

---

---

## REVISED 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.: 191-8210  
SRP Section: 14.02 – Initial Plant Test Program – Design Certification and New License Applicants  
Application Section:  
Date of RAI Issue: 09/01/2015

---

### **Question No. 14.02-14**

#### REQUIREMENTS

GDC 17 requires that onsite and offsite power systems provide sufficient capacity and capability and

GDC 18 requires the testing of electrical power systems

#### ISSUE AND INFORMATION NEEDED

DCD Tier 2 Section 14.2.12.1.88 discusses the EDG auxiliary systems test.

- A) Please discuss why EDG intake air and exhaust gas systems' ability to support full load capacity is not included in this test, in order to demonstrate that the system operates as described in Section 9.5.8. A test is required to show that the EDG intake air and exhaust gas systems provide sufficient capacity to support full load operation.
- B) Discuss how this test verifies that the starting air system is capable of achieving a single EDG start when the receiver is at the minimum receiver design pressure.

### **Response**

KHNP has reviewed the subject question and understands the staff's request. KHNP is in the process of upgrading the test plans presented in Section 14.2 of the DCD. This effort is focused on adding additional SSCs that are important to safety and risk significant as well as increasing the level of detail described in the DCD for test prerequisites, test methods and acceptance criteria for the various tests. It has been determined that the actions to be taken as a result of this question is within the scope of the upgrade effort. Therefore, KHNP will address the noted

items in the upgrade effort, which is scheduled to be completed by February 1, 2016. A revised response to this question that incorporates the results of the upgrade effort will be submitted to the NRC after completion.

### **Response – Rev. 1**

- A) KHNP provided a revised ITP for verifying the EDG system's intake air and exhaust gas in the response to RAI 127-8010, Question 09.05.08-2 (reference MKD/NW-16-0220L dated 03/10/2016; ML16070A136). In the response to that RAI the following was added to the original Section 14.2.12.1.88, Emergency Diesel Generator Auxiliary Systems Test to verify the EDG intake air and exhaust gas systems' ability to support full load capacity.

1.5 To demonstrate the operation of the EDG engine combustion air intake and exhaust system

3.20 Demonstrate the operation of the EDG engine combustion air intake and exhaust system.

5.5 The EDG engine combustion air intake and exhaust system operates as described in Subsection 9.5.8.

All of the EDG auxiliary systems are included in EDG package except for the emergency fuel oil system. To prevent redundancy in testing, in response to Question 14.02-12 of this RAI (submitted previously) testing of all support functions, including air intake and exhaust, was added into 14.2.12.1.86. However, the response neglected to delete the redundant portions from 14.2.12.1.88. Attachment 2 contains the revised Subsection 14.2.12.1.86 that contains items 1.1, 1.5, 3.2, 3.7, 4.1, and 5.11 which pertain to ensuring the intake air and exhaust gas auxiliary systems are capable of supporting full load operation of the EDGs.

This RAI response will change the title of Subsection 14.2.12.1.88 to "Emergency Diesel Engine Fuel Oil System Test" and will modify the ITP to contain only the guidance to independently verify the emergency diesel fuel oil system since that system is not tested as part of the EDG package in 14.2.12.1.86.

- B) KHNP understands that the minimum receiver design pressure means the minimum required pressure value to crank the engine one time. In the APR1400 standard design, the receiver is designed as a minimum to have sufficient air to crank a cold diesel engine five times with the pressure condition above the minimum receiver design pressure without recharging the receiver. After five cranking cycles, the pressure in the receiver is to remain above the minimum receiver design pressure.

The emergency diesel generator mechanical test will demonstrate that each air receiver is capable of providing five cranking cycles without being recharged. During the five times cranking test, the pressure in the receiver is recorded for each cranking cycle. Consequently, this test assures that the starting air system is capable of achieving EDG successful starts. The testing as written meets the guidance of SRP 9.5.6, Acceptance Criteria, Position 4.C. Therefore, there is no additional test

---

procedure to verify that the starting air system is capable of achieving a single EDG start when the receiver is at the minimum receiver design pressure, and the receiver pressure remains above “the minimum receiver design pressure” after five times cranking test.

---

**Impact on DCD**

The upgraded DCD Tier 2, Section 14.2.12.1.88 submitted by KHNP in letter MKD/NW-16-0156L, dated February 24, 2016 will be revised as indicated in Attachment 1 associated with this response.

The upgraded DCD Tier 2, Section 14.2.12.1.86 submitted by KHNP in letter MKD/NW-16-0684L, dated June 28, 2016 is provided for information only as indicated in Attachment 2.

**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

RAI 127-8010 - Question 09.05.08-2

RAI 191-8210 - Question 14.02-14\_Rev.1

14.2.12.1.88 Emergency Diesel Generator Auxiliary Systems Test1.0 ~~OBJECTIVE~~ OBJECTIVES

- 1.1 ~~To demonstrate that the emergency diesel generator (EDG) fuel oil system provides a reliable and adequate supply to each EDG~~
- 1.2 ~~To demonstrate the operation of the EDG engine cooling water system~~
- 1.3 ~~To demonstrate that the EDG engine starting air system provides an adequate amount of air for 5 consecutive starts of its EDG without makeup air~~
- 1.4 ~~To demonstrate the operation of the EDG engine lube oil system~~

## 2.0 PREREQUISITES

- 2.1 ~~Construction activities on the EDG auxiliary systems have been completed.~~
- 2.2 ~~EDG auxiliary systems instrumentation has been calibrated.~~
- 2.3 ~~Support systems required for operation of the EDG auxiliary systems are complete and operational.~~
- 2.4 ~~Test instrumentation is available and calibrated.~~
- 2.5 ~~The EDGs are available for a loaded run to measure fuel consumption and to perform consecutive starts.~~

## 3.0 TEST METHOD

- 3.1 ~~Demonstrate the operation of the fuel oil automatic transfer feature from the storage tanks to the day tank.~~

~~1.5 To demonstrate the operation of the EDG engine combustion air intake and exhaust system~~

Replacement A

RAI 191-8210 - Question 14.02-14\_Rev.1

14.2.12.1.88 Emergency Diesel Engine Fuel Oil System Test

## 1.0 OBJECTIVES

- 1.1 To demonstrate the operability of the diesel fuel oil transfer pumps and verify all system control functions
- 1.2 To demonstrate that the emergency diesel generator (EDG) fuel oil system provides a reliable and adequate supply to each EDG

## 2.0 PREREQUISITES

- 2.1 Construction activities on the emergency diesel engine fuel oil system have been completed.
- 2.2 Required electrical power supplies and control circuits are operational.
- 2.3 Adequate volume of diesel fuel oil is available to support this test.

## 3.0 TEST METHOD

- 3.1 Demonstrate the operation of the diesel fuel oil transfer pumps.
- 3.2 Initiate all automatic system function signals and verify required responses.
- 3.3 Demonstrate that the day tank can be filled manually.
- 3.4 Demonstrate the operation of the fuel oil recirculation system.
- 3.5 Demonstrate, by performing a loaded run of the EDG with its day tank filled to its low-level alarm point, that the day tank provides sufficient fuel for at least 60 minutes of EDG operation with the EDG supplying the power requirements of the most limiting design basis accident.
- 3.6 Demonstrate, by performing a loaded run of the EDG and analysis of EDG fuel storage capacity, that each EDG has sufficient fuel storage capacity to operate for a period of no less than 7 days with the EDG supplying the power requirements of the most limiting design basis accident.

## 4.0 DATA REQUIRED

- 4.1 EDG fuel oil consumption rate
- 4.2 Set points of alarms, interlocks, and controls
- 4.3 Operating data for pumps

## 5.0 ACCEPTANCE CRITERIA

- 5.1 Diesel fuel oil transfer pumps operate per system design specifications.

Replacement A (Con't)

RAI 191-8210 - Question 14.02-14\_Rev.1

- 5.2 Control functions are operable per system design requirements.
- 5.3 The EDG engine fuel oil system operates as described in Subsection 9.5.4.

## APR1400 DCD TIER 2

RAI 191-8210 Question 14.02-14\_Rev.1

- ~~3.2 Demonstrate the operation of the fuel oil and day tank level alarms.~~
- ~~3.3 Demonstrate that the day tank can be filled manually.~~
- ~~3.4 Demonstrate the operation of the fuel oil transfer pump.~~
- ~~3.5 Demonstrate the operation of the fuel oil recirculation system.~~
- ~~3.6 Demonstrate, by performing a loaded run of the EDG with its day tank filled to its low level alarm point, that the day tank provides sufficient fuel for at least 7260 minutes of EDG operation with the EDG supplying the power requirements of the most limiting design basis accident.~~
- ~~3.7 Demonstrate, by performing a loaded run of the EDG and analysis of EDG fuel storage capacity, that each EDG has sufficient fuel storage capacity to operate for a period of no less than 7 days with the EDG supplying the power requirements of the most limiting design basis accident.~~
- ~~3.8 Demonstrate the operation of the EDG cooling water system to keep the pump warm.~~
- ~~3.9 Demonstrate the operation of EDG cooling system heaters.~~
- ~~3.10 Demonstrate the operation of the EDG cooling system alarms.~~
- ~~3.11 Demonstrate the operation of EDG starting air compressors.~~
- ~~3.12 Demonstrate that each EDG starting air system has sufficient volume available to perform five consecutive starts of its EDGs.~~
- ~~3.13 Demonstrate the EDG starting air system operates the EDG pneumatic controls as designed.~~

## APR1400 DCD TIER 2

RAI 186-8009 Question 09.05.07-2

RAI 127-8010 Question 09.05.08-2

RAI 191-8210 Question 14.02-14\_Rev.1

~~3.14 Demonstrate the EDG starting air alarm interlocks and automatic operation.~~

~~3.15 Demonstrate the operation of the EDG lube oil prelube pump.~~

~~3.16 Demonstrate the operation of EDG lube oil heaters.~~

~~3.17 Demonstrate the operation of EDG lube oil alarms.~~

~~3.18 Demonstrate the operation of the EDG lube oil transfer pump.~~

4.0 DATA REQUIRED

~~4.1 EDG fuel oil consumption rate~~

~~4.2 Setpoints of alarms, interlocks, and controls~~

~~4.3 Operating data for pumps and compressors~~

~~4.4 Operating data for the heaters~~

~~4.5 EDG starting air volume parameters after consecutive starts~~

5.0 ACCEPTANCE CRITERIA

~~5.1 The EDG engine fuel oil system operates as described in Subsection 9.5.4.~~

~~5.2 The EDG engine cooling water system operates as described in Subsection 9.5.5.~~

~~5.3 The EDG engine starting air system operates as described in Subsection 9.5.6.~~

~~3.19 Demonstrate that the lube oil makeup tank for each EDG has sufficient capacity for 7 continuous days of the EDG rated full power operation~~

~~3.20 Demonstrate the operation of the EDG engine combustion air intake and exhaust system.~~



## APR1400 DCD TIER 2

RAI 127-8010 Question 09.05.08-2

RAI 191-8210 Question 14.02-14 Rev.1

~~5.4 The EDG engine lubrication system operates as described in Subsection 9.5.7.~~

14.2.12.1.89 Alternate AC Source System Test

1.0 ~~OBJECTIVE~~ OBJECTIVES

1.1 To verify the proper operation of the alternate ac (AAC) source system

2.0 PREREQUISITES

2.1 Construction activities on the AAC source system have been completed.

2.2 Support systems, including the AAC support systems and the 4,160V distribution system required for the operation of the AAC source system, are complete and operational.

2.3 AAC source system instrumentation has been calibrated.

2.4 Test instrumentation is available and calibrated.

3.0 TEST METHOD

3.1 Verify the system alarms, instrumentation, interlocks, and controls.

3.2 Verify the AAC source system provides rated power at the proper voltage and frequency.

3.3 Verify operation of the AAC source system from all its control stations.

3.4 Demonstrate the AAC source system can be connected in the design configuration to the dedicated train of the onsite 4,160 V Class 1E switchgear buses (train A or train B).

3.5 Verify AAC can carry design loads.

~~5.5 The EDG engine combustion air intake and exhaust system operates as described in Subsection 9.5.8.~~

## APR1400 DCD TIER 2

RAI 127-8010 Question 09.05.08-2

Table 14.2-1 (4 of 5)

Subsection	Test
14.2.12.1.82	Compressed air system test
14.2.12.1.83	Process sampling system test
14.2.12.1.84	Heat tracing system test
14.2.12.1.85	Fire protection system test
14.2.12.1.86	Emergency diesel generator mechanical system test
14.2.12.1.87	Emergency diesel generator electrical system test
14.2.12.1.88	<del>Emergency diesel generator auxiliary systems test</del>
14.2.12.1.89	Alternate AC source system test
14.2.12.1.90	Alternate AC source support systems test
14.2.12.1.91	Containment polar crane test
14.2.12.1.92	Fuel handling area cranes test
14.2.12.1.93	Reactor containment building HVAC system test
14.2.12.1.94	Reactor containment purge HVAC system test
14.2.12.1.95	Control room area HVAC system test
14.2.12.1.96	Turbine generator building HVAC system test
14.2.12.1.97	Emergency diesel generator area HVAC system test
14.2.12.1.98	Fuel handling HVAC system test
14.2.12.1.99	Compound building HVAC system test
14.2.12.1.100	Balance of control room HVAC system test
14.2.12.1.101	Hydrogen mitigation system test
14.2.12.1.102	Containment hydrogen recombiner system test
14.2.12.1.103	Liquid waste management system test
14.2.12.1.104	Solid waste management system test
14.2.12.1.105	Gaseous waste management system test
14.2.12.1.106	Process and effluent radiological monitoring system test
14.2.12.1.107	Airborne and area radiation monitoring system test



Emergency Diesel Engine Fuel Oil System Test

## APR1400 DCD TIER 2

RAI 127-8010 Question 09.05.08-2

Table 14.2-7 (4 of 18)

RG 1.68 APP. A	Subsection #	Individual Test
1.e.8	14.2.12.1.69	Condensate system test
1.e.9	14.2.12.1.68	Feedwater system test
1.e.10	14.2.12.1.73	Heater drains system test
1.e.11	14.2.12.1.52 14.2.12.1.67 14.2.12.1.69	Pre-core reactor coolant and secondary water chemistry data Main condenser and condenser vacuum systems test Condensate system test
1.e.12	14.2.12.1.67	Main condenser and condenser vacuum systems test
1.f.1	14.2.12.1.71	Circulating water system test
1.f.2	-	Exception The COL applicant is to prepare the pre-operational test of cooling tower and associated auxiliaries.
1.f.3	-	Exception The COL applicant is to prepare the pre-operational test of raw water and service water cooling systems.
1.g.1	14.2.12.1.110 14.2.12.1.111 14.2.12.1.112 14.2.12.1.113 14.2.12.1.116	Unit main power system test 13,800 V normal auxiliary power system test 4,160 V normal auxiliary power system test 480 V normal auxiliary power system test Offsite power system test
1.g.2	14.2.12.1.108 14.2.12.1.109 14.2.12.1.81	4,160 V Class 1E auxiliary power system test 480 V Class 1E auxiliary power system test Emergency lighting system test
1.g.3	14.2.12.1.86 14.2.12.1.87 14.2.12.1.88 14.2.12.1.89 14.2.12.1.90	Emergency diesel generator mechanical system test Emergency diesel generator electrical system test <del>Emergency diesel generator auxiliary systems test</del> Alternate AC source system test Alternate AC source support systems test
1.g.4	14.2.12.1.81 14.2.12.1.114 14.2.12.1.115	Emergency lighting system test Non-Class 1E dc power systems test Class 1E dc power systems test
1.h.1.a	14.2.12.1.117 14.2.12.1.118	BOP piping thermal expansion measurement test BOP piping vibration measurement test

Emergency Diesel Engine Fuel Oil System Test

**APR1400 DCD TIER 2**

RAI 191-8210 - Question 14.02-12\_Rev.1

14.2.12.1.86 Emergency Diesel Generator Mechanical System Test1.0 ~~OBJECTIVE~~ OBJECTIVES

1.1 To demonstrate the emergency diesel generator (EDG) mechanical system operates reliably

## 2.0 PREREQUISITES

2.1 Construction activities on the diesel generator system have been completed.

2.2 EDG system instrumentation has been calibrated.

2.3 Support systems required for operation of the EDG system are complete and operational.

2.4 Test instrumentation is available and calibrated.

## 3.0 TEST METHOD

3.1 Demonstrate that each EDG can be started from the control room and its local panel in automatic and manual.

3.2 Demonstrate that the following mechanical and electrical trips are operable and function as described in Subsection 8.3.1 (includes protective trips bypass tests).

3.2.1 Engine overspeed

3.2.2 Generator differential protection

3.2.3 Low-low lube oil pressure

3.2.4 Generator voltage-controlled overcurrent

## APR1400 DCD TIER 2

RAI 191-8210 - Question 14.02-12\_Rev.1

~~3.2.5 Low-pressure lube oil~~

~~3.2.6 High-pressure crankcase~~

~~3.2.7 High-temperature bearings~~

~~3.2.8 High-temperature lube oil out~~

~~3.2.9 High-high temperature jacket water~~

~~3.2.10 High vibration~~

~~3.3 Demonstrate that the following parameters are correctly monitored in the control room and at the local panel:~~

~~3.3.1 Lube oil temperature and pressures~~

~~3.3.2 Bearing temperatures~~

~~3.3.3 Cooling water temperatures and pressures~~

~~3.3.4 Speed~~

~~3.3.5 Starting air pressure~~

~~3.4 Demonstrate the operation of the following status indications:~~

~~3.4.1 Cooling water not available~~

~~3.4.2 Emergency diesel generator breaker racked out~~

~~3.4.3 Emergency diesel generator overspeed~~

~~3.4.4 Loss of control power~~

## APR1400 DCD TIER 2

RAI 191-8210 - Question 14.02-12\_Rev.1

~~3.4.5 Generator fault~~~~3.4.6 Low air and oil pressure~~~~3.4.7 Maintenance mode~~~~3.5 Demonstrate the capability for ~~35~~25 consecutive starts.~~~~3.6 Demonstrate full load capability.~~~~3.7 Demonstrate EDG speed control.~~

## 4.0 DATA REQUIRED

~~4.1 EDG engine operating parameters~~~~4.2 EDG engine consecutive starts data~~~~4.3 Setpoints of EDG trips~~~~4.4 EDG governor operating data~~~~4.5 Setpoints at which alarms and interlocks occur~~

## 5.0 ACCEPTANCE CRITERIA

~~5.1 The EDG mechanical system performs its designed functions as described in Subsection 8.3.1.1.3.~~14.2.12.1.87 Emergency Diesel Generator Electrical System Test

Replace with A

1.0 ~~OBJECTIVE~~OBJECTIVES

1.1 To verify the emergency diesel generators (EDGs) can supply power at the rated load, voltage, and frequency under all design conditions

Replacement A
---------------

RAI 191-8210 - Question 14.02-12_Rev.1
--

#### 14.2.12.1.86 Emergency Diesel Generator Mechanical System Test

### 1.0 OBJECTIVES

- 1.1 To demonstrate performance characteristics of the emergency diesel generators (EDGs) and associated auxiliaries, and verify that each diesel reaches rated speed within the required time.
- 1.2 To verify the operational capability of control circuits associated with the EDG and diesel auxiliaries, including the control circuit response to safety signals.
- 1.3 To demonstrate the reliability of each diesel generator by means of 25 consecutive valid tests.
- 1.4 To demonstrate the capability of each air storage tank to provide five diesel cranking cycles without being recharged.
- 1.5 To demonstrate the continuous operation of each diesel generator for 24 hours of full power, 2 hours at load equivalent to the short time rating and 22 hours at load equivalent to the continuous rating.
- 1.6 To demonstrate the fuel oil consumption of the EDG while operating at the continuous load rating.

### 2.0 PREREQUISITES

- 2.1 Construction activities on the diesel generator system have been completed.
- 2.2 Required electrical power supplies and control circuits are operational.
- 2.3 EDG system instrumentation has been calibrated.
- 2.4 Test instrumentation is available and calibrated.
- 2.5 The component cooling water system is available to supply cooling water to the diesel engine heat exchanger.
- 2.6 The fuel oil system, cooling water system, starting air system, lubrication system, and combustion air intake and exhaust system are available.

### 3.0 TEST METHOD

- 3.1 Start the EDGs and record the time required to reach rated speed.
- 3.2 Evaluate performance characteristics of the EDGs and associated auxiliaries.
- 3.3 Evaluate the operational capability of all control circuits associated with the EDG including the control circuit response to safety signals.
- 3.4 Evaluate the ability of each diesel generator by means of 25 consecutive valid test.
- 3.5 Evaluate the ability of each air storage tank to provide five diesel cranking cycles, without being recharged.

Replacement A (Con't)

RAI 191-8210 - Question 14.02-12\_Rev.1

- 3.6 Evaluate the fuel oil consumption is monitored with EDG operating at the continuous load rating.
- 3.7 Evaluate the continuous operation of each diesel generator for 24 hours of full power, 2 hours at load equivalent to the short time rating and 22 hours at load equivalent to the continuous rating.

#### 4.0 DATA REQUIRED

- 4.1 EDG and associated auxiliaries operating parameters
- 4.2 EDG engine consecutive starts data
- 4.3 Set points of EDG trips
- 4.4 EDG governor operating data
- 4.5 Set points at which alarms and interlocks occur
- 4.6 EDG starting air volume parameters after consecutive starts

#### 5.0 ACCEPTANCE CRITERIA

- 5.1 The required time for each EDG to reach rated speed is in accordance with Subsection 8.3.1.1.2.4.
- 5.2 Performance characteristics of the EDGs and associated auxiliaries are within design requirements.
- 5.3 Each EDG starts automatically on receipt of a safety injection actuation signal, containment spray actuation signal, auxiliary feedwater actuation signal, or 4.16 kV bus under-voltage signal.
- 5.4 Each EDG trips automatically on receipt of signals for automatic trip conditions described in Subsection 8.3.1.1.3.
- 5.5 The alarm, interlocks, controls, and operation of the EDG and associated auxiliaries are as described in Subsection 8.3.1.1.3, 9.5.5, 9.5.6, 9.5.7, and 9.5.8.
- 5.6 Each diesel generator completes 25 consecutive valid tests.
- 5.7 Each air storage tank is capable of providing five diesel cranking cycles without being recharged.
- 5.8 The EDG engine cooling water system operates as described in Subsection 9.5.5.
- 5.9 The EDG engine starting air system operates as described in Subsection 9.5.6.
- 5.10 The EDG engine lubrication system operates as described in Subsection 9.5.7.
- 5.11 The EDG engine combustion air and exhaust system operates as described in Subsection 9.5.8.