement for Unit 1. The total fuel supply of 70,000 gallons will supply one diesel-driven cooling water pump and one Unit 1 diesel generator (loaded per USAR Table 8.4-1) for greater than 14 days. ... Additional diesel fuel can normally be obtained within a few hours. This assures an adequate supply even in the event of the probable maximum flood.

The ITS conversion revised the TS format, relocated the diesel cooling water fuel requirements to the cooling water TS and revised the quantity required to provide a 14-day supply based on revised calculations, but the basic requirement for a 14 day supply to meet the maximum probable flood remained. Thus the 14-day fuel oil supply requirement in TS is derived from the maximum probable flood discussion in FSAR Section 2.7.

**NRC RAI EPTB-4:**

Please provide the acceptable range of American Petroleum Institute (API) gravity for fuel oil shipments that you receive for the FOS. What is the API gravity that is used in the fuel oil storage volume calculation?

**NSPM Response to RAI EPTB-4:**

The current acceptable American Petroleum Institute (API) gravity requirement on new fuel oil is maintained at a minimum of 28 per plant program requirements.

The fuel oil storage volume calculation for Unit 1 and Unit 2 are based on specific gravity at 60/60°F. The minimum and maximum acceptable 60/60°F specific gravity is found from ANSI/AN 59.51 Appendix C, per testing in accordance to ASTM D975-82. (TS 5.5.11 specifies ASTM D975-77.) The minimum and maximum values established in Appendix C are .83 and .89, respectively. The minimum density value of .83 was conservatively used in the storage volume calculations because this relates to a higher consumption rate. This value correlates to an API gravity value of 39 using Attachment A from Crane Technical Paper No. 410, "Flow of Fluids", 25th printing, 1891 Pg. A-7.

**NRC RAI EPTB-5:**

It is stated on Page 17 of the LAR that, "The diesel fuel oil (DFO) program also requires the following quarterly samples of copper corrosion, flash point, cloud point, water and sediment, ash, distillation recovery, end point recovery, saybolt viscosity, gravity (API), sulfur, and [cetane] index for the Unit 2 FOS." Please note if any of these requirements are applicable to the Unit 1 FOS.

**NSPM Response to RAI EPTB-5:**

The quarterly sampling is an additional requirement for Unit 2 based on an engineering change titled, "Sulfur Additive for Diesel Fuel Oil" (Unit 2 only). The engineering change allows for the addition of a sulphur additive, DTBDS (di-tert-Butyl Disulfide), to the Unit 2 diesel fuel oil system. The additional quarterly sampling requirements were established for a two year period to verify that the sulphur additive does not have negative impacts on the stored fuel oil and the sulphur additive remains in solution over long term use. The additive is not approved for use in Unit 1 FOS and therefore, these additional quarterly samples are not applicable to Unit 1. The plant fuel oil program clearly defines the additional requirements as only applicable to the Unit 2 FOS. The recommended two year sampling period for additional testing is complete and the results have not shown adverse affects on the stored diesel fuel oil. NSPM is currently in the process of removing these additional quarterly sampling requirements for Unit 2.

**NRC RAI EPTB-6:**

Reference 7, on page 25 of the LAR, does not provide the revision number of RG 1.137. Please provide the revision number of this RG that is used for this LAR.

**NSPM Response to RAI EPTB-6:**

Revision 1 of Regulatory Guide (RG) 1.137 was used which is consistent with TSTF-501.

**NRC RAI EPTB-7:**

Please discuss whether or not PINGP is currently using Ultra Low Sulfur Diesel (ULSD) fuel.

**NSPM Response to RAI EPTB-7:**

The diesel fuel oil supplier for PINGP performed their facility modifications to produce ULSD fuel prior to the Environmental Protection Agency June 1, 2006 deadline. PINGP received the first shipments of ULSD (sulphur concentration <15 ppm) fuel oil in May 2007. All subsequent shipments have met ULSD fuel requirements. Unit 1 fuel oil system sulphur levels have decreased over the years as the inventory has been consumed and replaced with ULSD fuel. Currently a sulphur additive is being added to the Unit 2 fuel oil system to maintain higher sulphur levels than what is defined as ULSD in accordance with the engineering change discussed in response to RAI EPTB-5 above.

**NRC RAI EPTB-8:**

Are the FOS values that are currently in the TSs and the diesel generator manufacturer's fuel consumption values based on ULSD fuel? If not, what type of fuel are they based on?

**NSPM Response to RAI EPTB-8:**

No, the FOS values that are currently in the TSs and the diesel generator manufacturer's fuel consumption values are not based on ULSD fuel. The values currently in TSs are based on the manufacturer's fuel consumption values which were determined prior to the availability of ULSD fuel. The fuel consumption values were based on the energy content of standard Number 2 diesel fuel oil.

**NRC RAI EEEB-1:**

The LAR states that six Design Class I fuel oil storage tanks supply fuel oil to the two Unit 1 EDGs (D1/D2) and the two diesel driven cooling water pumps (DDCLPs). Each tank is equipped with a transfer pump to pump fuel from the tank to the nominal capacity 500 gallon day tank of either EDG or either DDCLP. The six tanks are interconnected such that any tank can be manually aligned to supply any diesel day tank and any combination of the six tanks can be used to meet the 14 day storage capacity requirement for a probable maximum flood. Please provide the following information:

a) A flow diagram depicting the interties between the tanks and EDGs D1/D2 and the two DDCLPs, including valves that are required to operate for aligning the tanks. Identify the normal alignment required to satisfy TS requirements.
b) Identify tanks and components that may be unavailable during routine and major maintenance activities and associated limiting conditions for operation (LCOs) that are applicable during the maintenance activities.
c) Provide a detailed discussion on the power sources for each of the components required to align the fuel oil system for 14 day operation.
d) Identify and provide a detailed discussion on the procedures that are used to validate each of the paths required to transfer fuel for 14 day operation of the EDGs and the DDCLPs.

**NSPM Response to RAI EEEB-1a:**

See Attachment 1 to this Enclosure, flow diagram NF-39232, "Flow Diagram Fuel & Diesel System Unit 1 & 2", Revision 80. The normal flow path to satisfy TS requirements (provided as drawing equipment and pipe designations) follows:

D1 EDG (Two tanks available)

- 121 DSL GEN OIL STG TNK(053-221)→045-271(pump)→1½-FO-20→FO-2-12→2½-FO-20→2-FO-20→ 2½-FO-20→FO-2-10→2½-FO-28→D1 Day Tank
- 122 DSL GEN OIL STG TNK(053-222)→045-272(pump)→1½-FO-22→FO-2-13→2½-FO-22→2-FO-22→ 2½-FO-22→FO-2-9→2½-FO-28→D1 Day Tank

D2 EDG (Two tanks available)

- 123 DSL GEN OIL STG TNK(053-223)→045-273(pump)→1½-FO-24→FO-2-14→2½-FO-24→2-FO-24→ 2½-FO-24→FO-2-4→2½-FO-29→D2 Day Tank
- 124 DSL GEN OIL STG TNK(053-224)→045-274(pump)→1½-FO-26→FO-2-15→2½-FO-26→2-FO-26→ 2½-FO-26→FO-2-3→2½-FO-29→D2 Day Tank

12 DDCLP (One tank available)

- 121 DSL CLWP OIL STG TNK (053-251)→045-301(pump)→1½"→FO-13-1→ 2½-FO-35→FO-13-6→ 2½-FO-35→FO-13-8→2½-FO-35→12 DDCLP Day Tank

22 DDCLP (One tank available)

- 122 DSL CLWP OIL STG TNK (053-252)→045-302(pump)→1½"→FO-13-2→ 2½-FO-36→FO-13-7→ 2½-FO-36→FO-13-9→2½-FO-36→22 DDCLP Day Tank

**NSPM Response to RAI EEEB-1b:**

Current Tech Specs (without consideration of the current administrative controls)

The basis for the current fuel oil TS is a 14 day supply without consideration for a single failure. The diesel fuel oil system on Unit 1 is shared between the EDGs and DDCLPs. Therefore, the 14 day FOS requirement can be met by any of the 6 tanks available by taking credit for cross train volumes. Prior to removing a storage pump or tank from service, margin was maintained in the other operable tanks, by transferring fuel if necessary, to still meet TS requirements. Thus, a TS Condition for an LCO not met was usually not entered during online maintenance. If the FOS volume did drop below 14 days supply, the plant would have 48 hours (TS 3.8.3 Condition A or TS 3.7.8 Condition D) to restore FOS if there was still between 12 and 14 days supply of fuel available (TS 3.8.3 condition A or TS 3.7.8 condition D). If the FOS dropped below 12 days supply then both trains of either EDGs or DDCLPs would be declared inoperable (TS 3.8.3

condition D or TS 3.7.8 condition E). The plant would then enter TS 3.8.1 Condition E for two EDGs inoperable and would have 2 hours to restore one EDG before required plant shut down. The plant would enter TS 3.7.8 Condition A for two DDCLPs inoperable if the motor driven cooling water pump were operable which would allow 7 days to restore one DDCLP to operable status.

TS Proposed by this LAR

The TS change proposed in this LAR establishes a 7 day FOS requirement per train to protect against single failure as shown in Attachments 1 and 3 to the Enclosure with the submittal dated August 11, 2011 (ADAMS Accession No. ML112240140). If the transfer pump for the 121 Diesel Generator Oil Storage Tank (053-221) was removed from service, that tank volume would be unavailable. If the associated EDG (D1) volume is maintained between a 6 day and 7 day supply, the plant would have 48 hours to restore the FOS (proposed TS 3.8.3 Condition A). If the volume dropped below 6 days then the associated EDG would enter TS 3.8.3 Condition D and LCO 3.8.1 condition B for the inoperable EDG. The proposed TS requirements allow for separate EDG and DDCLP Condition entry instead of declaring both trains inoperable immediately. The new volume requirements are more restrictive on removing a tank from service. There is currently not enough volume in the remaining operable tanks to remove a tank or pump from service without entering a Condition for an LCO not met under the proposed TS based on tank volumes and the new train separation requirements. If the proposed TS are approved by the NRC, storage tank and pump maintenance will have to be planned for performance during refueling outages to avoid entry into a Condition for an LCO not met. However, the new 7 day train requirements will maintain a safer fuel oil storage configuration to protect the plant during a DBA.

**NSPM Response to RAI EEEB-1c:**

EDG fuel oil transfer pumps 121 and 122, “DSL GEN FOST XFER PUMPS” (045-271 and 045-272), receive control and supply power from “A” train 480V safeguards Bus 111, on Unit 1 4kV Bus 15. EDG fuel oil transfer pumps 123 and 124, “DSL GEN FOST XFER PUMPS” (045-273 and 045-274), receive control and supply power from “B” train 480V safeguards Bus 121, on Unit 1 4kV Bus 16.

DDCLP fuel oil transfer pump 121, “DSL CLG WTR PMP OIL STG TNK PMP” (045-301), receives control and supply power from motor control center (MCC) 1AB1 which can be fed from either 480V Bus 111, on Unit 1 4kV Bus 15, or 480V Bus 211, on Unit 2 4kV Bus 25. The normal power supply for MCC 1AB1 is Bus 111. DDCLP fuel oil transfer pump 122, “DSL CLG WTR PMP OIL STG TNK PMP” (045-302), receives control and supply power from MCC 1AB2 which can be fed from either 480V Bus 121, on Unit 1 4kV Bus 16, or 480V Bus 221, on Unit 2 4kV Bus 26. The normal power supply for MCC 1AB2 is Bus 121.

The requirements for the 14 day operation can be satisfied by either train of EDGs and DDCLP. Therefore, the normal alignment will satisfy the 14 day loading requirements with the availability of the transfer pumps. If a diesel was out of service for maintenance during the external event, fuel can be transferred between storage tanks, through manual valve lineups, as needed.

**NSPM Response to RAI EEEB-1d:**

There are currently procedures in place to transfer fuel oil from a specified storage tank to another storage tank in the Unit 1 FOS system. The fuel is transferred through a filter house that is also used during recirculation of a fuel oil tank (to provide fuel oil filtering). The DDCLP day tanks have one associated storage tank and pump available during normal operation. If a DDCLP day tank and associated storage tank are low on fuel, Abnormal Operating Procedures (AOPs) are in place to fill the associated day tank from another storage tank when the low level alarm is received. The Unit 1 EDGs have two associated tanks and pumps available during normal operation. If the day tank and both storage tanks associated with an EDG were low on fuel, the loads could be swapped to the other available EDG. The Unit 1 fuel oil system has the capability to transfer fuel from any storage tank to any day tank as defined in the USAR. However, procedures are not in place to cover the many different scenarios for transferring fuel during a 14 day flooding event. The transfer paths will be dependent on the equipment operating and fuel oil levels in the various tanks. The flow diagrams would be utilized to perform actions not covered under established procedures or AOPs. These actions would not be outside the bounds of the Unit 1 FOS system design function.

**NRC RAI EEEB-2:**

The current TS SR 3.8.3.1 has the following requirement: Unit 1 ≥ 42,000 gallons and Unit 2 ≥ 75,000 gallons of fuel oil. Provide the original calculation that supports the volume requirement and establishes the basis for this volume, including details on loads (rating, duration of operation, etc).

**NSPM Response to RAI EEEB-2:**

The current TS SR 3.8.3.1 requirements were implemented with approval of the ITS. At that time, revisions to the fuel oil volume calculations were completed to provide the basis for the values used in the ITS. These calculations are included as the following attachments to this enclosure:

Attachment 2: ENG-ME-020, Revision 1, "D1/D2 and DDCLP Fuel Oil Storage Capacity"

Attachment 3: ENG-ME-066, Revision 2, "D5/D6 Fuel Oil Storage Requirements"

Attachment 4: ENG-ME-066, Revision 1, "D5/D6 Fuel Oil Storage Requirements"

Attachment 5: ENG-ME-066, Revision 0, "Determination of D5/D6 Fuel Oil Storage Requirements"

Attachment 2 provides the calculation for the Unit 1 EDG fuel oil volume. Attachment 3 provides the calculation for the Unit 2 EDG fuel oil volume. Attachments 4 and 5 are included because Revision 2 of the calculation references Revision 0 and Revision 1 for the calculation methodology, assumptions, and design inputs.

**NRC RAI EEEB-3:**

The LAR states that the FOS volume equivalent to 14 days and the EDG and DDCLP consumption rates were calculated using the EDG loading as stated in USAR Revision 31, Tables 8.4-1 and 8.4-2. These Tables are entitled "EMERGENCY DIESEL GENERATOR LOADING DURING UNIT 1 (2) **LOCA/DBA COINCIDENT WITH LOOP UNIT 1 (2) (TRAIN B (A))"** (emphasis added) and provide loading criteria for 14 day operation of the EDGs, indicating that PINGP was licensed for a 14 day fuel oil requirement for LOCA/DBA coincident with LOOP. The LAR is proposing to replace the current TS requirement to maintain a 14 day FOS with the requirement to maintain a 7 day FOS for loss of coolant accident (LOCA)/design basis accident (DBA) mitigation.

a) Explain the differences between the USAR basis and the LAR basis.
b) Explain why the single failure criteria, as identified in Atomic Energy Commission (AEC) General Design Criteria (GDC) 21 "Single Failure Definition" and GDC 39 "Emergency Power for Engineered Safety Features" are not applicable to the licensing basis, as implied by the USAR Tables.

**NSPM Response to RAI EEEB-3:**

USAR Table 8.4-1 was used in the diesel fuel oil volume calculations because this table provides a convenient, conservative, pre-defined time dependent EDG loading. Use of USAR Table 8.4-1 was not intended to imply an association of a design basis accident coincident with an external flood. This is demonstrated in original plant licensing when FSAR Table 8.4-1 was used as the alternate loading input for determining EDG fuel consumption during external flooding. FSAR Section 2.7.3, page 2.7-8b (Amendment 22, 9/8/72) states:

> The design minimum supply of emergency diesel fuel oil (Figure 8.4-1, two Class I tanks unavailable) is 70,000 gallons for one emergency diesel set running at full load (3000 KW) for 11 days. It should also be noted 70,000 gallons will supply one diesel cooling water pump and one diesel generator (loaded per Table 8.4-1) for greater than 14 days. If flood stage above 691.5 feet is forecast, this Class I supply would be brought to maximum capacity of 105,000 gallons (all six tanks available).

A single active failure is required to be met during a design basis accident such as a loss of coolant accident (LOCA). However, a clearly defined LOCA time period does not exist for PINGP. The EDG loading from Table 8.4-1 of the USAR envelopes the 14 day period required for the most limiting external flood. The LOCA loading was conservatively used for the flooding event, but does not result in a 14 day LOCA requirement. USAR Section 2.4.3.5 for floods shows the 14 day relation to a flood condition:

> As discussed in Section 10.3.13, any combination of four of six Unit 1 Design Class I fuel oil storage tanks and any combination of three of four Unit 2 Design Class I fuel oil storage tanks will allow operation of one safety related Unit 1 emergency diesel generator, D1 or D2; one Unit 2 emergency diesel generator, D5 or D6; and one diesel driven cooling water pump, 12 or 22, for 14 days. This is longer than the 13 days that the river flood level for the probable maximum flood will remain above the plant grade elevation.

In response to Technical Interface Agreement (TIA) question 2001-10, the NRC concludes that PINGP is not designed to meet single failure criteria for external events. The TIA memorandum includes the following from the staff evaluation under original licensing basis:

> A review of the FSAR description of applicability of the 1967 AEC GDCs to the plant and a review of the specific FSAR sections pertaining to the electrical power system did not reveal that the emergency AC power system is required to meet single failure criteria coincident with external events.
>
> The staff's safety evaluation for PINGP was issued September 28, 1972, supplemented March 21, April 30, and May 31, 1973. As with the FSAR, the safety evaluation treats the single failure criteria separately from criteria related to protection against environmental effects. The staff reviewed the electrical power system with respect to compliance with single failure criteria in Chapter 8 of the safety evaluation. Except for noting the seismic classification of the structures housing the EDGs, external events were not mentioned in this part of the review. The staff made separate findings regarding protection against environmental effects. The staff's safety evaluation did not indicate that the emergency AC power system is required to meet single failure criteria coincident with external events.
>
> In summary, neither the GDCs, the FSAR, or the staff's September 28, 1972, safety evaluation, specify that the emergency AC power system is required to meet single failure criteria coincident with an external event.

In addition, the Unit 1 fuel oil system was not designed for a 14 day supply with single failure. The USAR describes a minimum fuel oil storage capacity to supply one EDG, D1 or D2, operating at the loads stated in Table 8.4-1 plus one DDCLP for 14 days. This shows the possibility of cross train capability and does not imply train separation for single failure. The USAR also describes that the 14 day FOS can be maintained in any (emphasis added) combination of four (4) of the six (6) storage tanks to meet the storage requirements. The tanks are not sized to handle a 14 day fuel oil supply for each train.

The proposed LAR basis describes the train separation for the 7 day fuel oil supply requirement under SR 3.8.3.1. The 7 day supply will be maintained for each diesel and the quantity can be cross-tied between the associated train tanks. There is not currently a TS requirement for 7 days for Unit 1 and therefore, the USAR does not have the details of the new train separation requirements. However, approval of the LAR under process will modify the USAR sections to align with the new TS basis. Also, the 14 day supply for the external event will remain in the USAR and the requirements to meet this supply requirement will be further defined. The 7 day and 14 day requirements will have clear definition in the USAR along with alignment of the new LAR TS Bases.

## NRC RAI EEEB-4:

USAR Tables 8.4-1 and 8.4-2 indicate that the load for Unit 1 Train B EDG decreases from 2447 kilowatts (kW) to 1525 kW within one hour and the Unit 2 Train A EDG load decreases from 3720 kW to 2509 kW within one hour. The loading remains steady for one hour to 14 days. Provide the following details:

a) Excerpts from the accident analyses that support the decrease in loads required to mitigate the consequences of the worst case accident from the EDG loading perspective.
b) Excerpts from plant procedures that allow plant operators to decrease EDG loading within one hour.
c) Manual actions that control the addition of desirable non-safety related loads such as air compressors.

## NSPM Response to RAI EEEB-4a:

Clarifying note 1: The question states that the loading remains steady for one hour to 14 days, however, as noted in footnotes 3 and 6 to USAR Tables 8.4-1 and 8.4-2 respectively, this is the peak load for the period, not a steady load.

Clarifying note 2: The question quotes USAR Table 8.4-1 and 8.4-2 values that are no longer current USAR values. These values are updated frequently for modifications and updating design considerations. These values are from PINGP calculation ENG-EE-021 Revision 4B. The current revision of this calculation is 5A and information is provided from the current revision in this answer. The current revision of ENG-EE-021, Revision 5A, which has not been incorporated into the USAR yet, will be incorporated into the USAR in accordance with the company procedures and the corrective action program.

The USAR defines the design basis worst case accident from the EDG loading perspective as a large break loss of coolant accident (LBLOCA) concurrent with a loss of offsite power (LOOP) in Section 8.4 as follows:

Per USAR Section 8.4, "Plant Standby Diesel Generator Systems", 8.4.1 Design Basis, "Each Emergency Diesel Generator is sized to start and carry the engineered safety features load required for the Design Basis Accident and concurrent loss of offsite power (LOOP). These loads are outlined in Table 8.4-1, and 8.4-2."

USAR Section 8.4.3, "Performance Analysis: Loss-of-Coolant Accident and Loss of Offsite Power", explains several loading variations and concludes with:

> Situations in which the double ended rupture of a main reactor coolant pipe remains the most severe of all of these accidents in terms of required operation of the engineered safety features system, and thus it is used together with a loss of auxiliary AC power as the basis for determining the requirements of the Emergency Diesel Generator capacity and, with a shutdown on the second unit, for determining the cooling water requirements, as described in Section 10.

The accident analyses do not specify the operating time of loads for EDG loading purposes. The accident analyses do not extend to 14 days. Thus there are no accident analyses that directly support the reduction in EDG loading at any particular time. However, most of the significant load decrease which occurs in the first hour of the LBLOCA/LOOP event is associated with the drain-down of the refueling water storage tank (RWST) which is the water source during the injection phase of LOCA mitigation and the subsequent transfer to the recirculation mode. The transfer to recirculation procedure stops the containment spray (CS) pumps, the residual heat removal (RHR) pumps and the safety injection (SI) pumps and aligns the containment sump as the source of water to the RHR pumps for long term cooling. The LBLOCA analysis is described in USAR Section 14.6. and the subsequent transfer to long term cooling following a LOCA is described in Section 14.10.

USAR Appendix K titled, "Containment Pressure Response to LOCA", provides some details regarding the timing and sequence of events for SI and CS component operation and termination of operation for a double ended break. Reference Table K-26 for minimum safeguards loads (one train) and K-27 for maximum safeguards loads (two trains). Table K-26 shows the longest operating time for an SI pump. Both the minimum (one train) and maximum (both trains) safeguards tables have the same time sequence for CS pump operation.

The tables show the last SI pump stopped at 2,520 seconds or 42 minutes for the minimum safeguards case and the last CS pump stopped at 1,440 seconds or 24 minutes for both cases. Two train operation is bounding for total fuel oil consumption.

PINGP analysis ENG-EE-021, "Diesel Generator Steady State Loading for an SI Event Concurrent with a Loss of Offsite Power (LOOP) for D1, D2, D5 and D6", is the source of the data in USAR Tables 8.4-1 and 8.4-2 as noted in footnotes 3 and 6 to these Tables. The calculation bounds operating conditions for a LBLOCA/LOOP by including loads that may operate during other events that result in an SI and extends to 14 days to bound the flood event. Thus it is a combination of loading for anticipated events that will not occur concurrently.

Unit 2 Train A shows the largest decrease in loads and will be used here to illustrate the decrease in loads following completion of the transfer to recirculation. The battery charger load is also shown to decrease in the ENG-EE-021 calculation, per the 21 DC system load calculation and is included in the table below. The following table lists the one hour reduction in loads required to mitigate the LBLOCA/LOOP event:

| **Component** | **KW** |
|---|---:|
| 21 SI Pump | 631.20 |
| 21 CS Pump | 199.10 |
| 21 RHR Pit Sump Pump | 2.60 |
| 22 Charging Pump | 99.08 |
| 22 Charging Pump Motor Unit Cooler | 0.76 |
| 21 Battery Charger | 37.26 |
| Pressurizer Heaters | 192.00 |
| SUBTOTAL | 1162.00 |
| 2% (of 480V Loads) XFMR losses | 6.63 |
| 3% Cable Losses (all Loads) | 34.86 |
| 2.51% Freq allowance (motor load) | 23.41 |
| **TOTAL** | **1226.90** |

**<u>NSPM Response to RAI EEEB-4b:</u>**

As described above, the majority of the significant load decrease at one hour is due to stopping large pumps taking suction from the RWST (for example, CS, SI and charging pumps) as part of the transfer to recirculation procedure. The emergency operating procedures (EOPs) that direct operations in the double-ended LBLOCA/LOOP event through the transfer to recirculation evolution are:

- 1E-0 [2E-0], "Reactor Trip or Safety Injection" transition to1E-1[2E-1] due to LOCA symptoms,
- 1E-1 [2E-1], "Loss of Reactor or Secondary Coolant", transition to 1ES-1.2 [2ES-1.2] on low RWST level,

- 1ES-1.2 [2ES-1.2], "Transfer to Recirculation", after completion, return to procedure and step in effect which is 1E-1.
- 1E-1 ends by directing operators to consult with the plant engineering staff for evaluation of long term plant status.

The Unit 1 EOP 1ES-1.2, Revision 21, which directs the transfer to recirculation is provided as Attachment 6 to this Enclosure. The Unit 2 AOP 2ES-1.2 is substantially the same and therefore is not provided.

**NSPM Response to RAI EEEB-4c:**

Significant desirable non-safety related loads which are powered from the EDGs are the air compressors, the charging pumps, and the spent fuel pool cooling pumps. A description of the loads and the steps that are included in the EOPs to prompt use or addition of these loads is provided in the following discussion.

The air compressors are rated approximately 79kW and are given a permissive to start at step 5 in the EDG load sequence as described in USAR section 8.4.3 and will automatically start based on low air header pressure. All of these loads and their auxiliaries are conservatively included in all four of their respective EDG load periods as shown on Tables 8.4-1 and 8.4-2 at 100% load per ENG-EE-021 Rev 5A. EOP 1E-0 [2E-0], "Reactor Trip or Safety Injection", Step 21 provides direction to establish instrument air to containment and could include restart of any air compressor if necessary.

The charging pumps are rated approximately 99kW and will not restart automatically during EDG load sequencing because their start signal is manual and does not seal in upon de-energization. These pumps may be manually restarted if conditions allow in many events and are included in ENG-EE-021 for that reason. EOP 1E-0 [2E-0] Steps 23 and 24 provide direction to start one or more charging pumps. In addition EOP 1E-1 [2E-1], "Loss of Reactor or Secondary Coolant", Steps 9 and 10 provide the same direction to start one or more charging pumps. Both procedures include a step prior to starting a pump to check 99kW available capacity if powered by the EDG. These pumps would not be restarted during recirculation mode with an empty RWST.

The spent fuel pool cooling pumps are rated approximately 56kW and will not restart automatically during EDG load sequencing because their start signal is manual and does not seal in upon de-energization. These loads are included in all four of their respective EDG load periods as shown on Tables 8.4-1 and 8.4-2 at 100% load per ENG-EE-021, Rev 5A. EOP 1E-0 [2E-0], Attachment L, "SI Alignment Verification", Step 24 [23] provides direction to establish SFP cooling if it is not already operating.

**NRC RAI EEEB-5:**

The LAR states that the current TS was found to be non-conservative during the 2007 Component Design Basis Inspection (CDBI). It was identified that, if a Unit 1 EDG operates at its upper TS frequency, the EDG load is increased and the DFO consumption rate is increased. The increased consumption rate requires a greater FOS volume to supply the EDG than that specified in TS 3.8.3 Condition A and Condition D. Explain how the change from volume requirements to number of days that the FOS capacity will be available resolves the non-conservatism identified in the 2007 CDBI.

**NSPM Response to RAI EEEB-5:**

The 2007 CDBI concluded that the impacts of operating the Unit 1 EDGs at the limits of the TS 3.8.1 allowed frequency range had not been considered and therefore TS 3.8.1 and TS 3.8.3 are non-conservative. These impacts may include, but are not limited to, reduced pump flow when the pump is supplied power by the EDG, increased load on the EDG and increased diesel fuel oil consumption. This LAR proposes to resolve one facet of the TS non-conservatism by addressing increased fuel oil consumption associated with operation of the EDGs at the upper frequency range limit.

Because of other industry-wide diesel fuel oil considerations, such as transition to low sulphur or ultra low sulphur diesel fuel oil, which may require larger diesel fuel oil supplies and make the TS storage requirements non-conservative, the nuclear industry initiated TSTF-501. The license basis for diesel fuel oil supply is a number of days that the diesel is required to operate until the event is terminated or the diesel fuel oil can be re-supplied. The volume of fuel necessary to fulfill this license basis can be determined with the appropriate inputs using an appropriate methodology.

The premise of TSTF-501 is that licensees can specify the number of days diesel fuel oil supply is required in the TS, calculate the corresponding required volume of fuel oil in accordance with the methodology approved by the TSTF, and specify the required volume in the TS Bases. Rather than specifying, in the TS, the increased fuel oil volume required to address diesel operation at a higher frequency, NSPM proposes to adopt the provisions of TSTF-501: state the required number of days supply in TS; calculate the required fuel oil volumes using the TSTF-501 approved methodologies including consideration for diesel operation at higher frequency; and specify the actual required volumes in TS Bases 3.8.3. Adoption of TSTF-501 will allow fuel oil volumes to be adjusted for future considerations without the need for LARs.

**NRC RAI EEEB-6:**

The LAR discusses the limitations of the current license bases and TS related to single active failure. In the LAR, an example is cited whereby an active failure of bus 111 could result in a FOS of 9,000 gallons for both the DDCLP and the Unit 1 EDG. It is further stated that NSPM has administrative controls in place to protect against this and the other active single failure vulnerabilities discussed in the background section of this LAR. Explain why hardware/structure changes are not required to maintain train separation and to eliminate vulnerabilities associated with single active failures.

**NSPM Response to RAI EEEB-6**

The example cited would result in the loss of the two fuel oil transfer pumps and the loss of the fuel oil supply from two storage tanks on Unit 1. The normal supply for the DDCLP transfer pump is also from the same Bus. Operator action would be required to restore power to the DDCLP transfer pump from Unit 2. The restoration of the DDCLP fuel oil supply would still not leave adequate FO supply for 7 days to envelope a LOCA event. This single failure example has to do with the volume of fuel oil supply between the storage tanks and not with hardware or structure deficiencies. Administrative controls have been implemented to maintain a minimum 7 day supply in each train to protect against a single active failure with a "train" defined as one EDG and one DDCLP. The 7 day volume of fuel oil in each train will keep one train available in the case of a single active failure. The current administrative controls for a 7 day FO supply per train will be controlled through TS upon approval of the LAR. Subsequently, an action statement will be entered if fuel oil supply drops below the 7 day TS requirement proposed in this LAR.

**NRC RAI STSB-1:**

The LAR states that, "The proposed TS changes revise current requirements to reflect the addition to the license bases, resolve non-conservative emergency diesel generator fuel oil supply volumes, "**incorporate portions of Technical Specification Task Force Traveler 501-A, "Relocate Stored Fuel Oil and Lube Oil Volume Values to Licensee Control" and provide administrative changes to the TS"** [Emphasis added]. Please identify all deviations from the referenced TSTF-501 and provide a brief explanation of the reason(s) for the deviation(s).

**NSPM Response to RAI STSB-1:**

The PINGP current TS (CTS) 3.8.3 differs significantly from the NUREG-1431, "Standard Technical Specifications, Westinghouse Plants", Revision 3 (NUREG-1431), the standard TS NUREG applicable to PINGP. The main differences between NUREG-1431 TS 3.8.3 and CTS 3.8.3 are: 1) CTS requires a single 14-day stored supply whenever one or both EDGs are required to be operable; 2) CTS does not include provisions for lubricating oil or starting air degradation; and 3) the PINGP diesel fuel oil system includes flexibility with multiple tanks which may supply each diesel. Due to the second difference, the title of the CTS 3.8.3 is "Diesel Fuel Oil" as opposed to NUREG-1431 TS 3.8.3 which is entitled, "Diesel Fuel Oil, Lube Oil, and Starting Air."

This LAR proposes compounded changes to the current TS to revise the license bases for the DFO TS and adopt the provisions of TSTF-501 which adds DFO requirements as a number of days supply and relocates actual DFO volumes to the Bases. Due to the proposed license bases changes, the LCO statement and Applicability statement have been revised, and an Actions Table Note for separate Condition entry has been added. The proposed changes to the PINGP CTS are shown in Attachment 1 to the Enclosure to the submittal dated August 11, 2011 (ADAMS Accession No. ML112240140). Specific changes to support the license bases change and adoption of TSTF-501 are discussed as follows:

LCO statement

"~~The~~Each stored diesel generator (DG) fuel oil supply shall be within limits." (Additions shown as double underline, deletions shown as strikethrough)

The CTS differs from NUREG-1431 by specifying that the "supply" shall be within limits. This LAR proposes to replace "Each" with "The" which changes the TS requirement from a single supply to a supply for each EDG. With the proposed changes, the LCO statement is consistent with the requirements of NUREG-1431. TSTF-501 does not make any changes to the LCO statement.

Applicability statement

"When ~~the~~ associated DG~~(s)~~ is required to be OPERABLE." (Additions shown as double underline, deletions shown as strikethrough)

The CTS differs from NUREG-1431 by including "the" prior to "DG" and "(s)" following "DG" which means that the LCO is applicable whenever one or both EDGs are required to be operable. This LAR proposes to replace "the" with "associated" and remove "(s)" which changes the TS to require the supply associated with each EDG to meet the LCO limits when that EDG is required to be operable. With the proposed changes, the Applicability statement is the same as the NUREG-1431 Applicability statement. TSTF-501 does not make any changes to the LCO statement.

Actions Note

"Separate Condition entry is allowed for each stored DG fuel oil supply" (Additions shown as double underline, deletions shown as strikethrough)

Since CTS specifies a single supply which is required for one or both EDGs, separate Condition entry is not applicable and there is no Actions Note. This LAR proposes to include an Actions Note which allows separate Condition entry for each supply. The proposed Note includes "supply" to be consistent with the CTS and proposed LCO statement which requires the "supply" to be within limits.

With the proposed changes, the Actions Note is consistent with the requirements of NUREG-1431. TSTF-501 does not make any changes to the Actions Note.

Actions Table Condition A and associated Required Actions and Completion Time

"A. One or both s~~S~~tored DG fuel oil supply(s) <7 days and >6 days~~: Unit 1 < 42,000 gal and > 36,000 gal; Unit 2 <75,000 gal and >65,000 gal~~." (Additions shown as double underline, deletions shown as strikethrough)

"One or both" is included and "(s)" is added to "supply" to recognize and allow separate Condition entry for the new license bases. The use of "both" rather than "more" as used in NUREG-1431 recognizes that PINGP specifically has only two trains of EDGs. To adopt TSTF-501 provisions, the clause "<7 days and >6 days" is added and the CTS clauses with the specific volumes are deleted. With these proposed changes, the Condition A statement is consistent with TSTF-501, but differs in that the less than (<) and greater than (>) symbols are used and "supply" is used once prior to the number of days. The use of symbols rather than spelling out these inequalities is consistent with ITS conversion guidance TSTF-GG-05-01, "Writer's Guide for Plant-Specific Improved Technical Specifications" Revision 1, August 2010, section 3.3.4 paragraph d. which states, "Widely understood symbols (i.e., Δk/k, %, ft) should be used in tables, figures, and text in place of the words the symbols represent."

"A.1 Restore fuel oil supply to ≥ 7 days~~within limits~~." (Additions shown as double underline, deletions shown as strikethrough)

This LAR proposes to replace "within limits" with "> 7 days" to make the actions clear and consistent with the Condition statement. TSTF-501 does not make any changes to the Required Action statement.

This LAR does not propose changes to the Completion Time which is the same as NUREG-1431 and TSTF-501.

The purpose of the TSTF-501 changes to Condition A is to specify the EDG diesel fuel oil LCO not met requirements in days of supply and delete the specific fuel oil volumes. The changes proposed in this LAR implement the purpose of the TSTF Condition A changes.

NUREG-1431 and TSTF-501 Actions Table Condition B and associated Required Actions and Completion Time

PINGP CTS does not include the lube oil provisions in NUREG-1431 and therefore the changes provided in TSTF-501 are not included.

NUREG-1431 Actions Table Condition C and associated Required Actions and Completion Time

PINGP CTS does not include a Condition for fuel oil particulates not within limits. TSTF-501 did not make any changes to this Condition.

PINGP Actions Table Condition B and associated Required Actions and Completion Time

"B. One or more ~~DG~~ fuel oil tank(s) with stored DG fuel oil properties not within limits~~(s)~~." (Additions shown as double underline, deletions shown as strikethrough)

PINGP CTS includes Condition B for stored diesel fuel oil properties not within limits similar to NUREG-1431 Condition D but specifies a more restrictive Completion Time of 7 days which is consistent with NUREG-1431 Condition C. The significant change to the Condition statement is the addition of "properties" since this word was missing. Also "DG" was relocated within the statement to make it read clearer and "(s)" was replaced with "s" on limits to be consistent with NUREG-1431.

B.1 Restore fuel oil ~~tank(s)~~ properties to within limits~~(s)~~. (Additions shown as double underline, deletions shown as strikethrough)

This LAR proposes to revise the B.1 Required Action to be more accurate and more consistent with NUREG-1431 Required Action D.1.

This LAR does not propose changes to the 7 day Completion Time.

PINGP Actions Table Condition C and associated Required Actions and Completion Time

"C.1 Isolate the associated ~~DG~~ fuel oil tank(s)." (Additions shown as double underline, deletions shown as strikethrough)

Due to the PINGP diesel fuel oil system design which provides flexibility through multiple tanks, the PINGP CTS includes a Condition C for Condition B not met which allows correction of fuel oil properties not met by isolation of one or more tanks. This LAR proposes to remove "DG" to be more accurate. Since this Condition is not included in NUREG-1431, no TSTF-501 changes apply.

## PINGP Actions Table Condition D and associated Required Actions and Completion Time

"D. One or both ~~S~~stored DG fuel oil supply(s) <6 days~~: Unit 1 < 36,000 gal; Unit 2 <65,000 gal~~. OR Required Action and associated Completion Time of Conditions A or C not met." (Additions shown as double underline, deletions shown as strikethrough)

"One or both" is included and "(s)" is added to "supply" to recognize and allow separate Condition entry for the new license bases. The use of "both" rather than "more" as used in NUREG-1431 recognizes that PINGP specifically has only two trains of EDGs. To adopt TSTF-501 provisions, the clause "<6 days" is added and the CTS clauses with the specific volumes are deleted.

"F.1 Declare associated DG~~s~~ inoperable." (Additions shown as double underline, deletions shown as strikethrough)

This LAR proposes to add "associated" and remove "s" from DG to implement the license bases change and provide the appropriated actions due to separate Condition entry for the new license bases.

This LAR does not propose changes to the Completion Time which is the same as NUREG-1431 and TSTF-501.

This Condition and associated Required Actions and Completion Time fulfills the function of and is comparable to NUREG-1431 TS 3.8.3 Condition F, but differs to complement the previous Conditions in CTS TS 3.8.3. NUREG-1431 TS 3.8.3 Condition F does not include specific volume limits and therefore TSTF-501 does not include any changes to this Condition, Required Action or Completion Time.

## Surveillance Requirements

"SR 3.8.3.1 Verify each stored DG fuel oil supply contains ≥7 day supply~~: Unit 1 ≥42,000 gal; and Unit 2 ≥75,000 gal of fuel~~."

This LAR proposes to include "each" to implement the license bases change and require storage of the appropriate quantities of fuel oil. To adopt TSTF-501 provisions, the clause "≥7 day supply" is added and the CTS clauses with the specific volumes are deleted.

TSTF-501 also included changes to NUREG-1431 SR 3.8.3.2 for the inventory of lubricating oil. Since the PINGP CTS 3.8.3 does not include provisions for lubricating oil and does not include a comparable surveillance requirement, these TSTF-501 changes were not included.

This LAR also included, for information only, Bases changes which support the proposed license bases changes and adoption of TSTF-501. Due to the significant differences between NUREG-1431 TS 3.8.3 and CTS 3.8.3 discussed above, the PINGP Bases 3.8.3 also differ significantly from NUREG-1431 Bases 3.8.3. The significant changes and differences from TSTF-501 are discussed briefly as follows:

Background Section

The days of fuel supply is changed to 7 to support the license bases change. TSTF-501 includes a bracketed reference to Regulatory Guide (RG) 1.137 which is not included here, but is rather referenced in SR 3.8.3.1 where it is the basis for calculating the required fuel oil volume.

LCO Section

The 14 days supply is revised to 7 days to support the license bases change and the maximum post loss of coolant accident load demand is stated as the basis for the 7 day supply. The only change provided in TSTF-501 to this section is bracketing of the "7"s.

Applicability Section

This LAR revised the discussion to include "supply" and "associated" and delete "(s)" from DG to support the proposed license bases changes. TSTF-501 does not include any changes to this section.

Action Section

This LAR proposes to include discussion of the Actions Note allowing separate Condition entry to support the proposed license bases changes. The Note includes terminology which is consistent with the PINGP fuel oil storage system and the proposed TS 3.8.3 and is consistent with NUREG-1431.

Required Action A.1 discussion revises 14 day and 12 day supply to 7 day and 6 day supply to support the proposed license bases changes which is the same as NUREG-1431. A sentence is added to state the gallons of fuel oil required to satisfy the 6 day supply requirement which is consistent with, but not the same as, TSTF-501 changes. The PINGP proposed change uses "fuel oil supply" to be consistent with the proposed TS rather than "fuel oil level" used in TSTF-501. TSTF-501 changes to NUREG-1431 Bases 3.8.3 Required Action B.1 are not included since the PINGP CTS does not include separate provisions for lubricating oil requirements not met.

Surveillance Requirements Section

The discussion of SR 3.8.3.1 is revised to refer to 7 days rather than 14 days to support the proposed license bases changes. Four new sentences have been added to the discussion which provide the specific required fuel oil volume, reference RG 1.137 and ANSI N195-1976, and discuss the basis for determining the required fuel oil volume. These new sentences are substantively the same as provided in TSTF-501 except for use of "fuel oil supply" rather than "fuel oil level" to be consistent with the proposed TS terminology. The CTS also includes discussion of the fuel oil system design which is not included in NUREG-1431 Bases 3.8.3 or TSTF-501. This system design discussion is revised to support the license bases changes from a single fuel oil supply for either EDG to two separate fuel oil supplies, one for each EDG.

The TSTF-501 changes to NUREG-1431 Bases SR 3.8.3.2 discussion are not included since the PINGP CTS does not include provisions for lubricating oil.

Reference Section

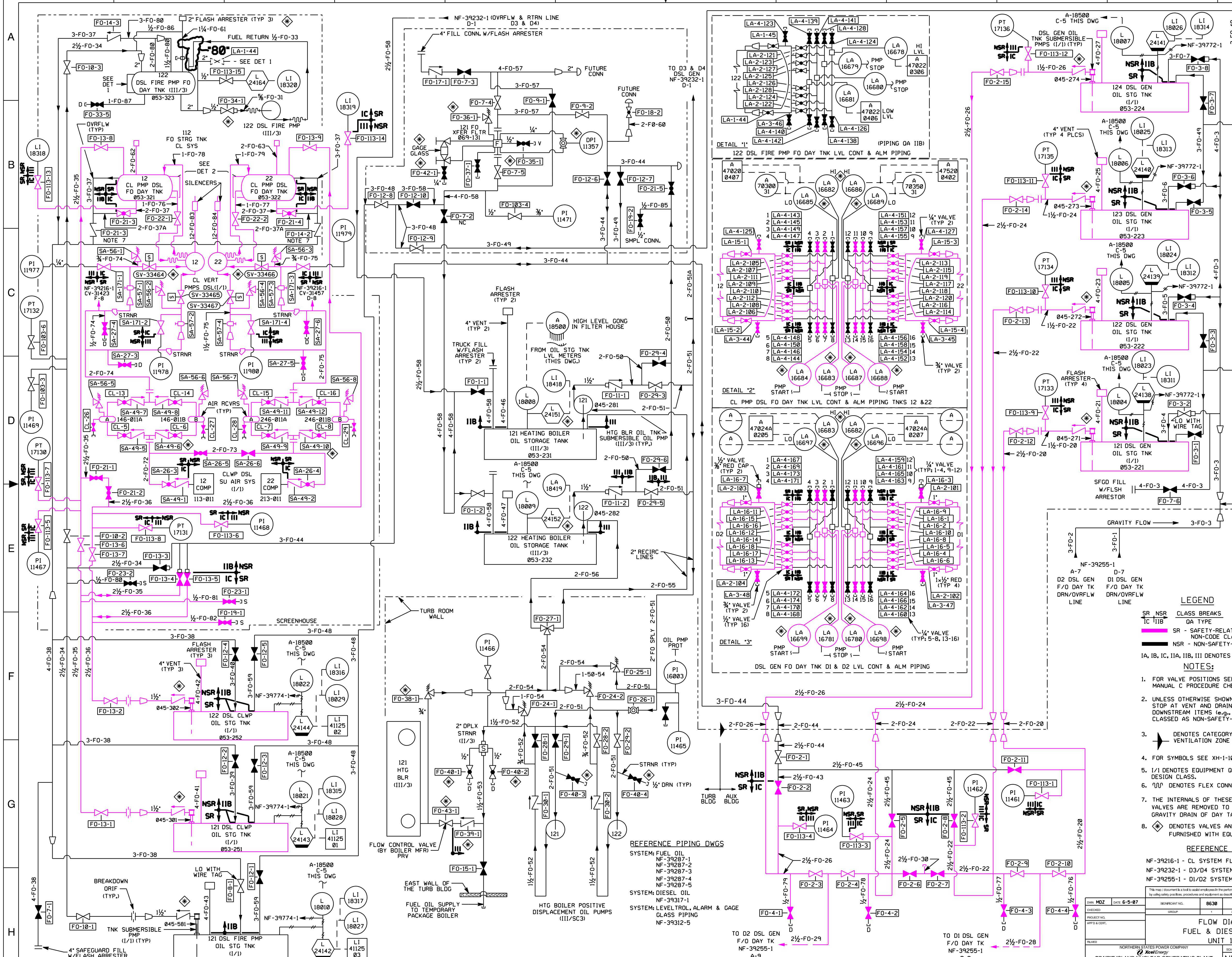
This LAR proposes to add two new references, RG 1.137 and ANSI N195-1976 which is consistent with NUREG-1431 Bases 3.8.3 References section and the TSTF-501 changes.

Enclosure

Attachment 1

NF-39232, “Flow Diagram Fuel & Diesel System Unit 1 & 2”, Revision 80

1 page follows




REVISIONS

AD AS BUILT-
ADD 12/22 DDCLP AIR RECIEVERS VALVE NUMBERS TO DWG.
PER DRR PI-00-108
DWN: ASJ 7/17/00
CHK'D: CMR 8-9-00
MOD#:
FILMED 8-00

AE AS BUILT-
SWITCHED VALVES SA-49-7 & CL-13
PER DRR PI-03-149
DWN: CLN 10/10/03
CHK'D: CMR 10/15/03
MOD#:
FILMED 10/03

76 AS BUILT-
CHANGED FO-26-1 FROM GATE VALVE TO BALL VALVE AND REMOVED MFGR VERBAGE
PER DRR PI-08-079
DWN: DMN 10-8-08
CHK'D: TCS 10-8-08
MOD#: EC-11134
FILMED 10-08

77 AS BUILT
REDRAWN PER SYSTEM WALKDOWN, INCORPORATED SAFETY CLASS DESIGNATIONS.
04NS15
PER DRR PI-09-030
DWN: MDZ 4-18-07
CHK'D: JEK 8-18-09
REVIEWED: WJI 8-18-09
MOD#: EC-13908
FILMED: 9-09

78 AS BUILT-
ADD SAFETY CLASS FLAGS FOR DD CLWP RELATED PIPING & MISC ROOT VLV NOS. 04NS15
PER DRR PI-10-048
DWN: JEK 4-8-10
CHK'D: DB 5-11-10
MOD#: EC-14552
APP'D: CMR 5-12-10

79 AS BUILT-
ADD SAFETY CLASS FLAGS FOR D1/D2 FO DAY TANK LVL CONT & ALM PIPING. 04NS15
PER DRR PI-10-110
DWN: JEK 7-7-10
CHK'D: DB 8-4-10
MOD#: EC-14782
APP'D: CMR 8-5-10

80 AS BUILT-
RELOCATED FUEL RETURN LINE ½-FO-33 CONNECTION AT 122 DSL FIRE PMP FO DAY TANK.
PER DRR PI-10-136
DWN: LAB 9-10-10
CHK'D: DEL 9-10-10
MOD#: EC-15307
APP'D: CMR 9-10-10

## LEGEND

SR NSR / IC IIB — CLASS BREAKS / QA TYPE

SR - SAFETY-RELATED FLUID BOUNDARY; NON-CODE CLASS

NSR - NON-SAFETY-RELATED

IA, IB, IC, IIA, IIB, III DENOTES THE PIPING QA TYPES

## NOTES:

1. FOR VALVE POSITIONS SEE OPS MANUAL C PROCEDURE CHECKLIST.
2. UNLESS OTHERWISE SHOWN, CLASS BOUNDARIES STOP AT VENT AND DRAIN VALVES WITH DOWNSTREAM ITEMS (e.g., PIPE, CAPS, ETC.) CLASSED AS NON-SAFETY-RELATED.
3. DENOTES CATEGORY I VENTILATION ZONE
4. FOR SYMBOLS SEE XH-1-105, NF-39214.
5. I/1 DENOTES EQUIPMENT QA TYPE/ DESIGN CLASS.
6. DENOTES FLEX CONN
7. THE INTERNALS OF THESE CHECK VALVES ARE REMOVED TO ALLOW GRAVITY DRAIN OF DAY TANK
8. DENOTES VALVES AND INSTRUMENTS FURNISHED WITH EQUIPMENT

## REFERENCE DWGS

NF-39216-1 - CL SYSTEM FLOW DIA. UNIT 1 & 2
NF-39232-1 - D3/D4 SYSTEM FLOW DIA. UNIT 1& 2
NF-39255-1 - D1/D2 SYSTEM FLOW DIA. UNIT 1 & 2



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SIGNIFICANT NO. | 8630 | | 400 | 100 | 4410 | 1 | 8700 |
| GROUP | 1 | 2 | 3 | 4 | 5 | CL | 6 |

DWN MDZ DATE 6-5-07
CHECKED
PROJECT NO.
APP'D & CERT.
FILMED

# FLOW DIAGRAM
# FUEL & DIESEL SYSTEM
# UNIT 1 & 2

NORTHERN STATES POWER COMPANY
Xcel Energy
PRAIRIE ISLAND NUCLEAR GENERATING PLANT
RED WING, MINNESOTA

SCALE NONE REV 80

NF-39232

$$USERNAME$$
$$$$$$SYTIME$$$$$$$$$$$$SYDATE$$$$$$
$$$$$$$$$DESIGNFIL$$$$$$$$$

NF-39232.DGN NSP GENERATION CAD

NF-39232

Enclosure

Attachment 2

ENG-ME-020, Revision 1, "D1/D2 and DDCLP Fuel Oil Storage Capacity"

24 pages follow

U000313001

PINGP 1083, Rev. 2
Page 1 of 1 (FRONT)
Retention: Life

# NORTHERN STATES POWER COMPANY

## PRAIRIE ISLAND NUCLEAR GENERATING PLANT

## CALCULATION COVER SHEET

Calculation Number: ENG-ME-020

Calculation Rev. No.: 1 Addenda No.: n/a

Calculation Title: D1/D2 and DDCLP Fuel Oil Storage Capacity

Safety Related?: yes

Calculation Verification Method (Check One):

☒ Design Review ☐ Alternate Calculation ☐ Qualification Testing

Scope of Revision:

1.Updated to reflect changes in D1/D2 loading,

2.Added 12 day quantities,

~~3.EDG loading reflects design change 98EB02~~

Documentation of Reviews and Approvals:

Originated By: M A Thompson (Maria Thompson) Date: 2-28-00

Checked By: Robert L Cole (Robert L.Cole) Date: 2-28-00

Verified By: Robert L Cole Printed Name: Robert L.Cole Date: 2-28-00

Approved By: [signature] Date: 2-28-2000

Document5

1/24

## CALCULATION VERIFICATION CHECKLIST

**Calculation No.:** ENG-ME-020 **Revision No.:** 1

**Use of Computer for Calculation**

- [X] Manual Calculation (no computer results)
- [ ] Computer
  - [ ] Verified Program (Reference ________ Provides Verification)
  - [ ] Unverified Program (Verification of Results Required)

| Verification Item * (Refer to Site Engineering Manual, Administrative Standard 1.2.3) | Initials/Date |
|---|---|
| **1.0 Purpose**<br>• Clear objective and problem statement.<br>• Identification of affected structure, system, and/or component.<br>• Identification of the intended use of the calculation results.<br>• Identification of summary results. | [signature] / 2/28/00 |
| **1.0 Methodology**<br>• Discussion of the method/approach and major steps.<br>• Definition of any limitations of methodology. | [signature] / 2/28/00 |
| **1.0 Acceptance Criteria**<br>• Clear definition of the acceptance criteria.<br>• Exceptions clearly defined. | [signature] / 2/28/00 |
| **1.0 Assumptions**<br>• Sufficient rationale to permit verification of assumption.<br>• Unverified assumptions identified as such.<br>• References provided for assumptions. | [signature] / 2/28/00 |
| **1.0 Design Inputs**<br>• All applicable design inputs identified.<br>– CODES, (ASME, CFR, STATE, etc.)<br>– STANDARDS (IEEE, ANSI, ANS, ASTM, etc.)<br>– USAR<br>– Design Criteria<br>– Input Data<br>– Regulatory Guides/Requirements (NRC, EPA, STATE, etc.)<br>– Design Bases Documents<br>• Appropriate verification of walkdown information. | [signature] / 2/28/00 |

**CALCULATION VERIFICATION CHECKLIST**
**(Continued)**

**Verification Item**

**6.0 Calculations**

- Correct formulas/methods selected to support the problem statement and objective.
- Formula variables clearly labeled (including engineering units) and consistent with source references.
- Review of computer program data input/output.
- Reference provided, as appropriate, for sketches.
- Sufficient bases/rational provided to permit verification of engineering judgment.

[signature] / 2/28/00

**6.0 Conclusions**

- Clear statement of the calculation results and consistency with the problem statement and objective.
- Acceptability of the results clearly defined.
- Recommendations for unacceptable results, provided, if applicable.
- Clear definition of limitations or requirements imposed by the calculation necessary to maintain the validity of the results.

[signature] / 2/28/00

**6.0 References**

- All pages of the attachments labeled with appropriate information (attachment no., project calculation no., revision no., number of sheets (Sht __ of __)).

[signature] / 2/28/00

**6.0 Verification Disciplines**

- Design/Calculation verifier proficient in discipline of verification. Multi-discipline verification obtained if needed.

[signature] / 2/28/00

**6.0 Administrative**

- Calculation prepared neat and legibly with sufficient contrast to allow satisfactory copies to be produced.
- Calculation number/revision and sheet number provided on each page.
- Revision block and revision bars completed for revised calcs.
- All attachments provided are included in page numbering.
- Calculation's name and subject appropriately identified.
- Calculation properly logged in the Site Analysis Index.
- Analysis of Record form completed (PINGP 1075).

[signature] / 2/28/00

## 1.0 Purpose

The purpose of this calculation is to document the required fuel oil storage capacity for the D1 and D2 emergency diesel generators (EDG) and the diesel driven cooling water pumps (DDCLP). This calculation will verify that the fuel oil capacities required by the Technical Specifications [Reference 1] for Unit 1 are sufficient to supply Unit 1 loads for greater than 14 days as specified in the USAR and Technical Specification bases. This calculation will also document the required minimum capacity for the proposed standard Technical Specifications condition statements. This calculation does not address the fuel storage capacity requirements for the D5/D6 EDG's.

## 2.0 Methodology

The calculation will determine fuel consumption rates for D1/D2 EDGs and a DDCLP using load profiles established for D1/D2 in USAR Table 8.4-1 following the update for modification 98EB02. The EDG and DDCLP fuel consumption rates will be integrated over a 14-day period and compared with the USAR and Technical Specification required capacities to ensure an adequate supply is maintained in the event of the probable maximum flood. 12-day supply quantities for the EDGs and the DDCLPs are also calculated for use in the new standard Technical Specifications.

## 3.0 Acceptance Criteria

The USAR and Tech Specs list several fuel oil storage requirements. These sources conflict and are inconsistent with the previous results of this calculation. These inconsistencies are being corrected under NRC 19993202. With regard to Unit 1, the following statements exist:

USAR Section 2.4 provides:

> The Unit 1 design minimum storage capacity of diesel fuel oil is based on one diesel generator operating at the loads stated in Table 8.4-1 plus one diesel driven cooling water pump for 14 days. Under these conditions one diesel generator would require approximately 40,100 gallons of fuel oil and the diesel driven cooling water pump would require approximately 19,500 gallons. Each diesel has a 500-gallon day tank. In addition to the day tanks there are four Class 1 fuel storage tanks (19,500 nominal, 17,500 available gallons each) for the diesel driven cooling water pumps. The six Class 1 tanks are interconnected such that any tank can be manually aligned to supply any diesel day tank. Therefore any combination of four tanks will meet the storage capacity requirements. The Unit 1 Class 1 fuel oil storage tanks can also be refilled from either of the two non-Class 1 heating boiler fuel oil storage tanks (35,000 nominal gallons each).

T.S.3.3.D.1.d. provides:

d. A fuel oil supply of 19,000 gallons is available for the diesel-driven cooling water pumps in the interconnected Unit 1-diesel fuel oil storage tanks. Note that the 19,000-gallon requirement is included in the 70,000-gallon total diesel fuel oil requirement of specification 3.7.A.5 for Unit 1.

T.S.B.3.3 provides:

The minimum fuel supply of 19,000 gallons will supply one diesel-driven cooling water pump for 14 days. Note that the 19,000-gallon requirement is included in the 70,000-gallon total diesel fuel oil requirement of specification 3.7.A.5 for Unit 1.

T.S.3.7.A.5 provides:

5. The following unit specific conditions apply:

(a) Unit 1: D1 and D2 diesel generators are OPERABLE, and a fuel supply of 51,000 gallons is available for the D1 and D2 diesel generators in the Unit 1 interconnected diesel fuel oil storage tanks. A total fuel supply of 70,000 gallons is available for the D1 and D2 diesel generators and the diesel-driven cooling water pumps in the Unit 1 interconnected diesel fuel oil storage tanks.

T.S.B.3.7 provides:

The minimum fuel supply of 51,000 gallons will supply one Unit 1 diesel generator for 14 days. Note that the 51,000-gallon requirement is included in the 70,000-gallon total requirement for Unit 1. The total fuel supply of 70,000 gallons will supply one diesel-driven cooling water pump and one Unit 1 diesel generator (loaded per USAR Table 8.4-1) for greater than 14 days

In summary, the acceptance criteria will be that the total fuel supply in Tech Specs of 70,000 gallons must supply one DDCLP and one Unit 1 EDG (loaded per USAR Table 8.4-1) for greater than 14 days. The details of how that fuel is allotted between components will be corrected by NCR 19993202.

**4.0 Assumptions:**

1. Fuel oil density conservatively assumed to be the minimum allowed by ASTM D975-82 [Reference 3] (referenced by ANSI/ANS 59.51-1989 [Reference 4]) which specifies a minimum absolute specific gravity at 60/60 F of 0.83. This corresponds to a density of 6.91 lb./gal.

2. Fuel consumption data obtained from testing can be converted to gallons per hour per kilowatt (gph/kW). The gph/kW are plotted in Figure 1 with best-fit curves applied. These curves can be interpolated and extrapolated to other load values to obtain fuel consumption rates at these values.

3. The DDCLP fuel rate is constant at 55.7 gph as given in the August 1971 Quality Assurance Inspection Report's data on the performance test [Reference 5].

4. No allowance for fuel consumed during periodic testing is included since the amount is minuscule compared to the storage capacity requirements and since the existing storage capacity margins are shown to be substantial.

5. Any 7-day fuel capacity requirements are necessarily met if the 14-day capacity requirements of this calculation are met.

Any other assumptions used are as stated in the calculation.

## 5.0 Design Inputs

1. Fuel oil consumption rates are given in the following documents (and tabulated in Table 1):

   a) D1 manufacturer test record for testing performed 9/17/70 – 10/13/70 [Reference 6].

   b) D2 manufacturer test record for testing performed 10/13/70 – 10/23/70 [Reference 6].

   c) D1 Pre-operational Test No. 20.1 [Reference 7].

   d) D2 Pre-operational Test No. 20.2 [Reference 7].

   e) DDCLP Quality Assurance Inspection Report [Reference 5].

2. D1/D2 loading profiles are as given in NSP calculation ENG-EE-021 [Reference 9]. The D2 loading profile will be used since it is more limiting than the D1 profile due to D2 being more heavily loaded.

## 6.0 Calculation:

The calculation consists of two parts. The first part determines the fuel oil consumed by a DDCLP. The second part determines the fuel oil consumed by D1 or D2.

### I. DDCLP Consumption:

#### A. 14 day consumption:

Data from [Reference 5] document that the DDCLP's consumed 55.6 gph and 55.7 gph for engines 35B554 and 35B556 respectively at full load. This testing was performed with fuel oil with an API value of 32.6

An API of 32.6 corresponds to a density of 7.18 lb/gal per [Reference 8].

To determine the fuel rate at the minimum allowable density of 6.91 lb/gal, the test data is corrected as follows:

Fuel Rate = (55.7 gph)(7.18 lb/gal) / (6.91 lb/gal)

= 57.9 gph

The total 14-day consumption is then

(57.9 gph)(14 days)(24 hr/day)

= 19,454 gallons

#### B. 12 day consumption:

The total 12-day consumption is then

(57,9 gph)(12 days)(24 hr/day)

= 16,675 gallons

### II. D1/D2 Consumption:

#### A. 14 day consumption:

Fuel rates obtained from the various sources are shown in Table 1. Gph values are conservatively based on a fuel oil density of 6.91 lb/gal. The values of gph/kW versus kW load are plotted in Figure 1. The values of gph/kW tend to decrease with increasing load since auxiliary loads remain essentially fixed for any kW load.

The EDG load profiles given in Reference 9 for the D2 EDG (which is more heavily loaded than the D1 EDG), produced the following profile:

| 0 – 5 Minutes kW | 5 – 30 Minutes kW | ½ - 1 Hour kW | After 1 Hour kW |
|---|---|---|---|
| 2478.92 | 2406.54 | 2405.06 | 1522.68 |

The EDG consumption over a 14-day period is then calculated as follows:

Total Consumption = (5/60 hr)(2478.92 kW)(gph/kW @ 2478.92 kW) +

(25/60 hr)(2406.54 kW)(gph/kW @ 2406.54 kW) +

(30/60 hr)(2405.06 kW)(gph/kW @ 2405.06 kW) +

(335 hr)(1522.68 kW)(gph/kW @ 1522.68 kW)

Values of gph/kW at various loads are obtained from the curves shown in Figure 1. For conservatism, all values were taken from the highest test curve for a given load.

Applying the gph/kw values to the equation above yields:

Total Consumption = (5/60)(2478.92)(0.0746) + (25/60)(2406.54)(0.0746) +

(30/60)(2405.06)(0.0746) + (335)(1522.68)(0.0815)

= 15.4 gal + 74.8 gal + 89.7 gal + 41,573.0 gal

= 41,753 gal.

Consequently, a single EDG (D1 or D2), operating for 14 days will consume a maximum of 41,753 gallons when loaded as noted above.

**B. 12 day consumption:**

Using the same values as part A, but changing the length of time to 12 days yields:

Total Consumption = (5/60)(2478.92)(0.0746) + (25/60)(2406.54)(0.0746) + (30/60)(2405.06)(0.0746) + (287)(1522.68)(0.0815).

= 15.4 gal + 74.8 gal + 89.7 gal + 35,616.2 gal
= 35,796 gal

Consequently, a single EDG (D1 or D2), operating for 12 days will consume a maximum of 35,796 gallons when loaded as noted above.

## 7.0 Conclusions:

A. 14 day requirement:
The 14-day fuel oil consumption acceptance criteria of a total fuel supply in Tech Specs of 70,000 gallons supplying one DDCLP and one Unit 1 EDG (loaded per USAR Table 8.4-1) is met because:

A combination of one EDG and one DDCLP will consume 41,753 gal + 19,454 gal = 61,207 gallons of fuel oil in 14 days.

B. 12 day conclusion:
For future reference a combination of one EDG and one DDCLP will consume 35, 796 gal + 16,675 gal = 52,471 gallons of fuel oil in 12 days.

## 8.0 References:

1. Prairie Island Technical Specifications.
2. Prairie Island Updated Safety Analysis Report.
3. ANSI/ASTM D975-82, "Classification of Diesel Fuel Oils."
4. ANSI/ANS-59.51-1989, "Fuel Oil Systems for Emergency Diesel Generators." (1 page attached)
5. Quality Assurance Inspection Report dated August 16, 1971. (4 pages attached)
6. Prairie Island RSN-96C (D1) and RSN-96D (D2), Receipt Inspection Reports, Section 6.3.f, Performance Test, Oct. 1970. (2 pages attached)
7. Prairie Island Pre-Operational Test Procedures 20.1 (D1) and 20.2 (D2), dated August 16, 1973. (4 pages attached)
8. Fairbanks Morse, "Diesel Fuel Oil Specifications for Stationary and Marine Engines," Table D3063A1-3, dated Dec, 1965. (1 page attached)
9. NSP Calculation ENG-EE-021, Rev. 2 Addendum. 4 "Diesel Generator Steady State Load," dated August 1999. (1 page attached)

GENERAL COMPUTATION SHEET

NSP Northern States Power Company

PROJECT: Prairie Island Unit 1

SUBJECT: D1/D2 and DDCLP Fuel Oil Storage Capacity

E NO. ENG-ME-020

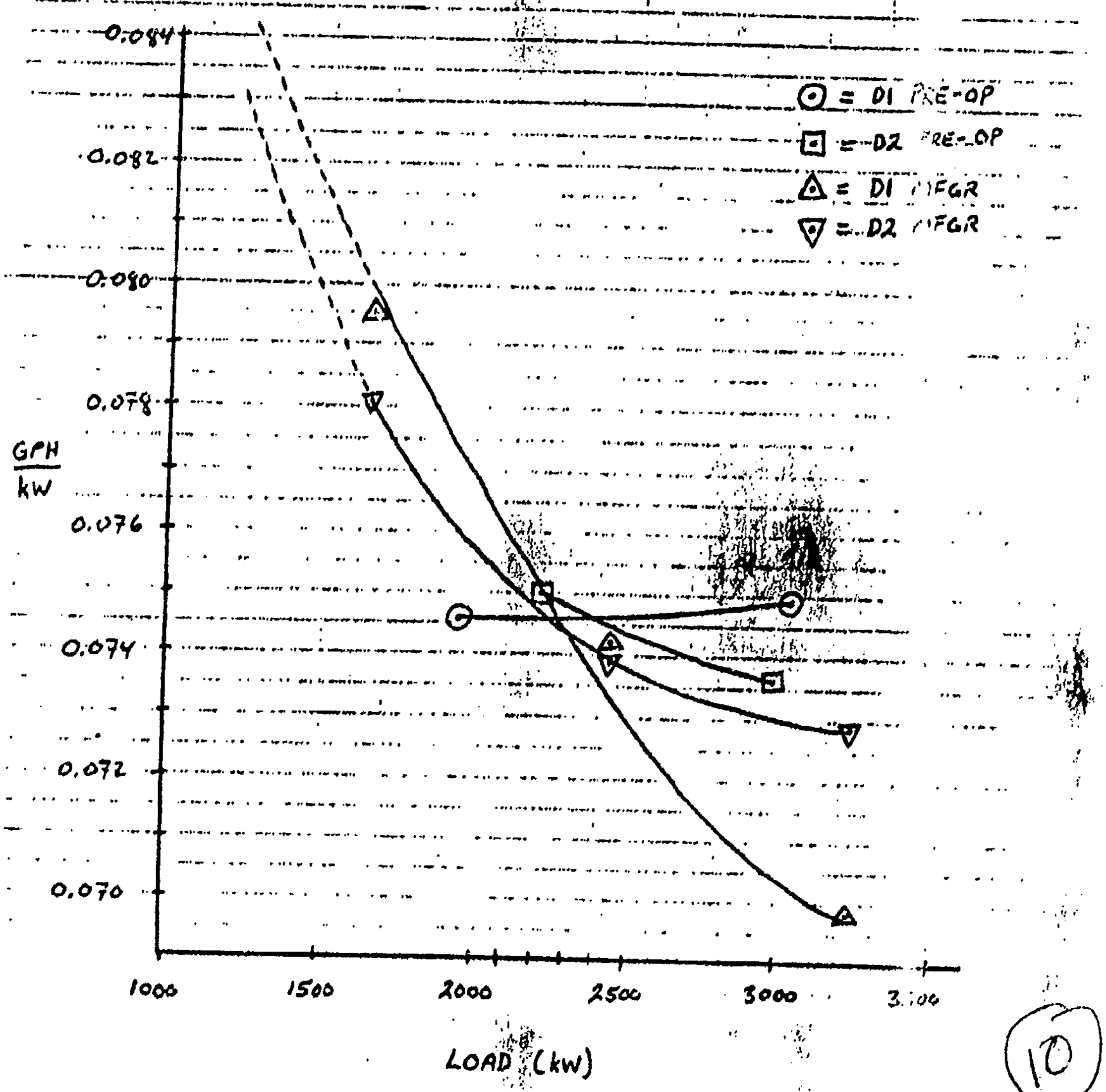
SHEET NO 6 OF 8

DATE 4/?/93

COMP. BY [illegible] C'K'D BY

FIGURE 1

GPH/kW VERSUS LOAD




(10)

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**Table 1**

EDG Fuel Consumption Test Data

| Source | Load (kW) | $BHP_{gross}$ | $Lb/BHP_g \cdot hr$ | gph | gph/kW |
|---|---|---|---|---|---|
| D1 Pre-Op | 1936 | 2585.[illegible] | 0.3861 | 144.5 | 0.074[illegible] |
| | 3019 | 3999.2 | 0.3909 | 226.2 | 0.074[illegible] |
| | | | | | |
| D2 Pre-Op | 2203 | 2935 | 0.389 | 165.2 | 0.0750 |
| | 2970 | 3937 | 0.3838 | 218.7 | 0.0736 |
| | | | | | |
| D1 Mfgr | 1647 | 2200 | 0.411 | 130.9 | 0.0795 |
| | 2431 | 3232 | 0.386 | 180.5 | 0.0742 |
| | 3230 | 4280 | 0.364 | 225.5 | 0.0698 |
| | | | | | |
| D2 Mfgr | 1647 | 2200 | 0.404 | 128.6 | 0.0781 |
| | 2431 | 3232 | 0.384 | 179.6 | 0.0739 |
| | 3227 | 4276 | 0.380 | 235.1 | 0.0729 |

Notes:

1. The kW loads for the Mfgr tests were calculated based on

   $kW = (BHP_{net})(0.746)/eff.$

   where $BHP_{net} = BHP_{gross} - 58$ and eff. values are given in [6]. (auxiliary loads are 58 BHP)

2. gph values were calculated as follows:

   $gph = (BHP_{gross})(Lb/BHP_g \cdot hr)/(6.91\ Lb/gal).$

3. gph/kW values were calculated as follows:

   $gph/kW = (gph)/(Load\ in\ kW).$

8/21 (11)

25X10

# Appendix C

(This Appendix is not part of American National Standard Fuel Oil Systems for Emergency Diesel Generators, ANSI/ANS-59.51-1989 but is included for information purposes only.)

## Recommended Fuel Oil Practices

The quantity of fuel oil available in storage is determined and logged monthly or in accordance with the plant Technical Specifications.

A fuel oil sample is obtained at least monthly from the supply tanks in accordance with ASTM D2276 [C1], and verifying that total particulate contamination is less than 10 mg/litre when checked in accordance with ASTM D2276, Method A, except that the engine fuel oil filters discussed in Section 5.5.3, may have a nominal pore size consistent with the diesel engine manufacturers requirements.

New fuel oil is sampled in accordance with ASTM D4057 [C2] prior to addition to the supply tanks. The new fuel oil sample is verified in accordance with the tests specified in ASTM D975 [C3] prior to addition to the supply tank that the sample has:

(1) An API gravity of within 0.3 degrees at 60°F or a specific gravity of within 0.0016 at 60/60°F, when compared to the supplier's certificate or an absolute specific gravity at 60/60°F of greater than or equal to 0.83 but less than or equal to 0.89 or an API gravity at 60°F of greater than or equal to 27 degrees but less than or equal to 39 degrees.
(2) A kinematic viscosity at 40°C (104°F) of greater than or equal to 1.9 centistokes (1.9 $mm^2/s$), but less than or equal to 4.1 centistokes (4.1 $mm^2/s$), if gravity was not determined by comparison with the supplier's certification.
(3) A flash point equal to or greater than 52°C (125°F)
(4) A clear and bright appearance with proper color when tested in accordance with ASTM D4176 [C4].

Also the new fuel oil sample is verified within one month of obtaining the sample that the other properties specified in Table 1 of ASTM D975 are met when tested in accordance with ASTM D975 except that the analysis for sulfur may be performed in accordance with ASTM D1552 or ASTM D2622 [C3,C5,C6].

Accumulated condensate is removed from supply tanks on a monthly basis. Accumulated condensate is removed from the day or integral tank(s) on a monthly basis and after each occasion when the diesel generator is operated for greater than one hour.

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NSP

NORTHERN STATES POWER COMPANY

**INSPECTION REPORT**

August 16, 1971

DDGWA

382-17

PRAIRIE ISLAND NUCLEAR GENERATING PLANT
Purchase Order Hia. #48
Vendor Caterpillar Tractor Co.
(Worthington - Prime Contractor - #CHI-034-70)

Components Model 399 diesel engine prime movers (35B554 & 6) for Worthington emergency cooling pumps

Facilities Visited Mossville Plant (Assy - test - shipment)

Date of Visit August 3 & 4, 1971

.0 Purpose of Visit To witness engine performance tests and review items residual from the August 1970 QA survey.

Persons Contacted
R. Aberle Patten Industries 312-626-1860
J. Sylvester Worthington Corp.
C. Adams Caterpillar - Order Analyst
J. McCullough Caterpillar - Test Foreman
F. Ozment Caterpillar - Test Engineer
O. Heuermann Caterpillar - Dealer Sales - Industrial
R. O'Neill Caterpillar - Application Engineer

.2 References

- NSP Specifications D-9.0 and D-6.0 (Original Issues)
- PS&E Specification SS-M454 Rev 9/69 with apparatus data sheets of 7/21/71
- Contract description for item #6 - Caterpillar diesel engines
- Caterpillar Technical Bulletins LE021226-02(11-70) and [illegible]721-02 (Model 399 engines)
- Worthington Corp. letter of W. R. Wagoner dated September 17, 1970 to PS&E on QA open items and engine load test procedure
- NSP (Prairie Island Site) letter of P. F. Suleski dated December 9, 1970 on same subject

(13) 10/21



25x

## INSPECTION REPORT

### 2.0 SUMMARY

Caterpillar engines model 399, #35B554 (test cell 20) and #35B556 (test cell 26) were tested satisfactorily for the initial phase of testing.

Inspection records were not yet collated due to the recent conclusion of the factory vacation period, but will be checked later.

### 3.0 PLANNED ACTION

Appendix I is being issued to expedite documentation intended for PS&E and NSP.

The final phase (estimated mid-Sept.) of engine tests and review of quality control records will be made at the Patten Industries facility in Oglesby, Illinois. This phase applies to the automatic start and load acceptance capability, on a repeat cycle basis.

### 4.0 INSPECTION RESULTS

#### 4.1 Review of Contract Status

Quality Control Records
The detailed documentation quoted in the order has been covered in past correspondence and is listed in "Table I". Followup effort to confirm the status of this table is in Appendix I.

The NSP Certificate of Conformance (COC) was also discussed. Although it was previously issued by PS&E letter of May 4, 1971, copies are being reissued to Worthington and Caterpillar according to discussions made during this inspection.

Engine Characteristics and Test Procedure
An advance set of apparatus data (7/21/71) sheets was received from PS&E and used during this inspection. The test procedure in use met the intent of PS&E specification SS-M454. The test log (certified) will be reviewed and approved by PS&E.

#### 4.2 Engine Performance

Preliminary review of performance data indicates satisfactory results. This applies to the first phase of 50 hr. operation @ 100% contract capacity. The second phase will be made at Patten Industries with all auxiliaries to test the automatic startup system and load acceptance over repeated cycles (this was covered in the two referred letters).

(14) 11/21

4.2 Engine Performance (Cont.)

A comparison of the first 22 hrs. of Caterpillar test for selected variables was as follows (18-22 hr. data):

| Engine #35B554 | Engine #35B556 | Requirement |
|---|---|---|
| (1) 1200 RPM | 1200 RPM | 1200 RPM |
| (2) Brake Thermal Efficiency 33.1% | 33.1% | Not Quoted |
| (3) ~~1008 BHP~~ | ~~1007-1010 BHP~~ | ~~1000 BHP Continuous~~ |
| (4) 1600 FPM Piston Speed | 1600 FPM | 1600 FPM |
| (5) 170 Bmep | 170 Bmep | 170 Bmep |
| (6) ~~55.6 gal./hr. fuel~~ Consumption rate | ~~55.7 gal./hr.~~ | ~~55 gal./hr. @ 1010 HP~~ |
| (7) Fuel Rate .393 lb./-Bhp-hr. | .394 lb./Bhp-hr. | .389 lb./Bhp-hr. Calculated but not quoted in data sheet. |
| (8) Exhaust Temp. 835°F | 850°F | 940°F |
| (9) Ambient Air 92°F | 100°F | See notes below |
| (10) Barometric 29.1" Hg | 29.1" Hg | See notes below |
| (11) Lube Oil 50 psig | 49 psig | Not quoted |
| (12) Lube Oil Temp. Out 194°F | 209°F | Not quoted |
| (13) Jacket Water In 178°F | 174°F | Not quoted |
| (14) Jacket Water Out 188°F | 188°F | Not quoted |

Notes - as follows (numbers same as above data):

Items (2), (4) and (5) are not recorded in the test log. Preliminary copies of the first 22 hrs. were received during this inspection trip.

(4) The piston speed quoted is the arithmetical average for a crankshaft revolution.

(2), (6), (7) Fuel consumption and fuel rate were a little high but satisfactory for intended service. This item was discussed with Ed Claeson of PS&E and is compatible with fuel tank capacity of 19,500 gallons to sustain a two-week continuous running period (18,816 gallons), not including the day tank. (ONLY 17500 USABLE) 56 gal/hr.

what's the fuel rate for this? cooling water WBB

(3), (7) Caterpillar also quotes a 5% tolerance for the (9), (10) horsepower rating in conjunction with 29.38"Hg and 85°F air with 2,500 feet above sea level minimum. DEMA standards are 28.25" Hg and 90°F and 1,500 ft. with adjustment allowed for variances from these minimums. The 92°F and 100°F ambient test conditions and the 5% tolerance factors qualify the fuel rates. The fuel heat value was interpolated as 19511 btu/lb. from an API report value of 32.6.

19 12/21

4.2 Engine Performance (Cont.)

The calibration status of all test panel instruments was checked as up-to-date. Calibration and due dates were in order for these tests.

4.3 Engine Stub Shaft

This item was checked to ensure compatability with the right angle gear drive (received on site). A copy of Caterpillar drawing 6L6787 Rev. 7 was received and will be used in receipt inspection at Prairie Island. Worthington (J. Sylvester) will also examine this item. It is worth noting that this engine is so standardized that the stub shaft is replaceable and is provided in a variety of designs.

4.4 Contract Management

Worthington Corporation, as prime contractor, has assigned John Sylvester to consolidate all of the QA records contributed by the numerous subcontractors/suppliers (change order #3 to Hia. #48). His mailing address is:

Mr. John Sylvester
Worthington Corp.
P.O. Box 16048
Stockyards Station
Denver, Colorado
80216

By P. F. Suleski
P. F. Suleski

PFS/dwa

cc: W. V. Jokela
Site Files
W. Brennen
E. U. Claeson



(16) 13/21

582-6 UNIT #1

R SM-96C C.S.C. Performance Test

## C. P. Diesel Engine Erection and Test Record

ENGINE SERIAL NO 3808700657TQSM12

Customer Order No. 205637 — P.O. AP 3

Model & Size 38TD8 1/8 — No. Cyls 12 — RPM 900 — HP 4160

Generator Type TGICS — KW 3200 — S/N 5021691 — S/N N.A.

Engineering List 16-606-637 — Block Cap No. 12R977 — Pat. 516

Crank (ex) 12 1/2 — Inj Timing (CS) 39 1/2 — (OCS) 39 1/2°

Crankshaft Nos (Upper) CA75BS (Lower) CA77BS

Blower Size (C.I.) 12 — Type Roots — S/N R31

Turbo Mfg Elliott — S/N J-9187-4 — T-9186-3 — Nozzle Ring 19

Governor Type 652-16701860 — 910750 — Yes

Water Pump (C.W. / H.W.) S/N 801563 (9/4) S/N 80150 — L.O. Pump S/N 1596

Piston Symbol (Upper) 16-103-802 (Lower) 16-401-372

Liner Symbol (Upper) 16-401-912 (16-401-192)

Ring Symbols — Upper [illegible]-217 — [illegible]-4-239 — 16-191-191

Ring Symbols — Lower [illegible]-217 — [illegible]-4-237 — 16-191-191

Inj. Nozzle Symbol

| % Load | RPM | BHP | Gen Eff | [illegible] | Scav Air | Exh Hdr Press | [illegible] Temp | Water Out Temp | Fuel Rate (lbs fuel / Gross BHP-hour) | Aux HP |
|---|---|---|---|---|---|---|---|---|---|---|
| 110 | | | | | | | | | | |
| 100 | 900 | [illegible] | 975 | 3.0 | 37.6 | 32 | 202 | 168 | .334 | 58 |
| 75 | 900 | 3174 | 974 | 6.2 | 25.5 | 32 | 201 | 167 | .336 | 58 |
| 50 | 900 | 2142 | 970 | 4.3 | 17.6 | 32 | 198 | 166 | .411 | 58 |
| 25 | | | | | | | | | | |

Engine Speeds — RPM (Hi) 950 (Slow) 475

Overspeed Governor — Tripped at 1045 RPM

Load Limit Setting 80 — BHP 4260

| Cyl | [illegible] | [illegible] | Inj | [illegible] | [illegible] | Compression | Firing | Contract Alarm |
|---|---|---|---|---|---|---|---|---|
| 1 | 3[illegible] | EH 211 | | 54075 | 54663 | 1320 | 610 | 910 |
| 2 | 3[illegible] | EH 264 | | 54076 | 54664 | 1130 | 610 | 920 |
| 3 | 3[illegible] | EH 277 | | 54077 | 54665 | 1220 | 610 | 920 |
| 4 | 3[illegible] | EH 561 | | 54078 | 54666 | 1230 | 630 | 875 |
| 5 | 3[illegible] | EH 1152 | | 54079 | 54667 | 1260 | 620 | 920 |
| 6 | 3[illegible] | EH 1150 | | 54080 | 54668 | 1220 | 620 | 750 |
| 7 | 3[illegible] | EH 1140 | | 54081 | 54669 | 1270 | 660 | 900 |
| 8 | 3[illegible] | EH [illegible] | | 54082 | 54670 | 1270 | 650 | 940 |
| 9 | 3[illegible] | EH 1158 | | 54083 | 54671 | 1280 | 650 | 755 |
| 10 | 3[illegible] | EH 1192 | | 54084 | 54672 | 1290 | 640 | 920 |
| 11 | 3[illegible] | EH 1117 | | 54085 | 54673 | 1320 | 660 | 900 |
| 12 | 377 | EH 1168 | | 54086 | 54674 | 1260 | 660 | 750 |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |

CHANGE ORDER OR VAR NUMBERS

19350 btu/lb fuel

Date of Test 9/17-10/1 1970

Accum Hours 1-51

109-153 153

[illegible signature]

5826 UNIT #2
1 F27-51

# O. P. Diesel Engine Erection and Test Record

1-5[illegible])-96D D-2 6.3.f Perf. Tests

ENGINE SERIAL NO 38D8700-59TDSM12

Customer Northern States Power.
Model & Size 38TD8 1/8 Cyls 12 RPM 900 HP 4160
Generator Type TGZGJ KW 3000 S/N 5021698-2 Exc. S/N NA
Engineering List 16-606 Block Cap No 12B103 Erect. Rot. 517
Crank lead 13[illegible] Inj. Timing (CS) 43° (OCS) 41.6
Crankshaft Nos (Upper) CA54BS (Lower) CA21BS
Blower Size (Cyl) 12 Type [illegible] S/N R3134
Turbo Mfg. Elliott S/N(LH) J9197-3 S/N(RH) J-9186-4 Noz. Ring 19°
Governor Type [illegible] S/N 85-1175 Booster Yes
Water Pump (Front) S/N 914 FC1534 (Rear) S/N 914 FC1535 L. O. Pump S/N 1597
Piston Symbol (Upper) 16-152-802 (Lower) 16-401-372
Liner Symbol (Upper) 16-401-912 16-701-192 (Lower)
Ring Symbols
Upper (top) 16-300-217 (comp) 16-704-239 (oil) 16-701-191
Lower (top) 16-300-217 (comp) 16-704-239 (oil) 16-701-191
Inj. Nozzle Symbol ____ Inj. Pump Symbol ____

| % Load | RPM | PHP | Gen Eff | #1 Pos C.S. | Scav Air | Upper Hdr. Press | Lube Out Temp | Water Out Temp | Fuel Rate | AUX HP |
|---|---|---|---|---|---|---|---|---|---|---|
| 110 | | | | | | | | | | |
| 100 | 900 | 4219 | .975 | 7.8 | 39.5 | 34 | 202 | 167 | .330 | 58 |
| 75 | 900 | 3174 | .974 | 6.0 | 24.5 | 34 | 200 | 167 | .334 | 58 |
| -- | 900 | 2142 | .970 | 4.1 | 17.9 | 34.5 | 197 | 166 | .404 | 58 |
| 25 | | | | | | | | | | |

Engine Speeds - RPM (Hi) 945 (Slow) 445
Overspeed Governor - Tripped @ 1050 RPM
[illegible] 80 4200

| No. | Clear | Nos | Nozzle Nos | Inj. Pumps | Inj. Pumps | Fire Press | Comp Press | Exh Temp |
|---|---|---|---|---|---|---|---|---|
| 1 | 340 | BH 730 | | 54226 | 54238 | 1395 | 630 | 910 |
| 2 | 397 | BH 454 | | 54227 | 54239 | 1230 | 635 | 960 |
| 3 | 412 | BH 1214 | | 54228 | 54240 | 1280 | 610 | 760 |
| 4 | 3[illegible] | BH 650 | | 54229 | 54241 | 1320 | 650 | 890 |
| 5 | 402 | BH [illegible] | | 54230 | 54242 | 1250 | 620 | 915 |
| 6 | 4[illegible]1 | BH 654 | | 54231 | 54243 | 1290 | 625 | 735 |
| 7 | 4[illegible]5 | BH 636 | | 54232 | 54244 | 1340 | 645 | 920 |
| 8 | 411 | BH 1106 | | 54233 | 54245 | 1320 | 660 | 940 |
| 9 | 391 | BH 1220 | | 54234 | 54246 | 1320 | 640 | 760 |
| 10 | 394 | BH 1035 | | 54235 | 54247 | 1340 | 660 | 900 |
| 11 | 405 | BH 1047 | | 5423[illegible] | 54243 | 1335 | 670 | 870 |
| 12 | 396 | BH 682 | | 54237 | 54249 | 1290 | 655 | 745 |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |

CHANGE ORDER OR [illegible] NUMBERS

Date of Test 10/2-10/[illegible]
Accum. Hours 140.[illegible]
Inspector 59-153-15[illegible]
CERTIFIED
[signature]

gary miller

Rev.

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

UNIT 1

OPERATIONAL TEST PROCEDURE

NO. 20.1

EMERGENCY DIESEL GENERATOR (D-1)

**MASTER COPY**

APPROVED FOR CONDUCT

F. P. [signature] R. H. [signature]

Operations Committee Chairman

TEST RESULTS APPROVAL

Operations Committee Chairman

N.S.P. Engineering

(19) 10/21

25X

## 6.11 Diesel Generator Fuel Consumption Test

During the two-week run, section 6.8 of this preop, the diesel engine efficiency will be checked.

Collect the following data:

(1) Actual kilowatts output
determined from kilowatt hour meter reading taken at 10-min. intervals during the test. 1936 | 3018.6 $KW_A$

(2) Fuel consumption
determined from initial $L_1$ and final $L_2$ level in the day tank. Convert to lbs. of fuel consumed. 2250.06 ~~964.22~~ | 583.76 Q

(3) Sample of the fuel oil

(4) Time required for level to change from $L_1$ to $L_2$ (hours) 2.133 | 2166 T

The following calculations are made:

(1) $BHP_N$ (net brake horsepower) = $\frac{KW_A \times Eff}{.746}$ where Eff = 97. 2527.69 | 3941.17

(2) $BHP_G$ (Gross brake horsepower) = $BHP_N + BHP_A$ where $BHP_A$ = 58 B 2585.69 | 3999.17

(3) Q is determined from $L_1$ and $L_2$ using Table 1-3b of Chemical Engineer's Handbook. $L_1$ must be between 3-6 inches from the tank top before beginning. $L_2$ must be between 10 - 12 inches from the tank bottom at the test end. .40796 | .3909

(4) $Lbs/BHP_G HR = \frac{Q}{BHP_G \times T}$ = lbs per brake hp hour

(5) Calculation 4 above is corrected to 19,350 BTU/lb. .3861 | 3909

The test will be run at loads of 2000 kw and 3000 kw. 18,310 BTU/lb

.8459

17/21

gary miller

Rev. 4

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

UNIT 1

OPERATIONAL TEST PROCEDURE

NO. 20.2

EMERGENCY DIESEL GENERATOR (D-2)

MASTER COPY

APPROVED FOR CONDUCT

F. P. Tierney Jr.   A. Stelly   R. H. Hays

Operations Committee Chairman

TEST RESULTS APPROVAL

Operations Committee Chairman

N.S.P. Engineering

18/21

(21) 2[illegible]

6.11 Diesel Generator Fuel Consumption Test

During the two-week run, section 6.8 of this preop, the diesel engine efficiency will be checked.

Collect the following data:

(1) Actual kilowatts output determined from kilowatt hour meter reading taken at 10-min. intervals during the test. 2203 | 2970 $KW_A$

(2) Fuel consumption determined from initial $L_1$ and final $L_2$ level in the day tank. Convert to lbs. of fuel consumed. 258 | 2612 Q

(3) Sample of the fuel oil

(4) Time required for level to change from $L_1$ to $L_2$ (hours) 2.13 | 1.63 T

The following calculations are made:

(1) $BHP_N$ (net brake horsepower) = $\frac{KW_A \times Eff}{.746}$ where Eff = 97.4 2877 | 3879

(2) $BHP_G$ (Gross brake horsepower) = $BHP_N + BHP_A$ where $BHP_A$ = 58 BHP 2935 | 3937

(3) Q is determined from $L_1$ and $L_2$ using Table 1-3b of Chemical Engineer's Handbook. $L_1$ must be between 3-6 inches from the tank top before beginning. $L_2$ must be between 10 - 12 inches from the tank bottom at the test end.

(4) Lbs/$BHP_G$HR = $\frac{Q}{BHP_G \times T}$ = lbs per brake hp hour .422 | .4062

(5) Calculation 4 above is corrected to 19,350 BTU/lb. .399 | .3838

The test will be run at loads of 2000 kw and 3000 kw.

analysis of fuel is 18,263 BTU/lb

19/21



22

Colt Industries | Fairbanks Morse Power Systems Division | New Page | D3063A1-3 Dec., 1965

FINGA Microfilm Roll 7250.1335 - 1980 582 - 10

**DIESEL FUEL OIL SPECIFICATION for Stationary and Marine Engines**

**CHARACTERISTICS OF OILS AT 60° FAHR.**

| Deg. Baume or A.P.I. | U.S. Bureau of Standards (Baume) | | American Petroleum Institute (A.P.I.) | |
|---|---|---|---|---|
| | ** Specific Gravity | * Pounds per U.S. Gallon | § Specific Gravity | * Pounds per U.S. Gallon |
| 10.0 | 1.0000 | 8.328 | 1.0000 | 8.328 |
| 10.5 | .9964 | 8.298 | .9965 | 8.299 |
| 11.0 | .9929 | 8.269 | .9930 | 8.270 |
| 11.5 | .9894 | 8.240 | .9895 | 8.241 |
| 12.0 | .9859 | 8.211 | .9861 | 8.212 |
| 12.5 | .9825 | 8.182 | .9826 | 8.183 |
| 13.0 | .9790 | 8.153 | .9792 | 8.155 |
| 13.5 | .9756 | 8.125 | .9759 | 8.127 |
| 14.0 | .9722 | 8.096 | .9725 | 8.099 |
| 14.5 | .9688 | 8.068 | .9692 | 8.071 |
| 15.0 | .9655 | 8.041 | .9659 | 8.044 |
| 15.5 | .9622 | 8.013 | .9626 | 8.016 |
| 16.0 | .9589 | 7.986 | .9593 | 7.989 |
| 16.5 | .9556 | 7.959 | .9561 | 7.962 |
| 17.0 | .9524 | 7.931 | .9529 | 7.935 |
| 17.5 | .9492 | 7.904 | .9497 | 7.909 |
| 18.0 | .9459 | 7.877 | .9465 | 7.882 |
| 18.5 | .9428 | 7.851 | .9433 | 7.856 |
| 19.0 | .9396 | 7.825 | .9402 | 7.830 |
| 19.5 | .9365 | 7.799 | .9371 | 7.804 |
| 20.0 | .9333 | 7.772 | .9340 | 7.778 |
| 20.5 | .9302 | 7.747 | .9309 | 7.752 |
| 21.0 | .9272 | 7.721 | .9279 | 7.727 |
| 21.5 | .9241 | 7.696 | .9248 | 7.701 |
| 22.0 | .9211 | 7.670 | .9218 | 7.676 |
| 22.5 | .9180 | 7.645 | .9188 | 7.651 |
| 23.0 | [illegible] | [illegible] | [illegible] | [illegible] |
| 23.5 | .9121 | 7.595 | .9129 | [illegible] |
| 24.0 | .9091 | 7.570 | .9100 | [illegible] |
| 24.5 | .9061 | 7.546 | .9071 | 7.554 |
| 25.0 | .9032 | 7.522 | .9042 | [illegible] |
| 25.5 | .9003 | 7.497 | .9013 | 7.505 |
| 26.0 | .8974 | 7.473 | .8984 | 7.481 |
| 26.5 | .8946 | 7.449 | .8956 | 7.458 |
| 27.0 | .8917 | 7.425 | .8927 | 7.434 |
| 27.5 | .8887 | 7.402 | .8899 | 7.410 |
| 28.0 | .8861 | 7.378 | .8871 | 7.387 |
| 28.5 | .8833 | 7.355 | .8844 | 7.364 |
| 29.0 | .8805 | 7.332 | .8816 | 7.341 |
| 29.5 | .8777 | 7.309 | .8789 | [illegible] |
| 30.0 | 0.8750 | 7.286 | 0.8762 | 7.296 |
| 30.5 | .8723 | 7.264 | .8735 | 7.273 |
| 31.0 | .8696 | 7.241 | [illegible] | 7.251 |
| 31.5 | .8669 | 7.216 | [illegible] | 7.228 |
| 32.0 | .8642 | 7.196 | [illegible] | 7.206 |
| 32.5 | .8615 | 7.173 | [illegible] | 7.184 |
| 33.0 | .8589 | 7.152 | [illegible] | 7.163 |
| 33.5 | .8563 | 7.130 | [illegible] | 7.141 |
| 34.0 | .8537 | 7.108 | [illegible] | 7.119 |
| 34.5 | .8511 | 7.087 | [illegible] | 7.098 |
| 35.0 | .8485 | 7.065 | [illegible] | 7.076 |
| 35.5 | .8459 | 7.044 | [illegible] | 7.055 |
| 36.0 | .8434 | 7.022 | [illegible] | 7.034 |
| 36.5 | .8408 | 7.001 | [illegible] | 7.013 |
| 37.0 | .8383 | 6.980 | [illegible] | 6.993 |
| 37.5 | .8358 | 6.960 | [illegible] | 6.972 |
| 38.0 | .8333 | 6.939 | [illegible] | 6.951 |
| 38.5 | .8309 | 6.918 | [illegible] | 6.930 |
| 39.0 | .8284 | 6.898 | [illegible] | 6.910 |
| 39.5 | .8260 | 6.877 | [illegible] | 6.890 |
| 40.0 | .8235 | 6.857 | [illegible] | 6.870 |
| 40.5 | .8211 | 6.837 | [illegible] | 6.850 |
| 41.0 | .8187 | 6.817 | [illegible] | 6.830 |
| 41.5 | .8163 | 6.797 | [illegible] | 6.810 |
| 42.0 | .8140 | 6.777 | [illegible] | 6.790 |
| 42.5 | .8116 | 6.758 | [illegible] | 6.771 |
| 43.0 | .8092 | 6.738 | [illegible] | [illegible] |
| 43.5 | .8069 | 6.718 | [illegible] | [illegible] |
| 44.0 | .8046 | 6.699 | [illegible] | 6.713 |
| 44.5 | .8023 | 6.680 | [illegible] | 6.694 |
| 45.0 | .8000 | 6.661 | [illegible] | 6.675 |
| 45.5 | .7977 | 6.642 | [illegible] | 6.656 |
| 46.0 | .7955 | 6.623 | [illegible] | 6.637 |
| 46.5 | .7932 | 6.604 | [illegible] | 6.618 |
| 47.0 | .7910 | 6.586 | [illegible] | 6.600 |
| 47.5 | .7887 | 6.567 | [illegible] | 6.502 |
| 48.0 | .7865 | 6.548 | [illegible] | 6.563 |
| 48.5 | .7843 | 6.530 | [illegible] | 6.545 |
| 49.0 | .7821 | 6.511 | [illegible] | 6.526 |
| 49.5 | [illegible] | 6.494 | [illegible] | 6.507 |

NOTE

In determining the relation between the Baume scale and the specific gravity of a liquid lighter than water, the U.S. Bureau of Standards adopted a figure of 140. Since that time, however, the American Petroleum Institute have adopted a slightly different modulus (141.5) and this relation is the one most widely used by the oil trade, and the one on which laboratory tests are based. Unless otherwise specified, it will be assumed that gravities are in deg. A.P.I.

** These are [illegible] values, expressed as the ratio of the weights of equal volumes of oil and water at temperatures of 60° F. when weighed in vacuo and are obtained from the formula $Sp.\ Gr. = \frac{140}{130 + deg.\ B}$

§ These are "apparent" values, expressed as the ratio of the weights of equal volumes of oil and water at temperatures of 60° F. when weighed in air and are obtained from the formula $Sp.\ Gr. = \frac{141.5}{131.5 + deg.\ A.P.I.}$

* Weight in [illegible] 8.328.

[illegible] subject to change without notice

(23) 20/21 28

25x

Unit 1 Train A (D1) totals

As described above there is no net change in D1 loading therefore the load table from Rev. 2 Addendum 1 is still valid for D1. The table is repeated here.

| LOAD PERIOD | D1 TOTAL LOAD (KW) | D1 CONTINUOUS RATING (KW) |
|---|---|---|
| 0-5 MINUTES | 2273.56 | 2750 |
| 5-30 MINUTES | 2242.46 | 2750 |
| 30 MINUTES – 1 HOUR | 2237.19 | 2750 |
| 1 HOUR – 14 DAYS | 1301.98 | 2750 |

**Conclusion: The D1 loading does not exceed the diesel continuous rating.**

Unit 1 Train B (D2) totals

As described above there is no net change in D2 loading therefore the load table from Rev. 2 Addendum 1 is still valid for D2. The table is repeated here

| LOAD PERIOD | D2 TOTAL LOAD (KW) | D2 CONTINUOUS RATING (KW) |
|---|---|---|
| 0-5 MINUTES | 2478.92 | 2750 |
| 5-30 MINUTES | 2406.54 | 2750 |
| 30 MINUTES – 1 HOUR | 2405.06 | 2750 |
| 1 HOUR – 14 DAYS | 1522.68 | 2750 |

**Conclusion: The D2 loading does not exceed the diesel continuous rating.**

Unit 2 Train A (D5) totals

| Train A | KW | KVAR |
|---|---|---|
| Added Transferable load 1 480V Load **MV-32144** | 3.63 | 4.24 |
| Added Xfmr and Cable Losses (5%) | 0.18 | 0.21 |
| Total Difference | 3.81 | 4.45 |

This MV is a load during the 0 to 5 minute interval only. Adding these values to the previous load period total yields:

| LOAD PERIOD | D5 TOTAL LOAD (KW) | D5 CONTINUOUS RATING (KW) |
|---|---|---|
| 0-5 MINUTES | 3481.05 | 5400 |
| 5-30 MINUTES | 3447.60 | 5400 |
| 30 MINUTES – 1 HOUR | 3452.12 | 5400 |
| 1 HOUR – 14 DAYS | 2579.62 | 5400 |

**Conclusion: The revised D5 loading does not exceed the diesel continuous rating.**

24/24 KB

Enclosure

Attachment 3

ENG-ME-066, Revision 2, "D5/D6 Fuel Oil Storage Requirements"

9 pages follow

U0007050066



**NORTHERN STATES POWER COMPANY**

**PRAIRIE ISLAND NUCLEAR GENERATING PLANT**

**CALCULATION COVER SHEET**

Calculation Number: ENG-ME-066

Calculation Rev. No.: 2 Addenda No.: 

Calculation Title: D5/D6 Fuel Oil Storage Requirements

Safety Related?: yes

Calculation Verification Method (Check One):

☒ Design Review ☐ Alternate Calculation ☐ Qualification Testing

Scope of Revision:

1. Update to reflect changes in D5/D6 loading
2. Added 12 and 6 day quantities
3. ~~EDG laoding reflects design change 98EB02~~

Documentation of Reviews and Approvals:

Originated By: M Thompson M A Thompson Date: 4/4/00

Checked By: R. Cole [signature] Date: 4/7/2000

Verified By: [signature] Printed Name: R. L Cole Date: 4/7/2000

Approved By: [signature] Date: 4/7/2000

BL
1 of 9

# CALCULATION VERIFICATION CHECKLIST

**Calculation No.:** ENG-ME-066 **Revision No.:** 2

**Use of Computer for Calculation**

| | | |
|---|---|---|
| X | Manual Calculation (no computer results) | |
| | Computer | |
| | | Verified Program (Reference ________ Provides Verification) |
| | | Unverified Program (Verification of Results Required) |

**Verification Item** *** (Refer to Site Engineering Manual, Administrative Standard 1.2.3)** **Initials/Date**

**1.0 Purpose** / 04-06-00

- Clear objective and problem statement.
- Identification of affected structure, system, and/or component.
- Identification of the intended use of the calculation results.
- Identification of summary results.

**1.0 Methodology** /04-06-00

- Discussion of the method/approach and major steps.
- Definition of any limitations of methodology.

**1.0 Acceptance Criteria** /04-06-00

- Clear definition of the acceptance criteria.
- Exceptions clearly defined.

**1.0 Assumptions** /04-06-00

- Sufficient rationale to permit verification of assumption.
- Unverified assumptions identified as such.
- References provided for assumptions.

**1.0 Design Inputs** /04-06-00

- All applicable design inputs identified.
  - CODES, (ASME, CFR, STATE, etc.)
  - STANDARDS (IEEE, ANSI, ANS, ASTM, etc.)
  - USAR
  - Design Criteria
  - Input Data
  - Regulatory Guides/Requirements (NRC, EPA, STATE, etc.)
  - Design Bases Documents
- Appropriate verification of walkdown information.

**CALCULATION VERIFICATION CHECKLIST
(Continued)**

**Verification Item**

**6.0 Calculations**

- Correct formulas/methods selected to support the problem statement and objective.
- Formula variables clearly labeled (including engineering units) and consistent with source references.
- Review of computer program data input/output.
- Reference provided, as appropriate, for sketches.
- Sufficient bases/rational provided to permit verification of engineering judgment.

/04-06-00

**6.0 Conclusions**

- Clear statement of the calculation results and consistency with the problem statement and objective.
- Acceptability of the results clearly defined.
- Recommendations for unacceptable results, provided, if applicable.
- Clear definition of limitations or requirements imposed by the calculation necessary to maintain the validity of the results.

/04-06-00

**6.0 References**

- All pages of the attachments labeled with appropriate information (attachment no., project calculation no., revision no., number of sheets (Sht ___ of ___)).

/04-06-00

**6.0 Verification Disciplines**

- Design/Calculation verifier proficient in discipline of verification. Multi-discipline verification obtained if needed.

/04-06-00

**6.0 Administrative**

- Calculation prepared neat and legibly with sufficient contrast to allow satisfactory copies to be produced.
- Calculation number/revision and sheet number provided on each page.
- Revision block and revision bars completed for revised calcs.
- All attachments provided are included in page numbering.
- Calculation's name and subject appropriately identified.
- Calculation properly logged in the Site Analysis Index.
- Analysis of Record form completed (PINGP 1075).

/04-06-00

# D5/D6 Fuel Oil Storage Requirements

## 1.0 Purpose:

The purpose of this revision to ENG-ME-066 is to:

1. Reflect diesel generator load updates in Section 8 of the USAR.

## 2.0 Methodology

The method used in this calculation will be the same as that used in Revision 0 and Revision 1. The fuel consumption rate determined in Revision 1 will be used in this revision.

1. Determine the total fuel consumption using equipment loads from USAR, Table 8.4-2 and time frames noted in different scenarios stipulated in the USAR and the Technical Specification bases as discussed in Section 4.0.

## 3.0 Assumptions

The assumptions used in this analysis are the same as those used in Revision 0 and Revision 1.

## 4.0 Acceptance Criteria

The USAR and the Technical Specification bases give three different scenarios for the Unit 2 diesel generators.

1. One EDG operating at rated load for seven days. This basis is found in the Technical Specification bases for Section 3.7.
2. Two EDG's operating at actual load for seven days. This basis is found in the USAR, Section 2.4.
3. One EDG operating at actual load for 14 days. This basis is found in the USAR, Section 2.4.

The new standard Tech Spec will contain conditions that use 12 day and 6 day quantities. To support this, additional calculations are added to section 6 of this revision to show consumption for the following two scenarios:

1. Two EDG's operating at actual load for six days.
2. One EDG operating at actual load for twelve days.

X 4

ANSI N195-1976 includes two optional methods for calculating minimum required fuel oil storage volume requirements:

1. EDG operates at rated load for 7 days, or

2. Time dependence of diesel generator loads.

ANSI N195 stipulates that an allowance for fuel consumption required by periodic testing be included and, if option 2 is chosen, a 10% margin be added.

The Technical Specifications specify that a minimum of 75,000 gallons available in the Unit 2 diesel fuel oil storage tanks. Zero level indication in a Unit 2 fuel oil storage tank is at 130 gallons. The centerline of the transfer pump suction line is 5'8" below the tank centerline the pipe is 3" schedule 80 (3.5" OD): thus, the top of the pipe is 5'6.25" below tank centerline (Reference 11). Fuel oil transfer pump NPSH calculation (Reference 10) shows that adequate NPSH is available with the level at the top of the pipe. Centerline of the level indication tap is 5'6" below tank centerline (Reference 12). Therefore, zero indicated level in the tank would provide sufficient fuel to ensure the pump suction is completely covered. In addition, margin should be available for potential level indication uncertainty. This margin is accounted for in the calculations.

## 5.0 Design Inputs

The design inputs used in this analysis are the same as those used in Revision 0 and Revision 1.

## 6.0 Results

### 6.1 Fuel consumption during testing

ANSI N195 suggests including an allowance for periodic testing in the determination of minimum required fuel oil inventory. The most limiting test is the 18-month test. However, it is reasonable to assume that operators would ensure that fuel oil volumes would not decrease below minimum required volumes due to testing. In addition, these surveillance procedures are being revised to include prerequisites to ensure the actual inventory is maintained above the minimum required inventory during this test. For the purposes of this evaluation the monthly test will be considered. This test is run for approximately one hour at full load of 5100 to 5300 kW. 1.5 hours at 5400 kW are assumed for this evaluation.

X5

Fuel Used = 1.5 hour * 5400 kW * 0.0714 gal/kW/hr = 578.3 gallons

6.2 One EDG operating at rated load for seven days.

Fuel Used = 7 days * 24 Hrs * 5400 kW * 0.0714 gal/kW/hr = 64,774.1 gal

Adding in the fuel consumed during the test yields the total minimum fuel inventory required: 578.3 + 64,774.1 = 65,352.4 gallons.

6.3 Two EDG's operating at actual load for seven days.

The worst case Unit 2 EDG load is in the USAR Table 8.4-2. The most recent load changes that update the EDG loading were made per project 98EB02 in calculation ENG-EE-021 Rev. 2 Add. 4. USAR changes will be submitted when the loads are turned over, however, this calculation is being updated prior to turnover to reflect the –021 calculation results. D5 continues to be the heaviest loaded Unit 2 EDG, with new loading as follows:

| | |
|---|---|
| 0 – 5 minutes | 3481 kW |
| 5 – 30 minutes | 3448 kW |
| 30 min – 1 hr | 3452 kW |
| 1 hr – 14 days | 2580 kW |

To allow future minor changes (approx. 120kW) in EDG loading the average first hour load is assumed to be 3600 kW. After the first hour the profile assumes the load remains constant throughout the 14 days at 2700 kW. This is very conservative.

| | |
|---|---|
| Fuel Used (1 EDG) = | |
| | (1 hr*3600 kW + 167 hrs*2700 kW) * 0.0714 |
| | = 32,451.3 gal |
| + Testing | + 578.3 |
| | = 33,029.6 gal |
| + 10% | * 1.1 |
| | = 36,332.56 gal |

For 2 EDG's = 2*36,332.56 = **72,665.1 gal**

6.4 One EDG at Actual Load for 14 days.

Using the same load profile as in Section 6.3

| | |
|---|---|
| Fuel Used | = (1 hr * 3600 kW + 335 hrs * 2700 kW )* 0.0714 |
| | = 64,838.3 gal |
| + Testing | +578.3 |

86

= 65,416.6 gal
+ 10% *1.1
= **71,958.3 gal**

6.5 For future use in the new Tech Specs, the following two variations are calculated:

1. Two EDG's operating at actual load for six days.

Using the same load profile as in Section 6.3 but one day less yields:

| | |
|---|---|
| Fuel Used (1 EDG) = | |
| | (1 hr*3600 kW + 143 hrs*2700 kW) * 0.0714 |
| | = 27,824.58 gal |
| + Testing | + 578.3 |
| | = 28,402.88 gal |
| + 10% | * 1.1 |
| | = 31,243.17 gal |

For 2 EDG's = 2*31,243.17 = 62,486 gal

2. One EDG operating at actual load for twelve days

Using the same load profile as in Section 6.3 but two days less yields:

| | |
|---|---|
| Fuel Used | = (1 hr * 3600 kW + 287 hrs * 2700 kW )* 0.0714 |
| | = 55,584.9 gal |
| + Testing | +578.3 |
| | = 56,163.2 gal |
| + 10% | *1.1 |
| | = 61,779.52 gal |

## 7.0 Conclusions

As demonstrated above, sufficient fuel is specified by the Technical Specifications (with margin) for operation of the Unit 2 Diesel Generators. Section 6.3 gives the largest fuel requirement of **72,665.1 gal.** Tech Specs requires **75,000 gal.** This margin (2335 gal) is adequate to account for potential instrument uncertainties or any unforeseen credible occurrences.

In addition, the following conservatism's are used in this analysis:

1. The load profiles are very conservative:

X 7

- The actual load is based on a DBA + LOOP and assumes that the load remains constant for the entire 14 days. As the unit is stabilized, the diesel loads would reduce.

- For both diesels operating at actual load for seven days, additional fuel can be delivered well within this time frame.

- For one diesel operating at actual load for 14 days the profile is very conservative. The 14 days of operation (without refilling the storage tanks) is based on a design basis flood, which would not include a DBA. The profile in this case would be due to a LOOP (2602 kW per calculation ENG-EE-045 Rev. 3 and USAR, Table 8.4-3). This would result in the following fuel consumption which is less than the DBA load total.

  Fuel = 14 days * 24 hr/dy * 2602 kW * 0.0714 gal/kW/hr
  = 62,423.02 gal
  + Test + 578.3
  = 63,001.32 gal
  + 10% * 1.1
  = 69,301.45 gal

2. The time dependent loading method includes an additional 10% margin.

3. The calculation assumes a fuel oil temperature of 120F. 75F would be a more reasonable assumption. The reviewer notes (attached to Revision 1) show that using a fuel oil temp. of 75F would require more than 3000 gal less than the result using the 120F fuel oil temperature.

4. The calculations for two EDGs operating at actual load use the load of the heaviest loaded EDG and multiply by two, rather than calculating the actual load for the lighter loaded EDG and adding it to the heavier loaded one.

**8.0 References**

1. ANSI N195-1976 "American National Standard, Fuel Oil Systems for Standby Diesel Generators."

2. NRC Regulatory Guide 1.137, "Fuel Oil Systems for Standby Diesel Generators," Rev. 1, dated Oct, 1979.

3. Technical Specification Bases B. 3.7, "Auxiliary Electrical Systems."

4. USAR, Section 8, "Plant Electrical Systems"

5. USAR, Section 2, "Plant site and Environments"

X8

6. Calculation ENG-EE-021, "Diesel Generator Steady State Loading for an SI Event Concurrent with a Loss of Off-Site Power (LOOP) for D1, D2, D5, D6," Revision 2, Addendum 4.

7. Calculation ENG-EE-045, "Diesel Generator Steady State Loading for a LOOP coincident with an SBO Event" Rev. 3.

9/9
8/6

Enclosure

Attachment 4

ENG-ME-066, Revision 1, "D5/D6 Fuel Oil Storage Requirements"

12 pages follow

U9701070005

PINGP 1083, Rev. 1
Front Page 1 of 1
Retention: Life

# NORTHERN STATES POWER COMPANY

## PRAIRIE ISLAND NUCLEAR GENERATING PLANT

## CALCULATION COVER SHEET

Calculation Number: ENG-ME-066

Calculation Rev. No.: 1 Addenda No.: 0

Calculation Title: D5/D6 Fuel Oil Storage Requirements

Safety Related?: Y

Calculation Verification Method (Check One):

✓ Design Review ______ Alternate Calculation ______ Qualification Testing

Scope of Revision:

Reflect Diesel Loading Updates

Documentation of Reviews and Approvals:

| | | | |
|---|---|---|---|
| Originated By: | [signature] | Date: | 10/15/96 |
| Checked By: | [signature] | Date: | 10/31/96 |
| Verified By: | [signature] | Date: | 10/31/96 |
| Approved By: | [signature] | Date: | 11/1/96 |

## CALCULATION VERIFICATION CHECKLIST

**Calculation No.:** ENG-MS-066 **Revision No.:** 1

**Use of Computer for Calculation**

- [x] Manual Calculation (no computer results)
- [ ] Computer
  - [ ] Verified Program (Reference ________ Provides Verification)
  - [ ] Unverified Program (Verification of Results Required)

| Verification Item | * (Refer to Site Engineering Manual, Administrative Standard 1.2.3) | Initials/Date |
|---|---|---|
| **1.0** | **Purpose**<br>• Clear objective and problem statement.<br>• Identification of affected structure, system, and/or component.<br>• Identification of the intended use of the calculation results.<br>• Identification of summary results. | Dun, 10/31/96 |
| **2.0** | **Methodology**<br>• Discussion of the method/approach and major steps.<br>• Definition of any limitations of methodology. | Dun, 10/31/96 |
| **3.0** | **Acceptance Criteria**<br>• Clear definition of the acceptance criteria.<br>• Exceptions clearly defined. | Dun, 10/31/96 |
| **4.0** | **Assumptions**<br>• Sufficient rationale to permit verification of assumption.<br>• Unverified assumptions identified as such.<br>• References provided for assumptions. | Dun, 10/31/96 |
| **5.0** | **Design Inputs**<br>• All applicable design inputs identified.<br>– CODES, (ASME, CFR, STATE, etc.)<br>– STANDARDS (IEEE, ANSI, ANS, ASTM, etc.)<br>– USAR<br>– Design Criteria<br>– Input Data<br>– Regulatory Guides/Requirements (NRC, EPA, STATE, etc.)<br>– Design Bases Documents<br>• Appropriate verification of walkdown information. | Dun, 10/31/96 |

## CALCULATION VERIFICATION CHECKLIST
**(Continued)**

**Verification Item**

**6.0 Calculations**

- Correct formulas/methods selected to support the problem statement and objective.
- Formula variables clearly labeled (including engineering units) and consistent with source references.
- Review of computer program data input/output.
- Reference provided, as appropriate, for sketches.
- Sufficient bases/rational provided to permit verification of engineering judgment.

Dew 10/31/96

**7.0 Conclusions**

- Clear statement of the calculation results and consistency with the problem statement and objective.
- Acceptability of the results clearly defined.
- Recommendations for unacceptable results, provided, if applicable.
- Clear definition of limitations or requirements imposed by the calculation necessary to maintain the validity of the results.

BS 11/7/96

**8.0 References**

- All pages of the attachments labeled with appropriate information (attachment no., project calculation no., revision no., number of sheets (Sht ___ of ___)).

Dew 10/31/96

**9.0 Verification Disciplines**

- Design/Calculation verifier proficient in discipline of verification.
- Multi-discipline verification obtained if needed.

BS 11/7/96

**10.0 Administrative**

- Calculation prepared neat and legibly with sufficient contrast to allow satisfactory copies to be produced.
- Calculation number/revision and sheet number provided on each page.
- Revision block and revision bars completed for revised calcs.
- All attachments provided are included in page numbering.
- Calculation's name and subject appropriately identified.
- Calculation properly logged in the Site Analysis Index.
- Analysis of Record form completed (PINGP 1075).

Dew 10/31/96

# D5/D6 Fuel Oil Storage Requirements

## 1.0. PURPOSE:

The purpose of this revision to ENG-ME-066 is to:

1. Reflect diesel generator load updates in Section 8 of the USAR.
2. Provide justification for use of less conservative fuel consumption during testing.

## 2.0 METHODOLOGY

The method used in this calculation will be the same as that used in the original issue.

1. Determine the fuel consumption rate per KW. This was previously determined in revision 0. Provided the load on the diesel is over 2100 KW, the fuel consumption will be taken as 215 grams/KW/hour (see attached figure). This is conservative, as the diesel load increases the fuel consumption rate decreases.
2. Determine the total fuel consumption using equipment loads from USAR, Table 8.4-2 and time frames noted in different scenarios stipulated in the USAR and the Technical Specification bases.

## 3.0 ASSUMPTIONS

The assumptions used in this analysis are the same as those used in Revision 0.

## 4.0 ACCEPTANCE CRITERIA

Between the USAR and the Technical Specification bases, three different scenarios are presented for the Unit 2 diesel generators.

1. One EDG operating at rated load for seven days. This basis is found in the Technical Specification bases for Section 3.7.
2. Two EDGs operating at actual load for seven days. This basis is found in the USAR, Section 2.4.
3. One EDG operating at actual load for 14 days. This basis is found in the USAR, Section 2.4.

ANSI N195-1976 includes two optional methods for calculating minimum required fuel oil storage volume requirements:

1. EDG operates at rated load for 7 days, or

2. Time dependence of diesel generator loads.

ANSI N195 stipulates that an allowance for fuel consumption required by periodic testing be included and, if option 2 is chosen, a 10% margin be added.

The Technical Specifications specify that a minimum of 75,000 gallons be available in the Unit 2 diesel fuel oil storage tanks. Zero level indication in a Unit 2 fuel oil storage tank is at 130 gallons. The centerline of the transfer pump suction line is 5'8" below the tank centerline. The pipe is 3" schedule 80 (3.5" OD); thus, the top of the pipe is 5'6.25" below tank centerline (Reference 11). Fuel oil transfer pump NPSH calculation (Reference 10) shows that adequate NPSH is available with the level at the top of the pipe. Centerline of the level indication tap is 5'6" below tank centerline (Reference 12). Therefore, zero indicated level in the tank would provide sufficient fuel to ensure the pump suction is completely covered. In addition, margin should be available for potential level indication uncertainty. This margin is accounted for in the calculations.

## 5.0 DESIGN INPUTS

The design inputs used in this analysis are the same as those used in Revision 0.

## 6.0 RESULTS

### 6.1 Fuel Consumption Rate

Based on revision 0, the following fuel consumption rate is used in this calculation.

For diesel load over 2100 KW, the consumption rate is 215 grams/KW/hour. Diesel fuel specific volume is $3.32 \times 10^{-4}$ gal/gr. Based on these values, the fuel consumption rate is 0.0714 gal/KW/hour.

### 6.2 Operating scenarios

#### 6.2.1 Fuel consumption during testing

ANSI N195 suggests including an allowance for periodic testing in the determination of minimum required fuel oil inventory. The most limiting test is the 18 month test. However, it is reasonable to assume that operators would ensure that fuel oil volumes would not decrease below minimum required volumes due to testing. In addition, these surveillance procedures are being revised to include prerequisites to ensure the actual inventory is maintained above the minimum required inventory during this test. For the purposes of this evaluation the monthly test will be considered. This test is run for approximately one hour at full load of 5100 to 5300 KW. 1.5 hours at 5400 KW is assumed for this evaluation.

Fuel Used = 1.5 hour * 5400 KW * 0.0714 gal/KW/hr = 578.3 gallons

6.2.2 One EDG operating at rated load for seven days

Fuel Used = 7 days * 24 hours * 5400 KW * 0.0714 gal/KW/hr = 64,774.1 gal

Adding in the fuel consumed during the test, and the total minimum fuel inventory required is 578.3 + 64,774.1 = 65,352.4 gallons.

6.2.3 Two EDGs operating at actual load for seven days

The EDG load in the USAR Table 8.4-2 is as follows

| | |
|---|---|
| 0 - 5 minutes | 3813 KW |
| 5 - 30 minutes | 3784 KW |
| 30 min - 1 hour | 3788 KW |
| 1 hour to 14 days | 2916 KW |

The average first hour load is less than 3800 KW. After the first hour, the profile assumes the load remains constant throughout the 14 days. This is very conservative. For example, this profile assumes that the AFW Pump (234 KW) remains in operation for the entire 14 days, when in fact, the AFW Pump would be secured shortly into the event. Conservatively assuming the AFW Pump is secured after eight hours, the load would be reduced to 2682 KW. Thus, the load profile used for this evaluation is as follows:

| | |
|---|---|
| 0 -1 hour | 3800 KW |
| 1 - 8 hours | 2916 KW |
| 8 hour - 14 days | 2682 KW |

Fuel Used (1 EDG) =

| | |
|---|---|
| | (1 hr*3800 KW + 7 hrs*2916 KW + 160 hrs*2682 KW) * 0.0714 |
| | = 32,367.9 gal |
| + Testing | + 578.3 |
| | = 32,946.2 gal |
| + 10% | * 1.1 |
| | 36,240.8 gal |

For 2 EDGs = 2 * 36,240.8 = 72,481.7 gal

6.2.4 One EDG at Actual Load for 14 Days

Using the same load profile as in Step 6.2.3

| | |
|---|---|
| Fuel Used | = (1 hr * 3800 KW + 7 hrs * 2916 KW + 328 hrs * 2682 KW) * 0.0714 |
| | = 64,539 gal |
| + Testing | + 578.3 |
| | = 65,117.3 gal |
| + 10% | * 1.1 |
| | 71,629.1 gal |

## 7.0 CONCLUSIONS

As demonstrated above, sufficient fuel is specified by the Technical Specifications (with margin) for operation of the Unit 2 Diesel Generators. This margin is adequate to account for potential instrument uncertainties and any unforeseen credible occurrences.

In addition, the following conservatisms are used in this analysis:

1. The load profiles are very conservative. The actual load is based on a DBA + LOOP and assumes that the load remains constant for the entire 14 days. As the unit is stabilized, the diesel loads would reduce.

   - For both diesels operating at actual load for seven days, additional fuel can be delivered well within this time frame.

   - For one diesel operating at actual load for 14 days the profile is very conservative. The 14 days of operation (without refilling the storage tanks) is based on a design basis flood, which would not include a DBA. The profile in this case would be due to a LOOP (2353 KW per USAR, Table 8.4-3). This would result in the following fuel consumption.

     | | |
     |---|---|
     | Fuel | = 14 days * 24 hr/dy * 2353 KW * 0.0714 gal/KW/hour |
     | | = 56,449.4 gal |
     | + Test | + 578.3 |
     | | = 57,027.7 gal |
     | + 10% | * 1.1 |
     | | 62,730.5 gal |

2. The time dependent loading method includes an additional 10% margin.

3. The calculation assumes a fuel oil temperature of 120F. 75F would be a more reasonable assumption. The attached reviewer notes show that using a fuel oil temperature of 75F would require more than 3000 gallons less than the result using the 120F fuel oil temperature.

## 8.0 REFERENCES

1. ANSI N195-1976, "American National Standard, Fuel Oil Systems for Standby Diesel Generators."

2. NRC Regulatory Guide 1.137, "Fuel Oil Systems for Standby Diesel Generators," Rev. 1, dated October, 1979.

3. Technical Specification Bases B.3.7, "Auxiliary Electrical System."

4. USAR, Section 8, "Plant Electrical Systems."

5. USAR, Section 2, "Plant site and Environments."

6. Calculation ENG-EE-021, "Diesel Generator Steady State Loading for an SI Event Concurrent with a Loss of Off-Site Power (LOOP) for D1, D2, D5, D6," Revision 2.

**STATION BLACKOUT/ESU PROJECT E-89Y974**
**DIESEL FUEL OIL CONSUMPTION/STORAGE Rev 1**

**FILE: ENG-ME-066**
**OCT 23, 1996**
**Review Notes**

**Factory Test data ESU-1415 shows (heat value +/- 3%):**

210 g/KWhm at full load and 42700 kJ/kg
213 g/KWhm at 3/4 load
223 g/KWhm at 1/2 load 60 deg F and SG=0.84 (actually in SACM Lab Report 90/417).

**Considerations**
Fuel is No 2 diesel oil at 28 deg API min and can range up to 39. For an API of 30 the heat value ranges 18250 Btu/lb low to 19420 Btu/lb high. API of 40 ranges from 18500 to 19750 (Mark's 9th Ed Pg 7-14).

The FDI High heat value includes water vapor heat of evaporation, not useful energy to the engine. Low heat value applies as net useful energy to the engine.

FDI Ltr FN-12177 storage capacity curves for a range of API/temperature are for information only. The worst case storage temperature at 120 deg F is not valid (too high) since it represents the day tank design limit. Underground vault storage temperature is realistically about 65-70 deg F.

ESU-1415 2-27-91 determined the fuel heat value is 18039 Btu/lb from SACM factory tests. This is the low heat value.

ASME PTC 17, 1973, Pg 6 Item 2.7.2 calls for low heat value of fuel to be used for tests.

Fuel consumption per ESU-1415 for 2 engines at combined output of 5400 KWe is reported at 208 g/KWe and corresponds to 353.2 gal/hr for 1 genset (2 engines; SACM fuel oil per LAB/90/417).

**USEFUL IDENTITIES**
Joules, mean (Marks Handbook 9th Ed Pg 1-20)

$Joule := 1.054350 \cdot 1000$ Btu

$Cal := 4.186800$ Joule

$\frac{Joule}{Cal} = 251.827171$ calories/Btu

**Fuel Consumption using SACM Factory Data**

$353.2 \cdot 7 \cdot 24 = 5.93376 \cdot 10^{4}$ gallons for 7 24 hr days at 5400KWe.

$\frac{1}{3.7854} = 0.264173$ gal/liter $\frac{.264173}{.84 \cdot 1000} = 3.144917 \cdot 10^{-4}$ gal/gr as used in ESU-1415 for SACM fuel at 0.84 SG, API 37, 60 deg F.

$Ggr := 3.144917 \cdot 10^{-4}$

Check Calculation, API, SACM Data

$API := \frac{141.5}{.84} - 131.5$

Ref: Steam Plant Operation 6th Edition Pg 130

$API = 36.952381$ For SG=0.84 at 60 deg F.

$208 \cdot Ggr \cdot 5400 = 353.237077$ Gallons per hour using specific heat rate (208 g/kwe) of ESU-1415.

9

STATION BLACKOUT/ESU PROJECT E-89Y974
DIESEL FUEL OIL CONSUMPTION/STORAGE Rev 1

FILE: ENG-ME-066
OCT 23, 1996
Review Notes

**RANGE OF SPECIFIC FUEL RATES, 60 deg F, 7-DAY Storage Needs :**

One extra day is included representing a day's test run.......

g/KWe(or m) X Gal/g X KWe X hrs = Gals (at 60 deg F, SG 0.84, API 37)

Using Genset Tech Manual....and mechanical KWm..... $Ggr = 3.144917 \cdot 10^{-4}$ Gal/gram

$203 \cdot Ggr \cdot 5561.28 \cdot (7 \cdot 24 + 24) = 6.81631 \cdot 10^4$ $\quad \frac{5400}{.971} = 5.561277 \cdot 10^3$ Gallons @ g/KWm=203 per DLTC-1605 pg 36.

Using Prairie Island Experience........210 g/KWe.....

$210 \cdot Ggr \cdot 5561.28 \cdot (7 \cdot 24 + 24) = 7.051873 \cdot 10^4$ Gallons

Gallons @ g/KWe=210 per telecon 12/12/93 of JA Pryatel& G Thoraldson.

Using Factory Test Experience..........212 g/KWe

$212 \cdot Ggr \cdot 5400 \cdot (7 \cdot 24 + 24) = 6.912578 \cdot 10^4$ Gallons

Gallons @ g/KWe=212 per Figure 1 as the mean engines' factory tests.

ENG-ME-066 Rev 1 Scenario g/KWe(or m) X Gal/g X KWe X hrs = Gals (at 60 deg F, SG 0.84, API 37)

One EDG operating at rated load following 1.5 hr test load

$216 \cdot Ggr \cdot 5400 \cdot (7 \cdot 24 + 1.5) = 6.217652 \cdot 10^4$ Gallons $\quad Ggr = 3.144917 \cdot 10^{-4}$ Gal/gram

**RANGE OF SPECIFIC FUEL RATES, 120 deg F, 7-DAY Storage Needs:**

One extra day is included representing a day's test run.......

$Ggrh = 3.3214 \cdot 10^{-4}$

Gallons/gram for 120 deg F

$212 \cdot Ggrh \cdot 5400 \cdot (7 \cdot 24 + 24) = 7.30049 \cdot 10^4$ Gallons

Gallons @ g/KWe=212 per Figure 1 as the mean engines' factory tests.

$215 \cdot Ggrh \cdot 5400 \cdot (7 \cdot 24 + 24) = 7.403799 \cdot 10^4$ Gallons

$216 \cdot Ggrh \cdot 5400 \cdot (7 \cdot 24 + 24) = 7.438235 \cdot 10^4$ Gallons

Gallons @ g/KWe=216 per (210 g/KWm)/(0.971) as converted to KWe basis.

ENG-ME-066 Rev 1 Scenario g/KWe(or m) X Gal/g X KWe X hrs = Gals (at 120 deg F SG 0.84, API 37)

One EDG operating at rated load following 1.5 hr test load

$215 \cdot Ggrh \cdot 5400 \cdot (7 \cdot 24 + 1.5) = 6.536166 \cdot 10^4$ **Gallons: Para 6.2.2 ENG-ME-066 Rev 1 for 120 deg F Fuel**

**STATION BLACKOUT/ESU PROJECT E-89Y974**
**DIESEL FUEL OIL CONSUMPTION/STORAGE Rev 1**

FILE: ENG-ME-066
OCT 23, 1996
Review Notes

**RANGE OF SPECIFIC FUEL RATES, 75 deg F, 7-DAY Storage Needs:**

---

Referring to STEAM 38th Edition by B&W, page 5-19 Figure 8, for temperature and volume correction factor, the value for 75 deg F is 0.995. Applying this to the Factory SG of 0.84 (60 deg F), the corrected SG is .8358. Resolving for gal/gr......

$Ggrm := \frac{0.264173}{.8358 \cdot 1000}$ Gals/liter @ std conditions and converted for Gals/grams

$Ggrm = 3.16072 \cdot 10^{-4}$ Gallons/gram — Gal/gr used in ESU-1415 SACM fuel at 0.84 SG API 37, 60 deg F, and corrected to 75 deg F.

$216 \cdot Ggrm \cdot 5400 \cdot (7 \cdot 24 + 24) = 7.078395 \cdot 10^{4}$ Gallons — Gallons @ g/KWe=216 per (210 g/KWm)/(0.971) as converted to KWe basis.

ENG-ME-066 Rev 1 Scenario g/KWe(or m) X Gal/g X KWe X hrs = Gals (at 75 deg F, SG 0.84, API 37)
One EDG operating at rated load following 1.5 hr test load

$215 \cdot Ggrm \cdot 5400 \cdot (7 \cdot 24 + 1.5) = 6.219966 \cdot 10^{4}$ Gallons; Para 6.2.2 ENG-ME-066 Rev 1 for 75 deg F Fuel

**TIME DEPENDENT Method with Various Storage Temps and Specific Fuel Rates**

---

ENG-ME-066 Rev 1 Scenario g/KWe(or m) X Gal/g X KWe X hrs = Gals (at 120 deg F, SG 0.84, API 37)

$Ggrh = 3.3214 \cdot 10^{-4}$ Gal/gram for 120 deg F

Two EDGs Operating Over 7 Days at Actual Load (stepped sequence)

$SL := 3800 + 7 \cdot 2916 + 160 \cdot 2682 + 1.5 \cdot 5400$ Total KWe for 1Genset including 1.5 hr testing

$215 \cdot Ggrh \cdot SL = 3.295091 \cdot 10^{4}$ Gallons for 1 Genset

$2 \cdot 215 \cdot Ggrh \cdot SL = 6.590181 \cdot 10^{4}$ Gallons for 2 Gensets

$2 \cdot 215 \cdot Ggrh \cdot SL \cdot 1.1 = 7.249199 \cdot 10^{4}$ **Gallons for 2 Gensets with 10% extra; Para 6.2.3 ENG-ME-066 Rev 1**

ENG-ME-066 Rev 1 14 Days g/KWe(or m) X Gal/g X KWe X hrs = Gals (at 75 deg F, SG 0.84, API 37)

$Ggrm = 3.16072 \cdot 10^{-4}$ Gals/gram at 75 deg F

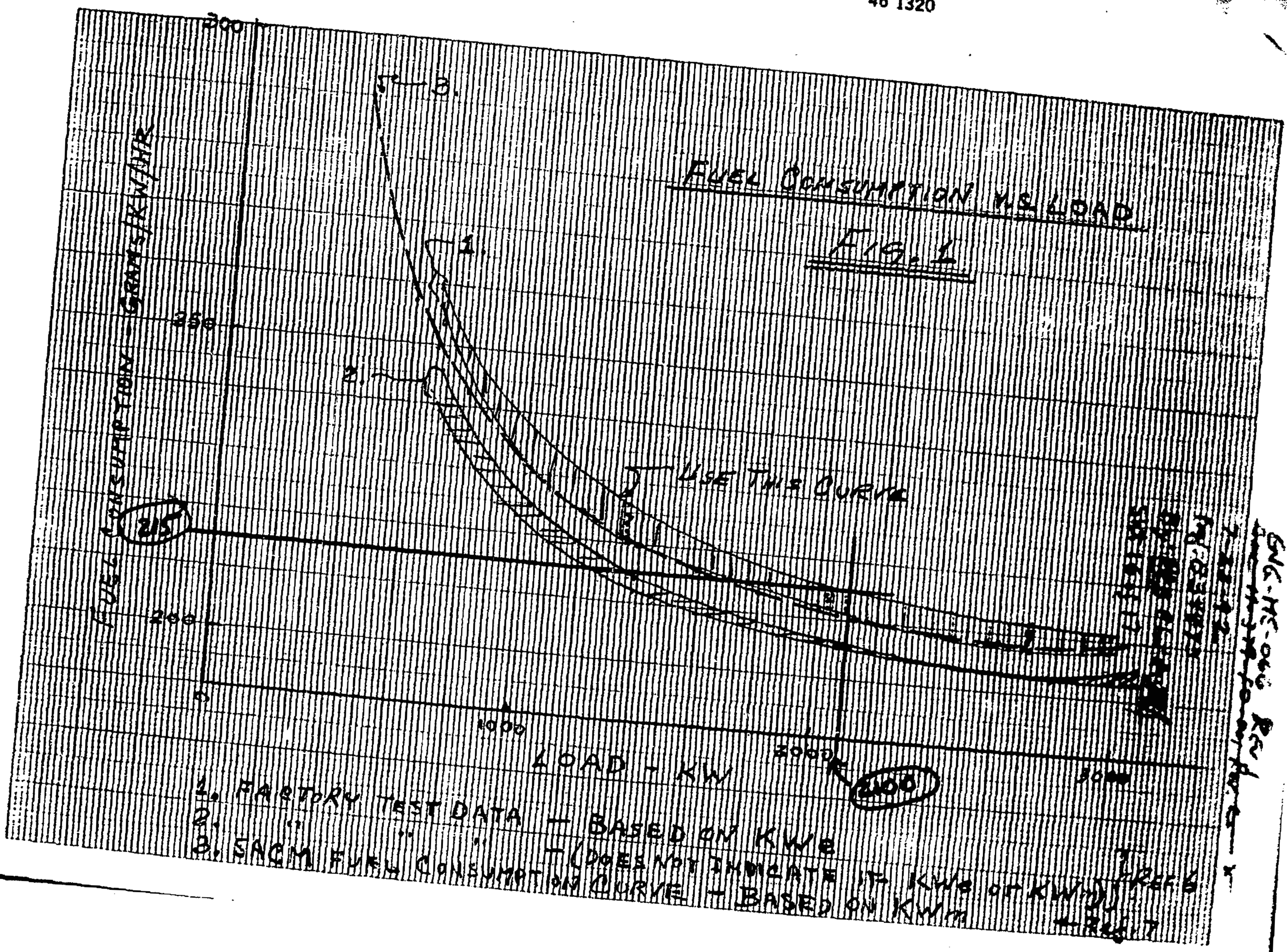
$2 \cdot 215 \cdot Ggrm \cdot SL \cdot 1.1 = 6.898504 \cdot 10^{4}$ Gallons for 2 Gensets with 10% extra if stored at 75 deg F

One EDG Operating Over 14 Days at Actual Load (at 120 deg F Fuel, SG 0.84, API 37)

$TL := 3300 + 7 \cdot 2916 + 328 \cdot 2682 + 1.5 \cdot 5400$ Total KWe including 1.5 hr testing

$215 \cdot Ggrh \cdot TL \cdot 1.1 = 7.163924 \cdot 10^{4}$ **Gallons for 1 Genset with 10% extra Para 6.2.4 ENG-ME-066 Rev 1**

$215 \cdot Ggrm \cdot TL \cdot 1.1 = 6.817354 \cdot 10^{4}$ Gallons for 1 Genset with 10% extra if stored at 75 deg F


FUEL CONSUMPTION VS LOAD
FIG. 1
USE THIS CURVE
1.
2.
3.
300
250
215
200
0
1000
2000
2100
3000
LOAD - KW
FUEL CONSUMPTION - GRAMS/KW/HR
1. FACTORY TEST DATA - BASED ON KWe
2. " " " - (DOES NOT INDICATE IT KWe or KWm) REF 6
3. SACM FUEL CONSUMPTION CURVE - BASED ON KWm REF 7
GNG-MS-066 Rev
7-23-92

Enclosure

Attachment 5

ENG-ME-066, Revision 0, “Determination of D5/D6 Fuel Oil Storage Requirements”

19 pages follow

U940823009

PINGP 1083, Rev. 1
Front Page 1 of 1
Retention: Life

**NORTHERN STATES POWER COMPANY**

**PRAIRIE ISLAND NUCLEAR GENERATING PLANT**

**CALCULATION COVER SHEET**

Calculation Number: ENG-ME-066

Calculation Rev. No.: 0 Addenda No.: NA

Calculation Title: Determination of D5/D6 Fuel Oil Storage Requirements

Safety Related?: Yes

Calculation Verification Method (Check One):

✓ Design Review ____ Alternate Calculation ____ Qualification Testing

Scope of Revision:

1. Supersedes and revises FDI calculation M-379-FO-001, Rev 2

2. Incorporation of final D5/D6 Operating data + System config.

Documentation of Reviews and Approvals:

| | | | |
|---|---|---|---|
| Originated By: | [signature] | Date: | 8/3/94 |
| Checked By: | [signature] | Date: | 7/16/94 |
| Verified By: | [signature] | Date: | 8/4/94 |
| Approved By: | [signature] | Date: | 8-5-94 |

Prepared by: JP Verified by: [signature] Date: 8/3/94

# D5/D6 Fuel Oil Storage Tank Sizing Requirements

# SBO/ESU Project, 89Y976

## TABLE OF CONTENTS

## 1.0 Introduction and Purpose

### 1.1 Background

a. As discussed in the Design Report, the original tank sizing was based on two tanks supply an EDG for seven days at 100% power. But to meet the fourteen day licensing commitment of the USAR it was recognized, through an early version of this calculation, that two tanks may not be adequate. Safety related tank piping interconnections, and appropriate redundant pumping support, were included to allow any (or all) of the four storage tanks to supply D5 and/or D6.

b. Recognition of the early design intentions and invoking of N195 (and Reg Guide 1.137), including single failure, the fourteen day USAR operating commitment, and the safety related piping interconnections and pumps, results in the following sizing requirements for the D5/D6 Fuel Oil Storage Tanks: any three tanks shall have the capacity to supply fuel oil to the D5/D6 EDGs to fulfill the licensing criteria outlined in 1.2, below and reflected in Section 4.0, "Acceptance Criteria."

### 1.2 Licensing and Design Basis

a. The PINGP USAR (Reference 1.) specifies: "Fuel from interconnected storage tanks can be transferred to the day tanks by electric pumps for operation of any single diesel up to two weeks."

b. The PINGP Technical Specification (Reference 2.) specifies: "a fuel supply of 75,000 gallons is available for D5 and D6 diesel generators in the Unit 2 interconnected diesel fuel oil storage tanks."

c. The SBO/ESU Project Design Report, Paragraph 3.4.1.2 a. specifies:

Each diesel generator shall be provided with two storage tanks, each with 30,800 gallons useable volume. This volume was determined to be adequate for two tanks to supply the fuel for one EDG to operate at 100% power (5.400 KW) for seven days. The conservative method of ANSI N195 (Reference 3.) was used.

The capacity of three tanks "is sufficient to supply D5 and D6 continuously for seven days at actual load," or one EDG continuously for fourteen days at actual load.

d. In addition, Subsection 3.5 of the Design Report invokes ANSI N195 and Regulatory Guide 1.137 (Reference 4.). Particulars follow:

Subsection 5.2 of N195 specifies that the Fuel Oil system be designed so that a single failure will not result in loss of minimum EDG capacity. Further that adequate storage capacity be provided to operate minimum EDG capacity per unit (one EDG in Prairie Island's case) for seven days following a DBA (SI event), or the time necessary to replenish fuel oil from off-site sources (which is not applicable here because of postulated flood levels for Prairie Island).

Subsection 5.4 provides two approaches for satisfying the above fuel capacity requirements, earlier interpreted as seven day operation for PINGP. First approach: 110% of the fuel oil volume to complete periodic testing and seven days EDG operation at the minimum required loads during the most limiting accident event. Second approach: the fuel oil volume to complete periodic testing and seven days of an EDG operating at its rated (100%) capacity. The second "conservative" approach is recommended. Reg Guide 1.137 accepts N195 and recognizes both approaches, with the caveat that for the actual load approach, capacity to power engineered safety features be included.

## 2.0 Summary of Results

2.1 Three of any four D5/D6 Fuel Oil Storage have the capacity to fulfill fuel demand requirements outlined above, including the conservative N195 method and USAR commitments.

2.2 For information, the less conservative method of N195, using 110% of actual power loads plus testing, can be satisfied with two tanks. Considering that actual loads, even under limiting, and conservatively calculated, DBA conditions, are well under the capacity of D5 or D6, this less conservative is not inappropriate. Also, PINGP has the ability to replenish fuel during an DBA event (Ops Procedure 2C38).

2.3 For information, the 75,000 gallon Tech. Spec. minimum storage requirement envelopes the defined sizing requirements. Further, the 14 day requirement plus 24-hour test usage (approximately 70,500 gallons) can be satisfied by three storage tanks.

## 3.0 Analysis Method

3.1 Determine the EDG fuel consumption rate per KW* of output at a 41 API grade and 120°F fuel storage temperature, utilizing oil characterizations provided by Marks (Reference 15.) and the Crane Technical Paper No.110 (Reference 16.).

3.2 Determine total scenario fuel consumption using SI/LOOP equipment loads from calculation ENG-EE-021 (Reference 10) and time frames defined by Sections 1. and 4. of this calculation.

3.3 Determine whether three Fuel Oil tanks have adequate capacity from the results of 3.2, and tank capacities provided by the PINGP Tank Book (References 8 and 9).

## 4.0 Acceptance Criteria

Any three Fuel Oil Tanks shall have the capacity for supplying fuel oil under the following scenarios, as derived from Subsection 1.2:

a. One EDG completing periodic SP testing (most severe) and operating at 100% capacity for seven days. [Provide 110% of seven day actual loads plus SP test for information.]

b. Both EDGs operating at actual loads for seven days, powering safeguard buses during a limiting DBA event.

c. One EDG operating at actual loads for fourteen days, powering safeguard buses during a limiting DBA event (conservative interpretation of PINGP USAR commitment).

## 5.0 Assumptions

5.1 Diesel generators ("EDGs") D5 and D6, and associated storage tanks, are of identical design, manufacture, installation and test; therefore they are considered identical for the purposes of this calculation. EDG D5 will be used as the source reference point for input materials.

5.2 The maximum API grade is 41, this value conservatively envelops expected anticipated maximums of 39 - 40 API grade (Reference 12.).

5.3 Emergency equipment will operate at full load ratings and in the modes designated in SI/LOOP defined scenarios reflected in, and with the total loads determined by, PINGP Calculation ENG-EE-021 (Reference 10).

5.4 Fuel Oil temperature will be 120°F, the system maximum design temperature (Reference 17.).

## 6.0 Design Inputs

1. XHAIW-2610-1364 [SACM Doc. DLTC 1605], Rev. A, March 1, 1991, Instruction Manual; Paragraph 2-1 2-2-B.

2. XHIAW-2610-1369 [Jeumont Schneider Doc. 6SN0055], Rev. 2, NSP Tech Manual: SACM D.G. Instruction Manual Vol. IV - Generator; Page 0-3-2-1.

3. NSP Prairie Island/SBO Specification No. G190-01, Rev. 4, April 7, 1992, Diesel Fuel Oil Specification.

4. PINGP Tank Book, D5 Fuel Oil Storage Tank (21), July 1, 1993.

5. PINGP Tank Book, D5 Fuel Oil Day Tank (21), July 1, 1993.

6. PINGP Calculation ENG-EE-021, Rev. 1, September 30, 1993, Diesel Generator Steady State Loading for an SI Event Concurrent with a Loss of Off-site Power (LOOP): for D1, D2, D5, D6; Subsection 7.1.

7. PINGP Operating Procedure 2C38, Rev. 4, September 28, 1993, D5/D6 Fuel Oil System; Attachments A and B.

8. Greg Thoraldson/James Pryatel telecon November 18, 1993, File 89Y974-D130.

9. Greg Thoraldson/James Pryatel telecon December 12, 1993, File 89Y974-D130.

10. PINGP Surveillance Procedure SP2334, Rev. 2, September 3, 1993, D5 Diesel Generator 24 Hour Load Test; page 2.

11. Marks Standard Handbook for Mechanical Engineers, Eigth Edition; page 7-16, Table 11 (Heating Value of Petroleum Oils).

12. Crane Technical Paper No. 410, Flow of Fluids, 23 rd Printing, 1986; page A-7 (Specific Gravity - Temperature Relationship for Petroleum Oils), And page A-6 (Properties of Water).

# 7.0 Analysis

## 7.1 EDG Consumption Rate:

Petroleum oils are standardized at 60°F (References 15 & 16).

- Minimum acceptable fuel oil API Gr [maximum density] is 28 (Reference 7).

- Maximum anticipated is API Gr 40 (Reference 12); use API Gr 41 per assumption 5.2,

From Reference 16 (Attachment 1), the corresponding specific gravities (SpG) for the above grades are:

API Gr 28 → 0.89 SpG
API Gr 41 → 0.82 SpG
↓

Minimum density:

$8.34 \ \#/\text{gal}[H_2O] \bullet 0.82 = 6.84 \ \#/\text{gal}.$

Conversion to gal/gr. for specific volume (SpV):

1) $\text{SpV} = 1\#/454 \text{ gr} \bullet 1 \text{ gal}/6.84\# = 3.22 \times 10^{-4} \text{ gal/gr}$

Correction due to higher Heat Value at the min. SpG, from Attachment 2 (extracted from FDI/SBO calc. M0379-FO-001, Rev. 2):

2) $(19.63 \text{ Btu}/\#) \div (19.78 \text{Btu}/\#) = 0.9924$

Correction due to 120°F (assumption 5.4), as opposed to 60°F standard (from Attachment 2) SpG at 120°F is 0.80:

3) $0.82 \text{ SpG}/0.80 \text{ SpG} = 1.025$

Corrected SpV from 1), 2) and 3):

4) $3.22 \times 10^{-4} \text{ gal/gr} \bullet 0.992 \bullet 1.025 = 3.32 \times 10^{-4} \text{ gal/gr}$

Now, calculate D5/D6 EDG output per gallon of fuel oil:

From References 6, 12 and 13, EDG output at 100% power:

5) $210 \text{ gr/KW-hr} \bullet 1 \text{ KW}_m/.971 \text{ KW}_e = 216 \text{ gr/KW}_e\text{-hr}$.

Further, from 4) and 5):

6) $216 \text{ gr/KW}_e \bullet 3.32 \times 10^{-4} \text{ gal/gr} = \mathbf{7.17 \times 10^{-2}} \text{ gal/KW}_e\text{-hr}$

## 7.2 Scenario EDG Fuel Oil Requirements

a. EDG testing: worse case is 24 hour test, from Reference 14 and eq. 6):

7) $(22 \text{ hrs} \bullet 5400 \text{ KW}_e + 2 \text{ hrs} \bullet 5600 \text{ KW}_e) \bullet 7.17 \times 10^{-2} \text{ gal/KW}_e\text{-hr} =$ **9,321gal.**

b. 7-day post accident (SI with LOOP); Reference 3:

i. Conservative method - 100% of rating (5400 $KW_e$):

8) $7\text{-days} \bullet 24 \text{ hr/day} \bullet 7.17 \times 10^{-2} \text{ gal/KW}_e\text{-hr} = 65{,}046$

Add test consumption, from 7) to 8):

9,321 gal + 65,046 gal = **74,367 gal.**

ii. Time dependent method, from Reference 10 and Attachment 3 (extracted from FDI/SBO calc. M0379-FO-001, Rev. 2, OK to use since values more conservative than SACM Instruction Manual, Reference 5):

0-1 hour:

9) $1 \text{ hr} \bullet 3280 \text{ KW}_e \bullet 219 \text{ gr/KW}_e\text{-hr} \bullet 3.32 \times 10^{-4} \text{ gal/gr} = 238 \text{ gal.}$

1 hr - 7 days (167 hrs):

10) $167 \text{ hr} \cdot 2382 \text{ KW}_e \cdot 230 \text{ gr/KW}_e \cdot 3.32 \times 10^{-4} \text{ gal/gr} = 30{,}376 \text{ gal.}$

| | | |
|---|---|---|
| | From 7): | 9,321 gal. |
| | From 9): | 238 |
| | From 10): | 30,376 |
| | Subtotal: | 39,935 gal. |
| | + 10% | 3,994 |
| 11) | 7-day total: | **43,929 gal** |

c. 14-day post accident (SI with LOOP), References 1 and 10:

0-1 hr:

from 9): 238 gal.

1 hr - 14 days (335 hrs):

$335 \text{ hrs} \cdot 2382 \text{ KW}_e \cdot 230 \text{ gr/KW}_e \cdot 3.32 \times 10^{-4} \text{ gal/gr} = 60{,}934 \text{ gal.}$

14 day total, from above:

12) 238 gal + 60,934 gal = **61,172 gal.**

### 7.3 Tank Capacity

Fuel Oil Storage Tank (FoV), Reference 8: 30,798 gal.

Day Tank volume (DtV), Reference 9: 600 gal.

Baseline Fuel Oil requirements, derived from Subsection 1.2 and Section 4:

3 • FoV + 1 • DtV:

13) 3 • 30,798 + 1 • 600 = **92,994 gal.**

## 8.0 Conclusions

The capacity of the D5/D6 Fuel Oil Storage Tanks have adequate capacity to satisfy the defined acceptance criteria, calculation Section 4, as follows, derived in Section 7.0, as follows:

Total useable capacity of three tanks, from 13): 92,994* gal.

a. Acceptance Criteria 4.0 a:

Minimum volume foı 1 EDG, 7 days 100% power + test, from 8):

74,367 gal. (acceptable)

[Less conservative alternative approach]

Minimum volume for 1 EDG, 110% seven day actual + test, from 11):

43,929 gal (acceptable)

b. Acceptance Criteria 4.0 b:

Minimum volume for 2 EDGs, 7 days actual, from 10):

2 × 30,376 gal. [1 EDG - 7 days actual] = 60,752 gal. (acceptable)

c. Acceptance Criteria 4.0 c:

Minimum volume for 1 EDG, 14 days actual, from 12):

61,172 gal. (acceptable)

* This volume includes 600 gallons from the Fuel Oil Day Tank, per Reference 9 and equation 13), above, which is routinely available through procedural and set-point controls during plant operation; if this added capacity is discounted through a stricter interpretation of storage capacity, the available volume of three Fuel Oil Storage Tanks is 92,394 gallons, which is adequate by observation to satisfy the prescribed acceptance criteria.

## 9.0 References

1. PINGP Updated Safety Analysis Report, Rev. 11, September 1993; Part 8.4.2, Page 8.4-4.

2. PINGP Technical Specification, Rev. 103, December 17, 1992; Subsection 3.7, Paragraph A.5 (b).

3. ANSI N-195-1976; Fuel Oil Systems for Standby Diesel Generators.

4. NRC Regulatory Guide 1.137, Rev. 1, Oct. 1979; Fuel Oil Systems for Standby Diesel Generators.

5. XHAIW-2610-1364 [SACM Doc. DLTC 1605], Rev. A, March 1, 1991, Instruction Manual; Paragraph 2-1 2-2-B.

6. XHIAW-2610-1369 [Jeumont Schneider Doc. 6SN0055], Rev. 2, NSP Tech Manual: SACM D.G. Instruction Manual Vol. IV - Generator; Page 0-3-2-1.

7. NSP Prairie Island/SBO Specification No. G190-01, Rev. 4, April 7, 1992, Diesel Fuel Oil Specification.

8. PINGP Tank Book, D5 Fuel Oil Storage Tank (21), July 1, 1993.

9. PINGP Tank Book, D5 Fuel Oil Day Tank (21), July 1, 1993.

10. PINGP Calculation ENG-EE-021, Rev. 1, September 30, 1993, Diesel Generator Steady State Loading for an SI Event Concurrent with a Loss of Off-site Power (LOOP): for D1, D2, D5, D6; Subsection 7.1.

11. PINGP Operating Procedure 2C38, Rev. 4, September 28, 1993, D5/D6 Fuel Oil System; Attachments A and B.

12. Greg Thoraldson/James Pryatel telecon November 18, 1993, File 89Y974-D130.

13. Greg Thoraldson/James Pryatel telecon December 12, 1993, File 89Y974-D130.

14. PINGP Surveillance Procedure SP2334, Rev. 2, September 3, 1993, D5 Diesel Generator 24 Hour Load Test; page 2.

15. Marks Standard Handbook for Mechanical Engineers, Eighth Edition; page 7-16, Table 11 (Heating Value of Petroleum Oils).

16. Crane Technical Paper No. 410, Flow of Fluids, 23 rd Printing, 1986; page A-7 (Specific Gravity - Temperature Relationship for Petroleum Oils [calculation Attachment 1]), And page A-6 (Properties of Water).

17. PI Design Basis Document, DBD-SYS-38A, Rev. 0, Feb. 4, 1992: Emergency Diesel Generator System.

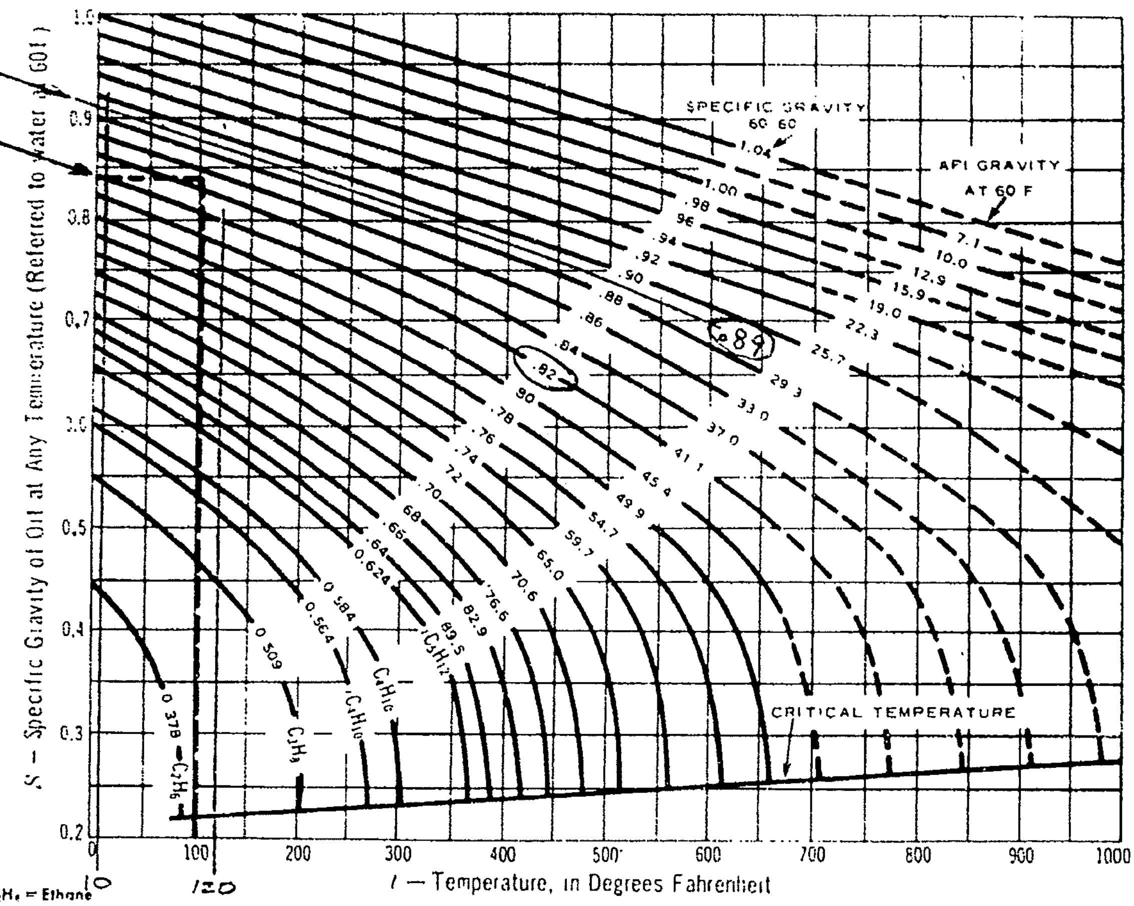
# ATTACHMENTS

ENG-ME-066 Rev 0 Attach. 1



## Specific Gravity-Temperature Relationship for Petroleum Oils[12]

(Reproduced by permission from the Oil and Gas Journal)




$C_2H_6$ = Ethane
$C_3H_8$ = Propane
$C_4H_{10}$ = Butane
$iC_4H_{10}$ = Isobutane
$iC_5H_{12}$ = Isopentane

**Example.** The specific gravity of an oil at 60 F is 0.85. The specific gravity at 100 F = 0.83.

To find the weight density of a petroleum oil at its flowing temperature when the specific gravity at 60 F/60 F is known, multiply the specific gravity of the oil at flowing temperature (see chart above) by 62.4, the density of water at 60 F.

## Weight Density and Specific Gravity* of Various Liquids

| Liquid | Temp. $t$ Deg Fahr | Weight Density $\rho$ Lbs per Cu Ft | Specific Gravity $S$ |
|---|---|---|---|
| Acetone | 60 | 49.4 | 0.792 |
| Ammonia, Saturated | 10 | 40.9 | 0.656 |
| Benzene | 32 | 56.1 | 0.899 |
| Brine, 10% Ca Cl | 32 | 68.05 | 1.091 |
| Brine, 10% Na Cl | 32 | 67.24 | 1.078 |
| Bunkers C Fuel Max | 60 | 63.25 | 1.014 |
| Carbon Disulphide | 32 | 80.6 | 1.292 |
| Distillate | 60 | 52.99 | 0.850 |
| Fuel 3 Max | 60 | 56.02 | 0.898 |
| Fuel 5 Min | 60 | 60.23 | 0.966 |
| Fuel 5 Max | 60 | 61.92 | 0.993 |
| Fuel 6 Min | 60 | 61.92 | 0.993 |
| Gasoline | 60 | 46.81 | 0.751 |
| Gasoline, Natural | 60 | 42.42 | 0.680 |
| Kerosene | 60 | 50.85 | 0.815 |
| M. C. Residuum | 60 | 58.32 | 0.935 |
| Mercury | 20 | 849.74 | 13.623 |
| Mercury | 40 | 848.03 | 13.596 |
| Mercury | 60 | 846.32 | 13.568 |
| Mercury | 80 | 844.62 | 13.541 |
| Mercury | 100 | 842.93 | 13.514 |
| Milk | ... | † | ... |
| Olive Oil | 59 | 57.3 | 0.919 |
| Pentane | 59 | 38.9 | 0.624 |
| SAE 10 Lube‡ | 60 | 54.64 | 0.876 |
| SAE 30 Lube‡ | 60 | 56.02 | 0.898 |
| SAE 70 Lube‡ | 60 | 57.12 | 0.916 |
| Salt Creek Crude | 60 | 52.56 | 0.843 |
| 32.6° API Crude | 60 | 53.77 | 0.862 |
| 35.6° API Crude | 60 | 52.81 | 0.847 |
| 40° API Crude | 60 | 51.45 | 0.825 |
| 48° API Crude | 60 | 49.16 | 0.788 |

*Liquid at specified temperature relative to water at 60 F

†Milk has a weight density of 64.2 to 64.6

‡100 Viscosity Index

Values in the table at the left were taken from *Smithsonian Physical Tables*, *Mark's Engineers' Handbook*, and [12]Nelson's *Petroleum Refinery Engineering*.

Calc ... Rev. 2
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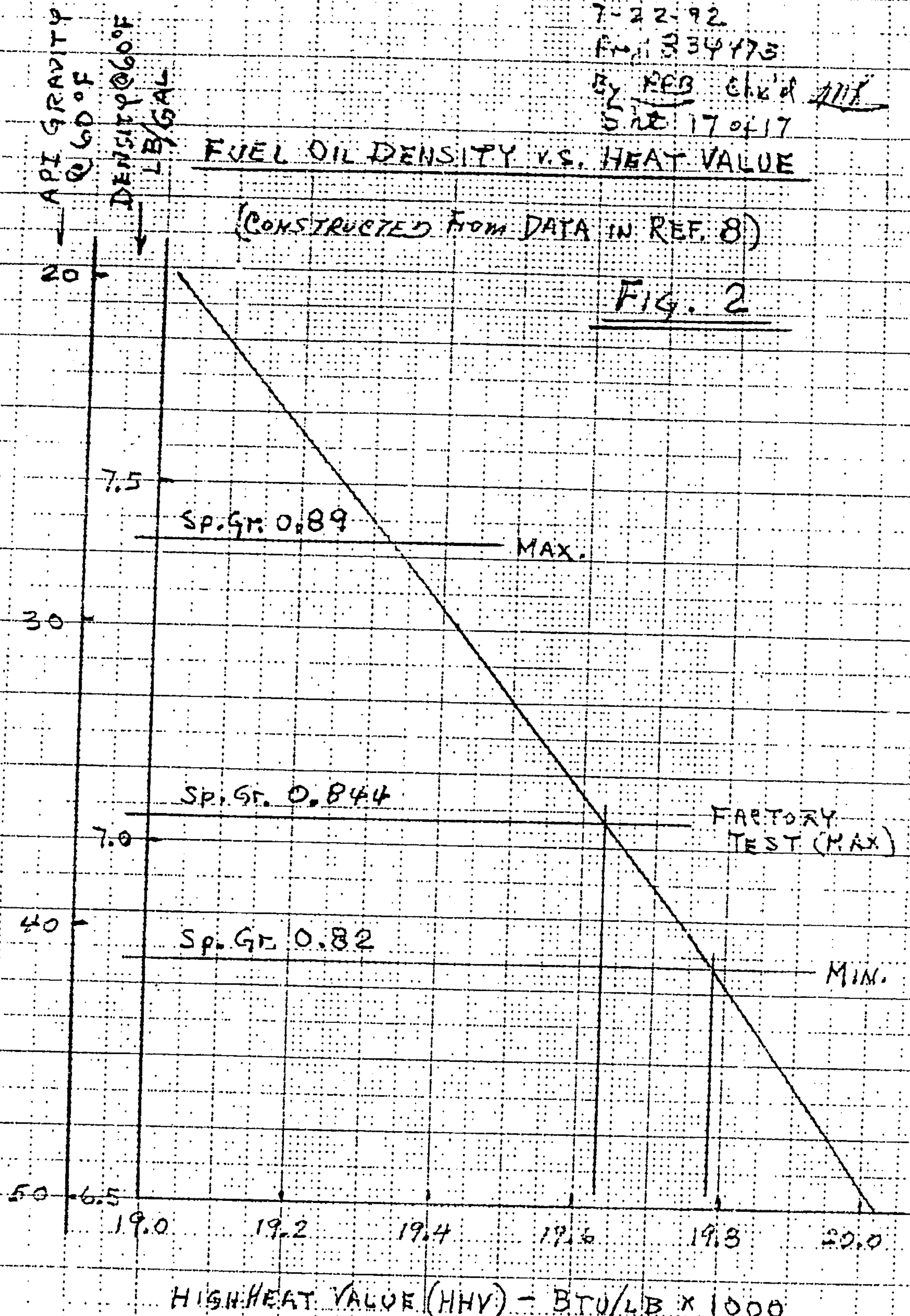
Sht 17 of 17

# FUEL OIL DENSITY VS. HEAT VALUE

(CONSTRUCTED FROM DATA IN REF. 8)

## FIG. 2



ENG-ME-066 Rev 0

Attach. 3

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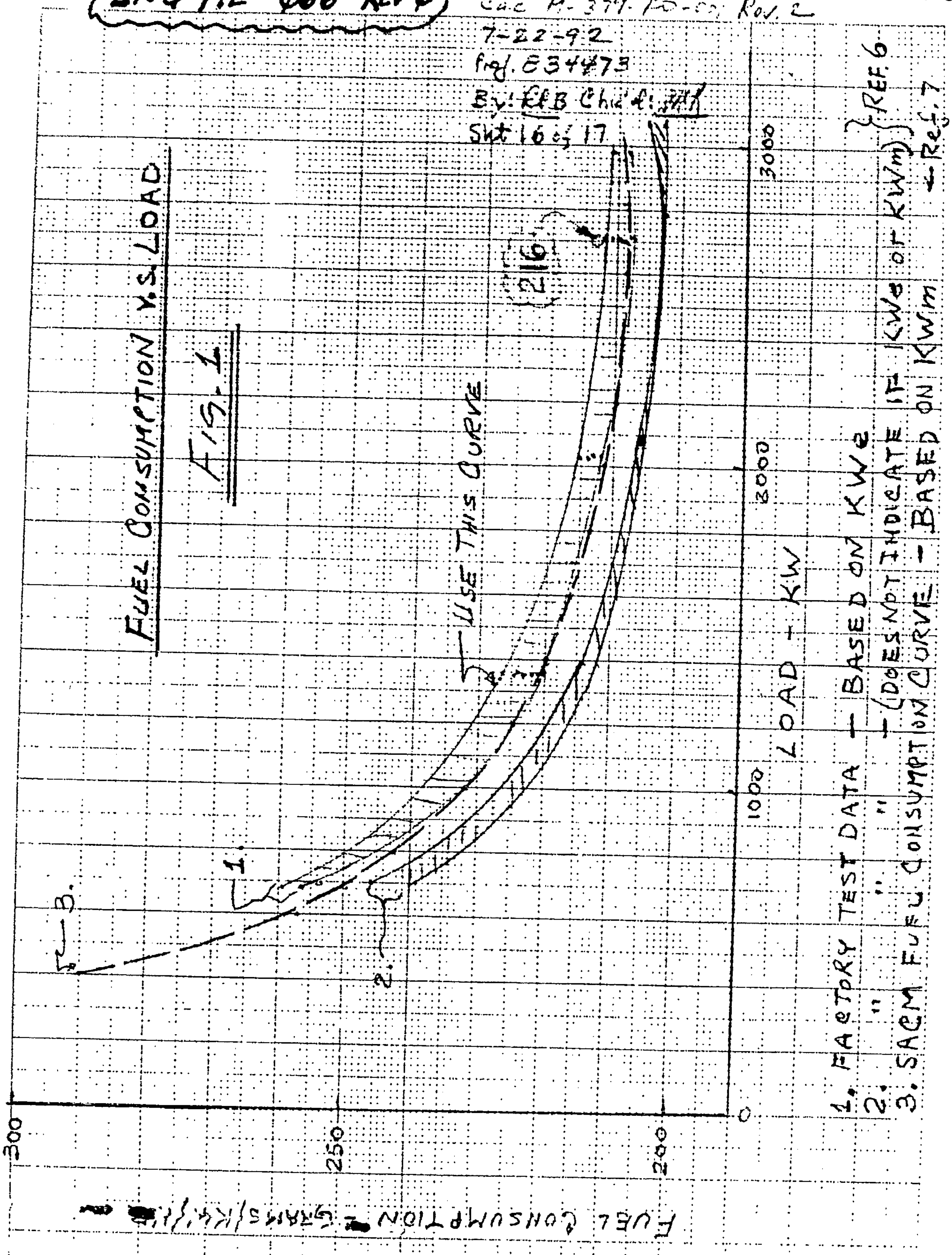


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Form # PP-3-2-VII
Rev. 0

**DOCUMENT AND REVISION NOs:** ENG-ME-066, Rev. 0

**SBO/ESU PROJECT CHECKLIST FOR MECHANICAL DISCIPLINE DESIGN CALCULATIONS** — **SHEET 1 OF 3**

INDICATE THE DESIGN INPUT DOCUMENTS USED:

| TYPE OF DOCUMENT | DOCUMENT ID, REV AND/OR DATE | YES | N/A | COMMENT[1] |
|---|---|---|---|---|
| 1. USAR or Pending USAR | USAR 8.4-4 Rev-11 9/93 | ✓ | | |
| 2. Tech Specs | TS 3.7-1 Rev 103 12/17/93 | ✓ | | |
| 3. System Definition | B38C Rev | ✓ | | |
| 4. Mechanical Discipline Input | Item 14.1 Below | ✓ | | |
| 5. Electrical Discipline Input | | | ✓ | |
| 6. Control System Discipline Input | | | ✓ | |
| 7. Civil/Structural Discipline Input | | | ✓ | |
| 8. Specifications | Hiaw 2610 Rev 8 | ✓ | | |
| 9. Vendor Drawings | Tank Book Charts | ✓ | | |
| 10. Design Standards | DLTC-1605 Rev D | ✓ | | |
| 11. Project Design Criteria | ANSI N195/NRC RG 1.137 | ✓ | | |
| 12. Checked Calculations | Revisions noted | ✓ | | |
| 13. Drawing Numbers | Listed in Par 9.0 | ✓ | | |
| 14. Other (Specify) | | ✓ | | below 14.1 |

14.1 SBO Design Report Rev-2 Pages 47, Par 3.4.1.2 and Pg 59, Par 3.5.3 on RG 1.137 Rev 1 10/79 and Pg 59, Par 3.5.5 ANSI-N195-1976

Also References 21 through 31 being added to FDI Calc M379-FO-001 Rev 2 to become NSP Calc ENG-ME-066. These became References 1 through 17 in final draft. [initials] resolved.

[1] Attach Additional Sheets if Required

Form # PP-3-2-VII
Rev. 0

**DOCUMENT AND REVISION NOs:** ENG- ME-066 Rev 0

| SBO/ESU PROJECT CHECKLIST FOR MECHANICAL DISCIPLINE DESIGN CALCULATIONS | | | | SHEET 2 OF 3 |
|---|---|---|---|---|
| CHECKER/REVIEWER TO COMPLETE THE FOLLOWING ITEMS: | YES | NO | N/A | COMMENT |
| 1. Has the objective purpose of the calculations been clearly and adequately stated? | ✓ | | | |
| 2. Have the applicable codes, standards and regulatory requirements been: | | | | |
| A. Properly identified? | ✓ | | | |
| B. Properly applied? | ✓ | | | |
| 3. Have references been adequately identified? | ✓ | | | |
| 4. Were appropriate references used? | ✓ | | | |
| 5. Were assumptions: | | | | |
| A. Adequately stated? | ✓ | | | |
| B. Reasonable? | ✓ | | | |
| C. Requiring subsequent verification identified? | | ✓ | ✓ | |
| 6. Have equations been clearly and correctly stated? | ✓ | | | |
| 7. Were input parameters: | | | | |
| A. Adequately identified? | ✓ | | | |
| B. Appropriately selected? | ✓ | | | |
| C. Properly used? | ✓ | | | |
| 8. Was the methodology: | | | | |
| A. Adequately described? | ✓ | | | |
| B. Appropriate for the application? | ✓ | | | |
| C. Properly applied? | ✓ | | | |
| 9. If a computer program was used: | | | | |
| A. Have you reviewed the program validation documents for the production version of the program? | | | ✓ | |
| B. Were codes properly verified? | | | ✓ | |
| C. Were they appropriate for the application? | | | ✓ | |
| D. Were they correctly used? | | | ✓ | |
| E. Was input data correct? | | | ✓ | |
| F. Is the computer program identified on the output? | | | ✓ | |
| G. Is the program revision identified on the output? | | | ✓ | |
| H. PC/computer hardware validated for this program? | | | ✓ | |
| I. Is the program controlled under NPSP-E-5.4? | | | ✓ | |
| 10. Were computations accurately performed? | ✓ | | | |
| 11. Were the results clearly stated? Rearranged in final draft. - Resolved PH | ✓ | | | |

Form # PP-3-2-VII
Rev. 0

**DOCUMENT AND REVISION NOs:** ENG-ME-066 Rev 0

**SBO/ESU PROJECT CHECKLIST FOR MECHANICAL DISCIPLINE DESIGN CALCULATIONS** **SHEET 3 OF 3**

| CHECKER/REVIEWER TO COMPLETE THE FOLLOWING ITEMS: | YES | NO | N/A | COMMENT |
|---|---|---|---|---|
| 12. Are the results reasonable? | ✓ | | | |
| 13. Are symbols and abbreviations adequately identified? | ✓ | | | |
| 14. Are the calculations: | | | | |
| A. Neat? | ✓ | | | |
| B. Legible? | ✓ | | | |
| C. Easy to follow? | ✓ | | | |
| D. Presented in a logical order? | ✓ | | | |
| E. Prepared in proper format? | ✓ | | | See below |
| 15. Does the document satisfactorily incorporate the requirements of the identified design input documents? | ✓ | | | |
| 16. Is the design input consistent with and appropriate for the stated purpose and title of the calculation? | ✓ | | | |
| 17. Will reasonably anticipated variations in the input have any material effect upon the results and conclusions? | | ✓ | | See below |

14. E Prairie Island Engineering Manual Section 1.2.3 is applied as needed to revise FPI (vendor) Calc to update results. Calc reformatted as new item 7-16-94. Resolved [initials]

17. Excess tank capacity between 4 storage tanks affords very generous margin over satisfying criteria.

[signature] 3/1/94

Enclosure

Attachment 6

1ES-1.2 Transfer to Recirculation
Revision 21

23 pages follow

| Number: | Title: | Revision Number: |
|---|---|---|
| 1ES-1.2 | TRANSFER TO RECIRCULATION | REV. 21 |

LEVEL OF USE

| CONTINUOUS USE |
|---|
| • Continuous use of procedure required.<br>• Read each step prior to performing.<br>• Mark off steps as they are completed.<br>• Procedure SHALL be at the work location. |

| PORC REVIEW DATE: | OWNER: | EFFECTIVE DATE: |
|---|---|---|
| 5/6/09 | D. Smith | 5/29/09 |

## A. PURPOSE

This procedure provides the necessary instructions for transferring the safety injection system to the recirculation mode.

## B. ENTRY CONDITIONS

This procedure is entered from:

1. 1E-1, LOSS OF REACTOR OR SECONDARY COOLANT, on low RWST level.
2. 1ECA-0.2, LOSS OF ALL SAFEGUARDS AC POWER RECOVERY WITH SI REQUIRED, and used as guidance for recirculation alignment on low RWST level.
3. 1ECA-2.1, UNCONTROLLED DEPRESSURIZATION OF BOTH STEAM GENERATORS, on low RWST level.
4. Other procedures whenever RWST level reaches the switchover setpoint.

## C. ATTACHMENTS:

ATTACHMENT K: Unit 1 Alignment For Switchover To Recirculation

| STEP | ACTION/EXPECTED RESPONSE | RESPONSE NOT OBTAINED |
|---|---|---|

**Caution** *Switchover to recirculation phase may cause high radiation in the Auxiliary Building.*

NOTE *Steps to establish recirculation flow SHALL be performed without delay. FR procedures should NOT be implemented until completion of this procedure.*

| STEP | ACTION/EXPECTED RESPONSE | RESPONSE NOT OBTAINED |
|---|---|---|
| 1 | **Prepare For Switchover To Recirculation Phase:**<br>a. Notify Auxiliary Building Operator to perform ATTACHMENT K (Copy of attachment with recirc keys in Aux Operator Shack)<br>b. Stop Spent Fuel Pool Ventilation System | |

**Caution** *IF offsite power is lost after SI reset, THEN manual action may be required to restart safeguard equipment.*

| STEP | ACTION/EXPECTED RESPONSE | RESPONSE NOT OBTAINED |
|---|---|---|
| 2 | **Reset SI** | |
| 3 | **Reset Containment Spray** | |
| 4 | **Check Both Trains Of Safeguards Pumps Available For Recirculation** | Go to 1ES-1.3, TRANSFER TO RECIRCULATION WITH ONE SAFEGUARD TRAIN OUT OF SERVICE, Step 1. |
| 5 | **Stop One Train Of Safeguards Pumps:**<br>• RHR pump<br>• SI pump<br>• CS pump and place in "PULLOUT" | |

| STEP | ACTION/EXPECTED RESPONSE | RESPONSE NOT OBTAINED |
|---|---|---|
| | NOTE *Stroke times for RHR suction valves from the RWST and Sump B are approximately two minutes. Completion of valve stroke is NOT required until specified by a step.* | |
| 6 | **Close RWST To RHR Isolation Valve For Idle RHR Pump:**<br>• MV-32084<br>-OR-<br>• MV-32085 | IF valve motion by switch or status lights can NOT be confirmed, THEN go to 1ES-1.3, TRANSFER TO RECIRCULATION WITH ONE SAFEGUARD TRAIN OUT OF SERVICE, Step 1. |
| | **Caution** *IF RCS pressure is greater than SI pump shutoff head pressure, THEN the SI pumps SHALL be stopped.* | |
| 7 | **Close SI Test Line To RWST Valves:**<br>• MV-32202<br>• MV-32203 | IF one valve closes, THEN go to Step 8.<br>IF NOT, THEN locally close one valve. |
| 8 | **Verify RHR To Reactor Vessel Injection Valve Alignment:**<br>• MV-32064 - OPEN<br>• MV-32065 - OPEN | Manually open valve(s). |
| 9 | **Align CC To RHR Heat Exchanger For Idle RHR Train:**<br>• Open MV-32093<br>-OR-<br>• Open MV-32094 | IF valve does NOT open, THEN go to 1ES-1.3, TRANSFER TO RECIRCULATION WITH ONE SAFEGUARD TRAIN OUT OF SERVICE, Step 1. |
| 10 | **Check Containment Level - GREATER THAN 2.0 FEET** | Check containment Sump B level greater than 76%.<br>IF NOT, THEN go to 1ECA-1.1, LOSS OF EMERGENCY COOLANT RECIRCULATION, Step 1. |

| STEP | ACTION/EXPECTED RESPONSE | RESPONSE NOT OBTAINED |
|---|---|---|
| 11 | **Check If RHR Suction Can Be Aligned To Containment Sump:** | |
| | a. Verify RWST to RHR isolation valve for idle RHR pump - CLOSED:<br>• MV-32084<br>-OR-<br>• MV-32085 | a. WHEN valve is closed, THEN continue with Step 11b.<br><br>IF valve does NOT close, THEN go to 1ES-1.3, TRANSFER TO RECIRCULATION WITH ONE SAFEGUARD TRAIN OUT OF SERVICE, Step 1. |
| | b. Check Sump B to RHR MV bonnets vented per ATTACHMENT K | b. WHEN bonnets have been vented, THEN continue with Step 11c. |
| | c. Open Sump B to RHR isolation valves for idle RHR pump:<br>• MV-32075 AND MV-32077<br>-OR-<br>• MV-32076 AND MV-32078 | |
| 12 | **Check If Second Containment Spray Pump Can Be Stopped:** | |
| | a. Containment spray pumps - ANY RUNNING | a. Go to Step 13. |
| | b. Containment pressure - LESS THAN 20 PSIG | b. Go to Step 13. |
| | c. Stop CS pump and place in "PULLOUT" | |

| STEP | ACTION/EXPECTED RESPONSE | RESPONSE NOT OBTAINED |
|---|---|---|
| | NOTE *Stroke times for RHR suction valves from Sump B are approximately two minutes.* | |
| **13** | **Place Idle RHR Train In Recirculation Operation:** | |
| | a. Verify Sump B to RHR isolation valves for idle RHR pump are - FULL OPEN:<br>• MV-32075 AND MV-32077<br>-OR-<br>• MV-32076 AND MV-32078 | a. WHEN valves are full open, THEN continue with Step 13b.<br>IF valves do NOT open, THEN go to 1ES-1.3, TRANSFER TO RECIRCULATION WITH ONE SAFEGUARD TRAIN OUT OF SERVICE, Step 1 |
| | b. Start idle RHR pump | b. IF pump can NOT be started, THEN go to 1ES-1.3, TRANSFER TO RECIRCULATION WITH ONE SAFEGUARD TRAIN OUT OF SERVICE, Step 1 |
| | c. Check for low head recirculation:<br>1) RCS pressure - LESS THAN 250 PSIG [550 PSIG]<br>2) RHR flow - GREATER THAN 950 GPM:<br>• 1FI-928<br>-OR-<br>• 1FI-626 | c. Go to Step 14. |
| | d. Go To Step 15 | |

| STEP | ACTION/EXPECTED RESPONSE | RESPONSE NOT OBTAINED |
|---|---|---|
| 14 | **Align Idle SI Pump For Recirculation:** | |
| | a. Close SI pump suction isolation valve for idle SI pump:<br>• MV-32162<br>-OR-<br>• MV-32163 | a. IF valve does NOT close, THEN go to 1ES-1.3, TRANSFER TO RECIRCULATION WITH ONE SAFEGUARD TRAIN OUT OF SERVICE, Step 1. |
| | b. Open RHR supply to idle SI pump:<br>• MV-32206<br>-OR-<br>• MV-32207 | b. IF valve does NOT open, THEN go to 1ES-1.3, TRANSFER TO RECIRCULATION WITH ONE SAFEGUARD TRAIN OUT OF SERVICE, Step 1. |
| | c. Check RWST level - LESS THAN 20% | c. Perform the following:<br>1) Check one SI pump running. IF NOT, THEN go to Step 14d.<br>2) Perform actions of other procedures in effect while RWST level is greater than 20%.<br>3) WHEN RWST level is less than 20%, THEN go to Step 14d. |
| | d. Start idle SI pump | d. IF pump can NOT be started, THEN go to 1ES-1.3, TRANSFER TO RECIRCULATION WITH ONE SAFEGUARD TRAIN OUT OF SERVICE, Step 1. |
| | e. Check SI flow - FLOW INCREASE (1FI-925) | e. IF flow from the sump to RCS can NOT be established, THEN stop SI pump and go to 1ES-1.3, TRANSFER TO RECIRCULATION WITH ONE SAFEGUARD TRAIN OUT OF SERVICE, Step 1. |

| STEP | ACTION/EXPECTED RESPONSE | RESPONSE NOT OBTAINED |
| --- | --- | --- |
| 15 | **Verify ECCS Pumps Not Affected By Sump Blockage:**<br>• ECCS pump flows - STABLE<br>• ECCS pump presssures - STABLE | Perform the following:<br>a. Stop any cavitating SI pump.<br>b. Attempt to adjust RHR flow control valve to establish RHR recirculation without cavitation.<br>c. <u>IF</u> RHR recirculation without cavitation can <u>NOT</u> be established, <u>THEN</u> perform the following:<br>• Initiate F3.17-2, LONG TERM CORE COOLING.<br>• Stop affected RHR pump.<br>• Go to 1ES-1.3, TRANSFER TO RECIRCULATION WITH ONE SAFEGUARD TRAIN OUT OF SERVICE, Step 1. |

| STEP | ACTION/EXPECTED RESPONSE | RESPONSE NOT OBTAINED |
|---|---|---|
| 16 | **Check RWST Level - LESS THAN 8%** | Perform the following:<br>• Initiate F3.17-2, LONG TERM CORE COOLING.<br>• Perform actions of other procedures in effect while RWST level is greater than 8%.<br>• <u>WHEN</u> RWST level less than 8%, <u>THEN</u> go to Step 17. |
| 17 | **Stop Pumps Aligned To RWST:**<br>• RHR pump<br>• SI pump<br>• CS pump and place in "PULLOUT"<br>• Charging pumps | |
| 18 | **Close RWST To RHR Isolation Valve For Idle RHR Pump:**<br>• MV-32084<br>-OR-<br>• MV-32085 | <u>IF</u> valve motion by switch or status lights can <u>NOT</u> be confirmed, <u>THEN</u> go to Step 23. |
| 19 | **Align CC To RHR Heat Exchanger For Idle RHR Train:**<br>• Open MV-32093<br>-OR-<br>• Open MV-32094 | <u>IF</u> valve does <u>NOT</u> open, <u>THEN</u> go to Step 23. |

| STEP | ACTION/EXPECTED RESPONSE | RESPONSE NOT OBTAINED |
| --- | --- | --- |
| | NOTE *Stroke times for RHR suction valves from the RWST and Sump B are approximately two minutes.* | |
| **20** | **Check If RHR Suction Can Be Aligned To Containment Sump:** | |
| | a. Verify RWST to RHR isolation valve for idle RHR pump - CLOSED:<br>• MV-32084<br>-OR-<br>• MV-32085 | a. WHEN valve is closed, THEN continue with Step 20b.<br>IF valve does NOT close, THEN go to Step 23. |
| | b. Open Sump B to RHR isolation valves for idle RHR pump:<br>• MV-32075 AND MV-32077<br>-OR-<br>• MV-32076 AND MV-32078 | |

| STEP | ACTION/EXPECTED RESPONSE | RESPONSE NOT OBTAINED |
|---|---|---|
| 21 | **Place Idle RHR Train In Recirculation Operation:** | |
| | a. Verify Sump B to RHR isolation valves for idle RHR pump are - FULL OPEN:<br>• MV-32075 AND MV-32077<br>-OR-<br>• MV-32076 AND MV-32078 | a. WHEN valves are full open, THEN continue with Step 21b.<br>IF valves do NOT open, THEN go to Step 23. |
| | b. Start idle RHR pump | b. IF pump can NOT be started, THEN go to Step 23. |
| | c. Check for low head recirculation:<br>1) RCS pressure - LESS THAN 250 PSIG [550 PSIG]<br>2) RHR flow - GREATER THAN 950 GPM:<br>• 1FI-928<br>-OR-<br>• 1FI-626 | c. Go to Step 22. |
| | d. Go To Step 23 | |

| STEP | ACTION/EXPECTED RESPONSE | RESPONSE NOT OBTAINED |
|---|---|---|
| 22 | **Align Idle SI Pump For Recirculation:** | |
| | a. Close SI pump suction isolation valve for idle SI pump:<br>• MV-32162<br>-OR-<br>• MV-32163 | a. IF valve does NOT close, THEN go to Step 23. |
| | b. Open RHR supply to idle SI pump:<br>• MV-32206<br>-OR-<br>• MV-32207 | b. IF valve does NOT open, THEN go to Step 23. |
| | c. Start idle SI pump | c. IF pump can NOT be started, THEN go to Step 23. |
| | d. Check SI flow - FLOW INCREASE (1FI-925) | d. IF flow from the sump to RCS can NOT be established, THEN stop SI pump and go to Step 23. |
| 23 | **Check Cooling Water Header Pressures - BOTH GREATER THAN 65 PSIG** | Initiate C35 AOP1, LOSS OF PUMPING CAPACITY OR SUPPLY HEADER WITH SI.<br><br>Continue with Step 24. |

| STEP | ACTION/EXPECTED RESPONSE | RESPONSE NOT OBTAINED |
| --- | --- | --- |

**Caution** *The SI Pump Room may be a Very High Radiation Area. Do not use stairwells into or out of the SI Pump Room.*

NOTE *The long term Component Cooling alignment may be performed earlier than 20 hours based on dose assessment and personnel availability. The alignment SHALL be completed within 24 hours of the event.*

| STEP | ACTION/EXPECTED RESPONSE | RESPONSE NOT OBTAINED |
| --- | --- | --- |
| **24** | **Align Component Cooling For Long Term Operation:** | |
| | a. Check 20 hours has elapsed since event initiation | a. <u>WHEN</u> 20 hours has elapsed, <u>THEN</u> perform Steps 24b, 24c, 24d, 24e and 24f.<br><br>Continue with Step 25. |
| | b. Locally remove travel stops from CC heat exchanger cooling water outlet valves (1 7/16" socket and open-end wrench required):<br>• CV-31381, 11 CC HX CLG WTR OUTLET CV<br>• CV-31411, 12 CC HX CLG WTR OUTLET CV | |
| | c. Check RCP status - BOTH STOPPED | c. Stop both RCPs. |

This Step continued on the next page.

| STEP | ACTION/EXPECTED RESPONSE | RESPONSE NOT OBTAINED |
| --- | --- | --- |

(Step 24 continued from previous page)

d. Locally close breakers for CC RCP inlet/outlet valves:

- MCC 1L1-C1, 11 RC PMP CC INLT MV-32089 (SFGDS BLOCK 1-176) (715' J.2/5.2)
- MCC 1L1-C2, 11 RC PMP CC OUTL MV-32090 (SFGDS BLOCK 1-177)
- MCC 1L2-A1, 12 RC PMP CC INLT MV-32091 (SFGDS BLOCK 1-178) (715' J.4/6.4)
- MCC 1L2-A2, 12 RC PMP CC OUTL MV-32092 (SFGDS BLOCK 1-179)
- MCC 1K1-H5, 11/12 RC PMP CC INLT MV-32266 (695' G.2/5.2 North of RHR pit)
- MCC 1K2-D5, 11/12 RC PMP CC INLT MV-32267 (695' G.8/6.5 by charging pump rooms)

e. Locally close CC inlet to RCP motor valves:

- MV-32267, 11/12 RCP CC INLT MV, using CS-19101 (695' H.6/6.3 by elevator)
- MV-32266, 11/12 RCP CC INLT MV A, using CS-19100 (695' J.0/6.8 by VCT H2)

This Step continued on the next page.

| STEP | ACTION/EXPECTED RESPONSE | RESPONSE NOT OBTAINED |
|---|---|---|

(Step 24 continued from previous page)

f. Close CC outlet/inlet RCP containment isolation valves:

- MV-32089/32090 using CS-46028
- MV-32091/32092 using CS-46031

**25** **Initiate F3-17.2, LONG TERM CORE COOLING**

**26** **Return To Procedure And Step In Effect**

-END-

ATTACHMENT K

UNIT 1 ALIGNMENT FOR SWITCHOVER TO RECIRCULATION

1. Obtain "UNIT 1 RECIRC KEYS" in Aux Operator Shack. ________

2. Vent the bonnets of Sump B to RHR MVs by OPENING <u>AND</u> <u>THEN</u> CLOSING the following valves (Located in CS pump room):

   - SI-32-3, CNTMT SUMP B TO 11 RHR PMP MV-32077 BONNET VENT ________
   - SI-32-4, CNTMT SUMP B TO 12 RHR PMP MV-32078 BONNET VENT ________

3. Notify Unit 1 Control Room both RHR MV bonnets have been vented. ________

4. CLOSE SI Pump shield door by placing 18849, U1 SI SHLD DOOR RELEASE to "CLOSE".(Located on wall Southwest of RHR pits) ________

5. Align RHR sump pump discharge valves (located above RHR Pits):

   - Position WL-87-1, RHR PIT SUMP #11 DISCHARGE, to "ANNULUS SUMP" ________
   - Position WL-87-2, RHR PIT SUMP #12 DISCHARGE, to "ANNULUS SUMP" ________

6. Unlock and place the following 480V breakers to "ON":

   - MCC 1K1-E2 (BKR 111J-19), 11 RHR HX TO 11 SI PMP MV-32206 (Located North of RHR pits) (Key #28) ________
   - MCC 1KA2-D1 (BKR 121B-34), 12 RHR HX TO 12 SI PUMP MV-32207 (Located East of Aux Operator Shack) (Key #29) ________

7. Position WL-86-1, SAMPLE SINK TO CHEM DRAIN/RHR SUMP, to "CLOSED, Sample Sink Drains to 12 RHR Pit Sump". (Located halfway up the stairs by the Aux Bldg Operator shack) ________

8. Stop the Rad Waste Building Vent System using CS-5725012. (Located on Panel 57250, 695', Aux Building drop area South wall) ________

BACKGROUND INFORMATION FOR

1ES-1.2, TRANSFER TO RECIRCULATION

## SUMMARY FOR ES-1.2

ES-1.2 provides instructional steps that will place the Emergency Core Cooling System (ECCS) in the recirculation mode. In this mode, water is taken from the Containment Emergency Sump B by the RHR pumps and is either recirculated back to the core by the RHR pumps or pumped to the SI pumps for their suction and then to the core. The latter flow path is termed high-head recirculation. High-head recirculation is used when RCS pressure stabilizes above the shutoff head of the RHR pumps.

## BASIS FOR ACTIONS IN ES-1.2

### Caution Procedure Steps, Step 1

During a LOCA, water from the RCS with higher than normal activity will be transferred from the break in the RCS to Sump B. When switchover to recirculation occurs, these higher activity levels may cause higher than normal radiation in the Auxiliary Building. F3-25, Reentry, provides failed fuel assumptions and shows plant radiation levels for the design basis analysis LOCA.

Because of the potentially high radiation levels in the Auxiliary Building, few local actions are directed in this procedure. If components fail while aligning the first train for recirculation, then the typical RNO response is to transition to ES-1.3 and complete transfer to recirculation with one train not available. For failures occurring while aligning the second train, further alignments are stopped and the operator is transitioned to the end of the procedure. For both conditions, the emergency response centers (TSC and OSC) will determine the appropriate course of action based on plant conditions.

### Note Procedure Steps, Step 1

Since the amount of water in the RWST between the switchover setpoint and empty point is limited, the realignment to recirculation must be done as quickly as possible. Because of the limited time, and potentially high radiation levels, local actions are not typically directed in RNO steps. If components fail, then the typical RNO response is to transition to ES-1.3 and complete transfer to recirculation with one train not available.

A suction source of water for the RHR/SI pumps must be maintained to provide for core cooling. Because the actions in this procedure are required for maintenance of core cooling, the actions of this procedure must be completed even if challenges to a Critical Safety Function occur at this time.

### Procedure Steps, Step 1

This step aligns numerous plant components necessary to support recirculation. This step may have already been completed as directed in 1E-1, LOSS OF REACTOR OR SECONDARY COOLANT. The first steps performed on the attachment, venting Sump B to RHR suction valve bonnets, are required prior to opening the valves. This action and subsequent notification to the control room should be completed within seven (7) minutes of initiating Attachment K. In aligning the sample sink drain to the RHR sump, the isolation to the Chemical Drain Tank is closed allowing drains to back up and drain to the RHR sump. Note the closed position of this valve is "CLOSED, Sample Sink Drains to 12 RHR Pit Sump".

Caution Procedure Steps, Step 2

Informs the operator that manual restart of safeguard equipment may be necessary on a loss of offsite power after the SI signal has been reset. This is particularly important when high-head recirculation is in progress (RHR to SI to core). If offsite power is lost and safeguard bus sequencing has taken place the SI pumps would be left without a suction supply, since the RHR pumps will not restart. In this case the SI pump should be stopped, RHR pump restarted to establish suction to the SI pump, and then the SI pump restarted.

Procedure Steps, Step 2

In order to realign safeguard equipment, deliberate action must be taken to reset the SI signal if it has not been previously reset.

Procedure Steps, Step 3

In order to stop the containment spray pumps during transfer to recirculation, deliberate action must be taken to reset the containment spray signal if it has not been previously reset.

Procedure Steps, Step 4

ES-1.2 is intended to be performed with two operable safeguards trains available for recirculation. If one train is NOT available, then injection flow to the core may have to be interrupted when transferring to recirculation. For the case of only one train available the operator must use the strategy employed in 1ES-1.3, TRANSFER TO RECIRCULATION WITH ONE SAFEGUARD TRAIN OUT OF SERVICE, to assure that flow interruptions to the core are minimized.

Procedure Steps, Step 5

The operator is instructed to manually stop one RHR, SI, and CS pump. This action reduces outflow from the RWST to the flow usage of one ECCS train and permits valve operation to re-align pump suctions to Sump B. The CS pump is placed in "PULLOUT" to preclude automatic pump start with low RWST level.

Note Procedure Steps, Step 6

The note informs the operator of the approximate valve stoke time. Since some of the following steps will require the RHR suction valves to fully close or open, this information is helpful for determining whether or not a valve is performing as expected. It is not necessary for a valve to travel full stroke prior to continuing with subsequent steps until specified in a procedure step.

Procedure Steps, Step 6

The RWST supply to the RHR pump is closed on the idle pump. This is done to prevent back flow from the RWST into Sump B. Flow directly from the RWST to Sump B has the potential to rapidly reduce RWST level, for the condition of low containment pressure, and thus reduce the available time to complete the transfer to recirculation sequence.

Caution Procedure Steps, Step 7

Since SI pump miniflow lines to the RWST will be isolated in the following step, the pumps will have no miniflow protection. If RCS pressure is above their shutoff head, the SI pumps would be dead-headed and could potentially be damaged.

Procedure Steps, Step 7

The SI test line isolation valves are closed to makeup the Sump B interlock. The interlock ensures positive isolation of the SI pump discharge recirculation lines to the RWST. This isolation prevents contamination of the RWST, release of radioactive gases to the Auxiliary Building environment via the RWST vent, and loss of containment sump inventory. Closure of either valve satisfies the interlock and isolates the flow path.

Procedure Steps, Step 8

This step verifies a flow path to the reactor vessel for each RHR pump. This action was also performed in E-0.

Procedure Steps, Step 9

Component cooling water flow to the RHR heat exchanger is operated automatically on RHR breaker position. When recirculation flow is initiated through the RHR heat exchanger, component cooling flow is required to provide decay heat removal. This step establishes component cooling flow to ensure decay heat removal on recirculation. If flow is not established, then significant voiding in the component cooling system could occur if recirculation flow is initiated, so the operator is transitioned to ES-1.3 for one train not available for recirculation.

Procedure Steps, Step 10

By the time the operator is ready to start an RHR pump, containment level should have increased to greater than the specified value for LOCAs inside containment. For certain size and location LOCAs and instrument uncertainty factors, the containment level indication may be increasing, but not to a value above the specified value. If not, then a check of the sump level is made. Level indication satisfying either the containment or sump level value indicates RWST water of sufficient quantity has transferred into containment, flowed into the recirculation strainer piping, and flooded Sump B. Water level above the specified value is confirmation of a LOCA inside containment. Analysis shows that sufficient water level in containment exists for design basis LOCAs to cover the recirculation strainers and provide adequate RHR pump NPSH. If sufficient water is NOT available, the operator is directed to 1ECA-1.1, LOSS OF EMERGENCY COOLANT RECIRCULATION to address a condition beyond design basis.

Since the Sump B level instrument is partially above the sump enclosure, the level indication will be affected by strainer differential pressure after recirculation is initiated. Several upper vent holes on Sump B level column are sealed to ensure air cannot be ingested into the RHR pump suction for LOCAs that do not completely cover the instrument. As a result, Sump B level instrument will not provide accurate or reliable indication above approximately 82% level.

Procedure Steps, Step 11

This step ensures the RWST supply to RHR suction valve has fully closed and the Sump B motor valve bonnets have been vented prior to opening Sump B valves. Closure of the RWST supply is required to prevent a flow path directly to containment Sump B that would reduce the available time for completion of transfer to recirculation. Venting of Sump B motor valve bonnets is required to vent any pressure buildup on the valve bonnet. This ensures the valves are not hydraulically locked. Valve bonnet pressure may increase due to containment spray pump operation increasing ambient temperature in the spray pump room.

Procedure Steps, Step 12

Stopping the second CS pump at this time reduces the outflow from the RWST and thus increases available time for completion of transfer to recirculation. This is a convenient time to perform the action because the operator is waiting for the Sump B valves to stroke full open. Analysis has shown that once the RWST has been depleted, Containment Spray is no longer needed for pressure suppression. The CS pump is placed in "PULLOUT" to preclude automatic pump start with low RWST level.

Note Procedure Steps, Step 13

The note informs the operator of the approximate valve stoke time. Since the following step will require the RHR suction valves to fully open, this information is helpful for determining whether or not a valve is performing as expected.

Procedure Steps, Step 13

When the Sump B valves are full open, the idle RHR pump is started. The valves are required to be full open prior to pump start to prevent valve torque switch actuation caused by higher torque requirements with flow through the valve. If either valve does not open or the pump does not start, then a transfer to ES-1.3 is made to complete the transfer with one train out of service.

The operator checks the RCS pressure and RHR flow to determine if high head recirculation is necessary. The stated RCS pressure is the shutoff head pressure of the RHR pumps and is used to determine if the RHR pumps should be delivering flow to the RCS. The specified recirculation flow is the minimum required value to ensure flow. If both of these conditions are met, then the LOCA is of sufficient size such that low head recirculation is sufficient for core cooling. If these conditions are not met, then the SI pump will be aligned for high head recirculation flow.

Procedure Steps, Step 14

This step aligns one train of SI for high head recirculation and is performed if RCS pressure is above a value that precludes sufficient RHR flow. The step re-aligns the SI pump suction from the RWST to RHR pump discharge. If the alignment is not successful, then ES-1.3 will be used to transfer to recirculation with one train of ECCS out of service.

A check of RWST level less than the specified value is performed prior to starting the SI pump on recirculation. This allows continued injection of water from the RWST prior to initiation of high head recirculation operation and adds margin to the determination of available NPSH to the RHR pumps and the determination of the potential for flashing across the debris bed accumulated at the containment Sump B strainers. If RWST level is above the specified value, then additional actions of other procedures are performed while waiting for RWST level to decrease. Continued cooldown of the RCS during this time period is one expected action to perform.

A common flow meter is used for both SI trains. Thus, flow indication will be present from the running SI pump before the pump aligned for recirculation is started. When starting the SI pump, the operator would expect to see SI flow increase.

Procedure Steps, Step 15

Following a high energy line break inside containment, debris may be transported to the recirculation sump and collect on the sump strainer. Analysis has shown that strainer blockage sufficient to affect RHR pump operation will not occur. This step confirms sump recirculation is not affected and provides contingencies for indications of blockage beyond analysis bases. Since a direct parameter to detect sump screen blockage (such as screen differential pressure) is not available, symptoms of pump distress resulting from the sump blockage are used to determine if blockage exists. Indications of pump cavitation or loss of suction caused by sump blockage include erratic or abnormally reduced ECCS pump discharge pressure or flow. Diverse ERCS indications such as erratic or abnormally reduced pump motor current or abnormally high pump vibration could also be used. Conversely, these indications would be stable at normal values if no sump blockage is evident.

If indications of ECCS pump cavitation are observed, initial operator actions specified will protect the pumps from damage. At this point in the transfer to recirculation only one train of ECCS will be affected by sump blockage, such that the other train may be capable of providing recirculation flow. If recirculation flow without cavitation can be established, then actions will continue in this procedure. If recirculation flow without cavitation can not be established, then the affected SI and RHR pumps are stopped and a transition to 1ES-1.3 occurs.

Procedure Steps, Step 16

The operator is placed in a hold until the RWST level reaches the RWST low-low level setpoint, at which time the RWST is no longer considered a viable supply for the running safeguards pumps. Waiting for the low-low level setpoint ensures the maximum RWST inventory is transferred to the containment sump. If RWST level is above the specified value, then additional actions RNO actions are performed to ensure progression to stable RCS conditions is continued.

Procedure Steps, Step 17

The pumps aligned to the RWST are stopped because level below the low-low level setpoint is not sufficient to provide adequate NPSH. The CS pump is placed in "PULLOUT" to preclude automatic pump start with low RWST level.

Procedure Steps, Step 18

The RWST supply to the idle RHR pump is closed. This is done to prevent back flow from the RWST into Sump B.

Procedure Steps, Step 19

Component cooling water flow to the RHR heat exchanger operates automatically on RHR breaker position. When recirculation flow is initiated through the RHR heat exchanger, component cooling flow is required to provide decay heat removal. This step establishes component cooling flow to ensure decay heat removal on recirculation. If flow is not established, then significant voiding in the component cooling system could occur if recirculation flow is initiated. Since one train of ECCs is aligned for recirculation, the operator is transitioned to the end of the procedure.

Note Procedure Steps, Step 20

The note informs the operator of the approximate valve stoke time. Since some of the following steps will require the RHR suction valves to fully close or open, this information is helpful for determining whether or not a valve is performing as expected.

Procedure Steps, Step 20

This step ensures the RWST supply to RHR suction valve has fully closed prior to opening Sump B valves. Closure of the RWST supply is required to prevent a flow path directly to containment. The associated Sump B valves are given an open signal after full closure of the RWST supply.

Procedure Steps, Step 21

When the Sump B valves are full open, the idle RHR pump is started. The valves are required to be full open prior to pump start to prevent valve torque switch actuation caused by higher torque requirements with flow through the valve. If either valve does not open or the pump does not start, then a transfer to the end of the procedure is directed.

The operator checks the RCS pressure and RHR flow to determine if high head recirculation is necessary. The stated RCS pressure is the shutoff head pressure of the RHR pumps and is used to determine if the RHR pumps should be delivering flow to the RCS. The specified recirculation flow is the minimum required value to ensure flow. If both of these conditions are met, then the LOCA is of sufficient size such that low head recirculation is sufficient for core cooling. If these conditions are not met, then the SI pump will be aligned for high head recirculation flow.

Procedure Steps, Step 22

This step aligns the second train of SI for high head recirculation and is performed if RCS pressure is above a value that precludes sufficient RHR flow. The step re-aligns the SI pump suction from the RWST to RHR pump discharge. If the SI train cannot be aligned for high head recirculation, then the operator is transitioned to the end of the procedure.

A common flow meter is used for both SI trains. Thus, flow indication will be present from the running SI pump before the pump being aligned for recirculation is started. When starting the SI pump, the operator would expect to see SI flow increase.

Procedure Steps, Step 23

The demand on cooling water will increase as a result of decay heat being transferred into the cooling water system in the RHR heat exchangers. This step ensures sufficient cooling water pressure to supply the required heat loads.

Caution Procedure Steps, Step 24

During a LOCA, water from the RCS with higher than normal activity will be transferred from the break in the RCS to the containment sump. When the plant is switched over to the recirculation mode, these higher activity levels may cause higher than normal radiation in the auxiliary building. The radiation levels in the SI Pump area could exceed Very High Radiation levels so access to or from the 695' elevation must use stairwells bypassing the SI Pump room.

Note Procedure Steps, Step 24

The following step will perform component cooling water alignment actions that are required to be completed within 24 hours of the event. The step is performed after 20 hours to allow decay of short lived radionuclies and a lower exposure for personnel performing the actions. The purpose of the note is to allow the next step to be performed earlier than directed based on dose evaluation and personnel availability. The actions can be performed any time after the event provided the total dose received by the performer(s) is less than 5 rem. The dose assessment could be a check of Aux Building area radiation monitors and multiple personnel may be used to lower individual dose. If area monitors show the Aux Building to be a high radiation area, then further assessment and coordination of the actions in the next step should be through the OSC and TSC with the actions being performed between 20 and 24 hours after the event. If high radiation areas do not exist, then the actions can be performed when desired. In either case the next step needs to be completed within 24 hours of the event.

Procedure Steps, Step 24

This step aligns the Component Cooling water system for long term containment sump recirculation. Removal of the CC heat exchanger travel stops ensures adequate cooling for the RHR heat exchangers is provided for bounding conditions. Isolation of CC to and from the RCPs is performed to remove the possibility for a passive failure (CC system leakage) in common CC sections affecting both trains of CC. Although multiple motor valves are closed, only MV-32266 and MV-32267 along with check valves CC-3-3 and CC-3-4 are credited with providing isolation. The RCPs are expected to have been stopped prior to performance of this step and are required to be stopped prior to isolating CC flow to them. Thus, this step will also stop the RCPs if necessary. If high radiation areas exist in the Aux Building, then this step should be coordinated through the OSC and TSC with Operator routes selected to minimize dose to the performer(s). The lowest dose routes would typically include Aux Building entry and/or exit using Door 92, Aux Building to (D3) Instrument Air Compressor Room. The dose limit for any individual is 5 rem.

Procedure Steps, Step 25

Recirculation flow to the RCS must be maintained at all times. This step initiates long term monitoring of recirculation operation and provides guidance for issues such as recirculation flow blockage, decay heat reduction, sump pH, and refilling the RWST.

Procedure Steps, Step 26

The operator is directed to return to the procedure in effect following the completion of this procedure.