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## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

### APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.: 355-8438

SRP Section: 09.05.04 – Emergency Diesel Engine Fuel Oil Storage and Transfer System

Application Section: 9.5.4

Date of RAI Issue: 12/28/2015

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### **Question No. 09.05.04-9**

FSAR Tier 2 Subsection 9.5.4.5 states that inservice inspection of Emergency Diesel Engine Fuel Oil System (EDEFOS) piping is governed by the requirements of ASME Boiler and Pressure Vessel Code, Section XI, “Rules for Inservice Inspection of Nuclear Power Plant Components.” This subsection of the FSAR does not identify the inspection code for the storage tanks and day tanks. RG 1.137, Rev. 2, Position C7, states that ASME Code, Section XI applies to fuel oil system components designed to the ASME Code, Section III, “Rules for Construction of Nuclear Facility Components.” Please confirm that the storage tanks and day tanks in the EDEFOS will be inspected according to ASME Code, Section XI, and discuss your plans to include this information in the FSAR.

### **Response**

Safety-related components and piping of EDEFOS are designed in accordance with ASME Section III. Also, Inservice inspection for the items designated by ASME Section III Class 3 is performed in accordance with ASME Section XI. The above description is applied to other emergency diesel generator support systems described in Sections 9.5.5, 9.5.6, and 9.5.7, which contain a similar statement. DCD Tier 2, Subsection 9.5.4.5, 9.5.5.4, 9.5.6.4, and 9.5.7.4 will be revised.

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### **Impact on DCD**

DCD Tier 2, Subsection 9.5.4.5, 9.5.5.4, 9.5.6.4, and 9.5.7.4 will be revised as shown in the attachment.

### **Impact on PRA**

There is no impact on the PRA.

**Impact on Technical Specifications**

There is no impact on the Technical Specifications.

**Impact on Technical/Topical/Environmental Reports**

There is no impact on any Technical, Topical, or Environmental Report.

**APR1400 DCD TIER 2****9.5.4.5 Inspection and Testing Requirements**

The EDEFOS is tested prior to initial startup. Preoperational testing is described in Section 14.2. The EDEFOS is tested periodically along with the complete EDG system. This test demonstrates the performance, and structural and leaktight integrity, of each system component.

~~Inservice inspection of piping is performed in accordance with the requirements of ASME Section XI (Reference 50).~~

The operability of EDEFOS may be demonstrated during tests of the emergency diesel generator, or testing may be performed by operation of the system in recirculation mode (bypassing day tank) and sending fuel through the recirculation line back to the fuel oil storage tank.

The fuel oil in the storage tank and day tanks is periodically sampled to verify quality as defined in the EDG fuel sampling and testing program. Prior to addition of new fuel oil into the storage tanks, samples will be tested for specific gravity, cloud point, viscosity, and water and sediment content in accordance with ASTM D975 (Reference 55) limits. Accumulated moisture and sediment are removed periodically, via the sump drain, to minimize degradation of the fuel oil.

The COL applicant is to specify that adequate and acceptable sources of fuel oil are available, including the means of transporting and recharging the fuel storage tank, following a design basis accident (COL 9.5(10)).

Equipment and components are readily available for inspection and maintenance. Provisions are made to pressure test portions of the system. The EDEFOS can be tested independently of each EDG by draining the day tanks to the levels that automatically start the pumps. The pump flow rate is verified by monitoring the day tank level indicators.

The exterior surfaces of the fuel oil storage tanks and day tanks are painted with a primer and finish coat system for corrosion protection. The inspection on the interior surfaces of the tanks is done when the tanks are emptied and cleaned. Buried fuel oil system piping is inspected by means of a visual examination at each end of the buried piping for evidence of leakage.

Inservice inspection of safety-related components and piping designated by ASME Section III Class 3 is performed in accordance with the requirements of ASME Section XI (Reference 50).

**APR1400 DCD TIER 2****9.5.5.4 Inspection and Testing Requirements**

System components and piping are tested to pressures designated by ASME Section III Class 3 (Reference 49) for safety-related items. Inspection and functional testing are performed prior to initial operation as described in Section 14.2; thereafter, the system operability is tested along with the complete EDG system during regularly scheduled tests in accordance with the Technical Specifications as described in Chapter 16. This testing demonstrates the performance of active components, leaktightness, operability, and the capability of the system to function as intended under accident conditions.

~~Piping is inservice inspected in accordance with the requirements of ASME Section XI (Reference 50).~~

**9.5.5.5 Instrumentation Requirements**

Each diesel engine is provided with sufficient instrumentation and alarms to monitor the operation of the cooling water system.

The following instruments are provided at the diesel generator engine and engine panel.

- a. Temperature indicator (TI) for LT water at the outlet of lube oil/LT water heat exchanger
- b. TI for LT water at the inlet of lube oil/LT water heat exchanger
- c. TI for HT water at the outlet of the lube oil/preheating water heat exchanger
- d. TI for HT water at the outlet of the engine
- e. TI for LT water at the outlet of supercharging air coolers
- f. TI for CC water at the inlet of HT/CC water heat exchanger
- g. TI for HW water at the outlet of the engine-driven HT water pump

Inservice inspection of safety-related components and piping designated by ASME Section III Class 3 is performed in accordance with the requirements of ASME Section XI (Reference 50).

**APR1400 DCD TIER 2**

Each EDG unit is housed separately in a structure designed to seismic Category I requirements. Each EDG has a separate and independent EDESS so that the EDESS performs the safety function under accident conditions, assuming a single active component failure. The four trains of the EDG provide reasonable assurance that a single active failure in an EDESS does not lead to a loss of more than one EDG. Air driers of refrigerant type meet the recommendations of NUREG/CR-0660. The safety-related portion of the EDESS has the capability of starting the diesel engine and storing sufficient air to crank a cold diesel engine five times without recharging the receivers. The EDESS has drain valves to blow down periodically accumulated moisture in the air receivers. The system has sufficient instrumentation to monitor the system parameters and alarm to alert operating personnel.

The EDESS is initially tested prior to initial operation. Periodic inspection and functional testing are also performed along with the complete EDG system in accordance with the Technical Specifications.

#### 9.5.6.4 Inspection and Testing Requirements

System components and piping are tested to pressures designated by ASME Section III Class 3 (Reference 49) for safety-related items. Inspection and functional testing are performed prior to initial operation as described in Section 14.2; thereafter, the system is periodically tested along with the complete EDG system in accordance with the Technical Specifications as described in Chapter 16. This testing demonstrates the performance of active components, leaktightness, operability, and the capability of the system to function as intended under accident condition.

~~Piping is inservice inspected in accordance with the requirements of ASME Section XI (Reference 50).~~

Periodic blowdown of the starting air tanks is done to check for moisture. The frequency is determined based upon operating experience.

#### 9.5.6.5 Instrumentation Requirements

Each starting air receiver is equipped with a set of pressure switches that automatically control the operation of the air compressor on its associated train, starting the compressor

Inservice inspection of safety-related components and piping designated by ASME Section III Class 3 is performed in accordance with the requirements of ASME Section XI (Reference 50).

**APR1400 DCD TIER 2**

quality standards consistent with the quality group classification assigned by NRC RG 1.26 and the seismic category assigned by NRC RG 1.29. Each EDG unit is housed separately in structure that is designed to seismic Category I requirements. Each EDG has a separate and independent EDELS so that the EDELS performs the safety function under accident conditions, assuming a single active component failure. The four trains of the EDG provide reasonable assurance that a single active failure in an EDELS is not lead to a loss of more than one EDG. The three-way thermostat valve meets the recommendation of NUREG/CR-0660 (Reference 48). The EDELS performs its safety-related function to store and supply the clean lube oil to the engine to lubricate and cool various engine components.

The EDELS is initially tested prior to initial operation. Periodic inspection and functional testing are also performed along with the complete EDG system in accordance with the Technical Specifications.

#### 9.5.7.4 Inspection and Testing Requirements

System components and piping are tested to pressures designated by ASME Section III Class 3 (Reference 49). Inspection and functional testing are performed prior to initial operation as described in Section 14.2; thereafter, the system is periodically tested along with the complete EDG system in accordance with the Technical Specifications as described in Chapter 16. This testing demonstrates the performance of active components, leaktightness, operability, and the capability of the system to function as intended under accident conditions.

~~Piping is inservice inspected in accordance with the requirements of ASME Section XI (Reference 50).~~

The lube oil in the lube oil makeup tank is periodically inspected to determine the purity of the oil. Parameters are monitored, including viscosity, neutralization number, and percentage of water. Any accumulated water detected in the bottom of the makeup tank is removed. If degradation of the oil is detected, the oil is drained out for disposal.

Inservice inspection of safety-related components and piping designated by ASME Section III Class 3 is performed in accordance with the requirements of ASME Section XI (Reference 50).

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SRP Section: 09.05.04 – Emergency Diesel Engine Fuel Oil Storage and Transfer System  
Application Section: 9.5.4  
Date of RAI Issue: 12/28/2015

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### **Question No. 09.05.04-10**

FSAR Subsection 9.5.4.5 states that fuel oil samples are tested for specific gravity, cloud point, viscosity, water content, and sediment content prior to adding new fuel to the storage tanks. APR1400 Technical Specification 5.5.13.a.2 and Regulatory Guide 1.137, Rev. 2, “Fuel Oil Systems for Emergency Power Supplies,” (Position C.13.3.4) include flash point and exclude cloud point in the list of parameters to test prior to adding new fuel to the storage tanks. (According to RG 1.137, cloud point is one of the parameters measured in accordance with ASTM D975 within 31 days after new fuel delivery.) Please provide your plans to revise the FSAR to address this apparent discrepancy.

### **Response**

In the APR1400 Standard design, prior to addition of new fuel oil into the storage tanks, samples will be tested in accordance with ASTM D975 as specified in RG 1.137 for following;

- Flash point
- Viscosity
- Water and sediment

Flash point will be added and Cloud point will be deleted in DCD Tier 2, Subsection 9.5.4.5.

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### **Impact on DCD**

DCD Tier 2, Subsection 9.5.4.5 will be revised as shown in the Attachment.

**Impact on PRA**

There is no impact on the PRA.

**Impact on Technical Specifications**

There is no impact on the Technical Specifications.

**Impact on Technical/Topical/Environmental Reports**

There is no impact on any Technical, Topical, or Environmental Report.

**APR1400 DCD TIER 2****9.5.4.5 Inspection and Testing Requirements**

The EDEFOS is tested prior to initial startup. Preoperational testing is described in Section 14.2. The EDEFOS is tested periodically along with the complete EDG system. This test demonstrates the performance, and structural and leaktight integrity, of each system component.

Inservice inspection of piping is performed in accordance with the requirements of ASME Section XI (Reference 50).

The operability of EDEFOS may be demonstrated during tests of the emergency diesel generator, or testing may be performed by operation of the system in recirculation mode (bypassing day tank) and sending fuel through the recirculation line back to the fuel oil storage tank.

The fuel oil in the storage tank and day tanks is periodically sampled to verify quality as defined in the EDG fuel sampling and testing program. Prior to addition of new fuel oil into the storage tanks, samples will be tested for specific gravity, ~~cloud point~~, viscosity, and water and sediment content in accordance with ASTM D975 (Reference 55) limits. Accumulated moisture and sediment are removed periodically, via the sump drain, to minimize degradation of the fuel oil.

flash point

The COL applicant is to specify that adequate and acceptable sources of fuel oil are available, including the means of transporting and recharging the fuel storage tank, following a design basis accident (COL 9.5(10)).

Equipment and components are readily available for inspection and maintenance. Provisions are made to pressure test portions of the system. The EDEFOS can be tested independently of each EDG by draining the day tanks to the levels that automatically start the pumps. The pump flow rate is verified by monitoring the day tank level indicators.

The exterior surfaces of the fuel oil storage tanks and day tanks are painted with a primer and finish coat system for corrosion protection. The inspection on the interior surfaces of the tanks is done when the tanks are emptied and cleaned. Buried fuel oil system piping is inspected by means of a visual examination at each end of the buried piping for evidence of leakage.

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### **Question No. 09.05.04-11**

The APR1400 Technical Specifications Bases for Surveillance Requirement 3.8.3.3 refer to ASTM International D5452-12, "Standard Method for Particulate Contamination in Aviation Fuels by Laboratory Filtration," for sampling and determining particulate concentration in stored fuel. However, Regulatory Guide (RG) 1.137, Rev. 2, "Fuel Oil Systems for Emergency Power Supplies," (Positions C.13.1 and C.13.8) references ASTM International D6217-11, "Standard Test Method for Particulate Contamination in Middle Distillate Fuels by Laboratory Filtration." Please discuss your plans to revise the Technical Specifications Bases to conform to RG 1.137, Rev. 2, since FSAR Tier 2, Table 1.9-1, "Conformance with Regulatory Guides," identifies no exceptions to conformance. Alternatively, provide a justification for using ASTM D5452-12 and identify this in the FSAR as an exception to RG 1.137, Rev. 2.

### **Response**

The APR 1400 Standard Design conforms to Regulatory Guide (RG) 1.137, Rev. 2 with no exceptions. The reference on standard method for particulate contamination will be changed from ASTM D5452-12 to ASTM D6217-11 in accordance with Positions C.13.1 and C13.8 of RG 1.137.

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### **Impact on DCD**

Same as changes described in Impact on Technical Specification section.

### **Impact on PRA**

There is no impact on the PRA.

**Impact on Technical Specifications**

TS Bases for Surveillance Requirement 3.8.3.3 will be revised as shown in the Attachment.

**Impact on Technical/Topical/Environmental Reports**

There is no impact on any Technical, Topical, or Environmental Report.

BASES

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## SURVEILLANCE REQUIREMENTS (continued)

The 31-day period is acceptable because the fuel oil properties of interest, even if they were not within stated limits, would not have an immediate effect on EDG operation. This Surveillance ensures the availability of high quality fuel oil for the EDGs.

Fuel oil degradation during long term storage shows up as an increase in particulate, due mostly to oxidation. The presence of particulate does not mean the fuel oil will not burn properly in a diesel engine. The particulate can cause fouling of filters and fuel oil injection equipment, however, which can cause engine failure.

Particulate concentrations should be determined in accordance with ASTM ~~D5452-12~~ (Reference 6). This method involves ~~a gravimetric determination of total~~ particulate concentration in the fuel oil and has a limit of 10 mg/l. It is acceptable to obtain a field sample for subsequent laboratory testing in lieu of field testing. The Frequency of this test takes into consideration fuel oil degradation trends that indicate that particulate concentration is unlikely to change significantly between Frequency intervals.

D6217-11

the determination of the

SR 3.8.3.4

This Surveillance ensures that, without the aid of the refill compressor, sufficient air start capacity for each EDG is available. The system design requirements provide for a minimum of five engine start cycles without recharging. A start cycle is defined by the EDG vendor, but usually is measured in terms of time (seconds or cranking) or engine cranking speed. The pressure specified in this SR is intended to reflect the lowest value at which the five starts can be accomplished.

The 31-day Frequency takes into account the capacity, capability, redundancy, and diversity of the AC sources and other indications available in the MCR, including alarms, to alert the operator to below normal air start pressure.

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**BASES**

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**SURVEILLANCE REQUIREMENTS (continued)**SR 3.8.3.5

Microbiological fouling is a major cause of fuel oil degradation. There are numerous bacteria that can grow in fuel oil and cause fouling, but all must have a water environment in order to survive. Removal of water from the fuel storage tanks eliminates the necessary environment for bacterial survival. This is the most effective means of controlling microbiological fouling. In addition, it eliminates the potential for water entrainment in the fuel oil during EDG operation. Water can come from any of several sources, including condensation, ground water, rain water, and contaminated fuel oil, and from breakdown of the fuel oil by bacteria. Frequent checking for and removal of accumulated water minimizes fouling and provides data regarding the watertight integrity of the fuel oil system. The 31-day Surveillance Frequency is established by NRC RG 1.137 (Reference 2). This SR is for preventative maintenance.

The presence of water does not necessarily represent failure of this SR provided the accumulated water is removed during performance of the Surveillance.

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**REFERENCES**

1. DCD Tier 2, Subsection 9.5.4.
  2. NRC RG 1.137, Rev. 2, June 2013.
  3. ANSI/ANS-59.51, Rev. 1, 1997.
  4. DCD Tier 2, Chapter 6.
  5. DCD Tier 2, Chapter 15.
  6. ASTM Standards: D4057-06 (Reapproved in 2011); D975-13; D1298-12b (2012); D4176-04 (2009); D2709-96 (Reapproved in 2011) e1; D1552-08; D2622-10; D4294-10; ~~D5452-12~~ ← D6217-11.
  7. ASTM Standards, D975-13, Table 1.
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### **Question No. 09.05.04-12**

The KHNP response on November 13, 2015 (ADAMS Accession Number ML15317A521) to Action Item Nos. AI 9-45.3 and AI 9-45.5, proposes revisions to FSAR Subsection 9.5.4. These revisions would state that fuel in the storage tanks and day tanks will be sampled periodically according to the Fuel Oil Testing Program in Section 5.5.13 of the Technical Specifications (TS), and that sediment and moisture are removed in accordance with TS Surveillance Requirement (SR) 3.8.3.5. The staff requests clarification on the following: (1) TS 5.5.13 does not appear to include a provision for sampling fuel from the day tanks, (2) SR 3.8.3.5 as written does not apply to day tanks, and (3) SR 3.8.3.5 does not apply to sediment.

### **Response**

- (1) The Fuel Oil Testing Program in Section 5.5.13 of the TS is implemented for both new fuel oil and stored fuel oil. Stored fuel oil means fuel oil in storage tanks and day tanks. Section 5.5.13 will be revised to clarify.
- (2) SR for checking and removing accumulated water from each day tank is provided in DCD Tier 2, TS SR 3.8.1.5. DCD Tier 2, Subsection 9.5.4.5 will be revised.
- (3) SR 3.8.1.5 and 3.8.3.5 are provided for eliminating the necessary environment for bacterial survival by removing water from the day tanks and storage tanks, respectively. NRC RG 1.137, Rev.2, Position 13.4 and 13.5 only expresses concerns about accumulated water in the tanks. Also, the TS bases for each SR expresses concerns about the accumulated water in the tanks, not sediment, which is based on NUREG-1432, Standard Technical Specifications.

Since an accumulation of sediment in fuel oil can (a) obstruct the flow of oil from the tank to the combustor and (b) it is difficult to remove only accumulated water excluding sediment in the tank, ASTM D975 provides the properties including sediment.

Therefore, accumulated water and sediment are removed periodically with the sediment being filtered through the duplex basket strainer that that is described in the APR1400 design. SR 3.8.1.5 and 3.8.3.5 will be revised to clarify.

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**Impact on DCD**

DCD Tier 2, Subsection 9.5.4.5 will be revised as shown in the Attachment.

**Impact on PRA**

There is no impact on the PRA.

**Impact on Technical Specifications**

DCD Tier 2, TS SR 3.8.1.5 and 3.8.3.5 and Subsection 5.5.13 will be revised as indicated in the attachment.

**Impact on Technical/Topical/Environmental Reports**

There is no impact on any Technical, Topical, or Environmental Report.

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.1.5	<p>water and sediment</p> <p>Check for and remove accumulated water from each day tank and engine mounted tank.</p>	31 days
SR 3.8.1.6	Verify fuel oil transfer system operates to automatically transfer fuel oil from storage tank to the day tank.	92 days
SR 3.8.1.7	<p>----- NOTE -----</p> <ol style="list-style-type: none"> <li>1. EDG loadings may include gradual loading as recommended by the manufacturer.</li> <li>2. Momentary transients outside the load range do not invalidate this test.</li> <li>3. This Surveillance shall be conducted on only one EDG at a time.</li> <li>4. This SR shall be preceded by and immediately follow without shutdown a successful performance of SR 3.8.1.2 or SR 3.8.1.7.</li> </ol> <p>-----</p> <p>Verify each EDG starts from standby condition and achieves:</p> <ol style="list-style-type: none"> <li>a. In <math>\leq 17</math> seconds, voltage <math>\geq 3,744</math> V and frequency <math>\geq 58.8</math> Hz and</li> <li>b. Steady stage voltage <math>\geq 3,744</math> V and <math>\leq 4,576</math> V, and frequency <math>\geq 58.8</math> Hz and <math>\leq 61.2</math> Hz.</li> </ol>	184 days

RAI 355-8438 Question 09.05.04-12

SURVEILLANCE REQUIREMENTS (continued)

AI 09-45.3\_9.5.4\_#5

SURVEILLANCE		FREQUENCY
SR 3.8.3.4	Verify each DG air start receiver pressure is $\geq 40.77$ kgf/cm <sup>2</sup> G (580 psig) psig.	31 days
SR 3.8.3.5	Check for and remove accumulated water from each fuel oil storage tank.	31 days

water and sediment

## 5.5 Programs and Manuals

5.5.13 Diesel Fuel Oil Testing Program

A diesel fuel oil testing program to implement required testing of both new fuel oil and stored fuel oil shall be established. The program shall include sampling and testing requirements, and acceptance criteria, all in accordance with applicable ASTM Standards. The purpose of the program is to establish the following:

- a. Acceptability of new fuel oil for use prior to addition to storage tanks by determining that the fuel oil has:
  1. An API gravity or an absolute specific gravity within limits,
  2. A flash point and kinematic viscosity within limits for ASTM 2D fuel oil, and
  3. A clear and bright appearance with proper color or a water and sediment content within limits.
- b. Within 31 days following addition of the new fuel oil to storage tanks, verify that the properties of the new fuel oil, other than those addressed in a., above, are within limits for ASTM 2D fuel oil, and
- c. Total particulate concentration of the fuel oil is <10 mg/l when tested every 31 days.

The provisions of SR 3.0.2 and SR 3.0.3 are applicable to the Diesel Fuel Oil Testing Program test frequencies.

stored fuel oil in storage tanks and day tanks

5.5.14 Technical Specifications (TS) Bases Control Program

This program provides a means for processing changes to the Bases of these TS.

- a. Changes to the Bases of the TS shall be made under appropriate administrative controls and reviews.
- b. Licensees may make changes to Bases without prior NRC approval provided the changes do not require either of the following:
  1. A change in the TS incorporated in the license or
  2. A change to the updated DCD TIER 2 or Bases that requires NRC approval pursuant to 10 CFR 50.59.

#### 9.5.4.5 Inspection and Testing Requirements

The EDEFOS is tested prior to initial startup. Preoperational testing is described in Section 14.2. The EDEFOS is tested periodically along with the complete EDG system. This test demonstrates the performance, and structural and leaktight integrity, of each system component.

Inservice inspection of piping is performed in accordance with the requirements of ASME Section XI (Reference 50).

The operability of EDEFOS may be demonstrated during tests of the emergency diesel generator, or testing may be performed by operation of the system in recirculation mode (bypassing day tank) and sending fuel through the recirculation line back to the fuel oil storage tank.

The fuel oil in the storage tank and day tanks is periodically sampled to verify quality as defined in the EDG fuel sampling and testing program. Prior to addition of new fuel oil into the storage tanks, samples will be tested for specific gravity, cloud point, viscosity, and water and sediment content in accordance with ASTM D975 (Reference 55) limits. Accumulated moisture and sediment are removed ~~periodically~~, via the sump drain, to minimize degradation of the fuel oil.

in accordance with Surveillance Requirement 3.8.3.5,

3.8.3.1 and 3.8.3.5,

The COL applicant is to specify that adequate and acceptable sources of fuel oil are available, including the means of transporting and recharging the fuel storage tank, following a design basis accident (COL 9.5(10)).

Equipment and components are readily available for inspection and maintenance. Provisions are made to pressure test portions of the system. The EDEFOS can be tested independently of each EDG by draining the day tanks to the levels that automatically start the pumps. The pump flow rate is verified by monitoring the day tank level indicators.

The exterior surfaces of the fuel oil storage tanks and day tanks are painted with a primer and finish coat system for corrosion protection. The inspection on the interior surfaces of the tanks is done when the tanks are emptied and cleaned. Buried fuel oil system piping is inspected by means of a visual examination at each end of the buried piping for evidence of leakage.