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.:	**444-8530**
SRP Section:	**16 – Technical Specifications**
Application Section:	**16.3.7, 16.3.3.8, 16.3.3.9, 16.3.3.10**
Date of RAI Issue:	**03/16/2016**

Question No. 16-131

Paragraph (a)(11) of 10 CFR 52.47 and paragraph (a)(30) of 10 CFR 52.79 state that a design certification (DC) applicant and a combined license (COL) applicant, respectively, are to propose TS prepared in accordance with 10 CFR 50.36 and 50.36a. 10 CFR 50.36 sets forth requirements for technical specifications to be included as part of the operating license for a nuclear power facility. NUREG-1432, “Standard Technical Specifications-Combustion Engineering Plants,” Rev. 4, provides NRC guidance on format and content of technical specifications as one acceptable means to meet 10 CFR 50.36 requirements. Staff needs to evaluate all technical differences from standard TS (STS) NUREG-1432, STS Combustion Engineering Plants, Rev. 4, which is referenced by the DC applicant in DCD Tier 2 Section 16.1, and the docketed rationale for each difference because conformance to STS provisions is used in the safety review as the initial point of guidance for evaluating the adequacy of the generic TS to ensure adequate protection of public health and safety, and the completeness and accuracy of the generic TS Bases.

Staff understands that each of the two AFW Divisions consists of one turbine-driven AFW pump train and one motor-driven AFW pump train that both only supply AFW to the one associated steam generator from the single divisional AFW Storage Tank. Staff notes that there appears to be

(i) No direct water flow path to the division’s AFW pump suction header from the other division’s AFW storage tank, in the normal system lineup.

However, Figure 10.4.9-1 Auxiliary Feedwater System Flow Diagram (Sheet 1 of 3) depicts a 10 inch pipe with two normally locked closed locally-operated manual valves connecting the two AFW storage tanks. It also depicts a 10 inch pipe with two normally locked closed locally-operated manual valves connecting the two divisional AFW pump 12 inch suction headers from each AFW storage tank. Between these valves is a 10 inch connection to supply raw water to one or both divisional AFW pump suction headers.

(ii) No water flow path from the division's AFW pump discharge header to supply AFW to the other steam generator, and

(iii) No steam flow path to the division's turbine-driven AFW pump's turbine from the nonassociated steam generator (DCD Tier 2 Subsection 10.3.2.2.5).

Therefore, staff concludes that the two AFW divisions are completely independent, with no AFW storage tank suction cross-connect flow paths between them that can be unisolated remotely from the control room.

If one steam generator has a fault that degrades or defeats its heat sink function, the associated AFW division (both AFW Pump trains) may be unable to fulfill its function of reactor coolant heat removal by maintaining adequate water level in the associated steam generator.

Therefore, the applicant is requested to revise generic TS LCO 3.7.6 so that it requires two AFW Storage Tanks to be operable; this is necessary to support operability of both AFW divisions, both turbine-driven AFW Pump trains, and both motor-driven AFW Pump trains, as required by LCO 3.7.5 ("Four independent auxiliary feedwater (AFW) trains shall be OPERABLE.") and to meet the single failure criteria.

The applicant is requested to revise generic TS LCO 3.7.5 to state: "The turbine-driven AFW pump train and the motor-driven AFW pump train associated with each steam generator shall be OPERABLE."

The first Condition statement of Action A of generic TS 3.7.5, which states, "Turbine driven AFW train inoperable due to one inoperable steam supply." Since only one of the two main steam lines on each steam generator is connected to the associated turbine-driven AFW pump turbine steam supply pipe, the first Condition statement of Action A of generic TS 3.7.5, which is based on STS 3.7.5 Action A, does not apply to the APR1400 design. The applicant is requested to remove the first Condition statement of Action A from generic TS 3.7.5.

Generic TS 3.7.5 Condition C is based on STS 3.7.5 Condition C, which assumes an AFW system design having two independent motor driven AFW pumps and one turbine-driven AFW pump each capable of supplying AFW to either steam generator, with the turbine-driven AFW pump turbine capable of being supplied steam from either steam generator. Generic TS 3.7.5 Condition C states:

> One turbine driven AFW train inoperable due to associated inoperable steam supply.
>
> AND
>
> One motor driven AFW train inoperable.

Since each turbine-driven AFW pump turbine only gets steam from its associated steam generator through a single steam supply line, there is no need to consider how the turbine driven pump was made inoperable. The relevant concern is whether two AFW trains are inoperable in the same AFW division or one train is inoperable in both AFW divisions. It is not clear that the STS 3.7.5 Action C Completion Time of 48 hours is justified for either of these APR1400 Conditions:

- One AFW division with two AFW pump trains inoperable
- Two AFW divisions with one AFW pump train inoperable

The applicant is requested to replace generic TS 3.7.5 Action C with one or more Actions for the above two Conditions, with appropriate Required Actions and Completion Times. Appropriate Bases discussions that justify the new Actions must also be provided.

Response

KHNP agrees with the NRC staff's conclusion on (i), (ii), and (iii) as above described.

Two auxiliary feedwater (AFW) divisions of APR1400 Standard Design are completely independent, with no AFW storage tank suction cross-connect flow paths between them that can be not remotely isolated from the control room in the normal system lineup. Therefore, generic TS LCO 3.7.6 will be revised to require each AFW storage tank to be operable to support operability of two AFW divisions.

According to revised generic TS LCO 3.7.6 as above described, generic TS LCO 3.7.5 will be revised to require four independent auxiliary feedwater flow paths to be operable to support operability of the turbine-driven AFW pump train and the motor-driven AFW pump train associated with each steam generator.

According to revised generic TS LCO 3.7.5 as above described, the Condition, Required Action, and Completion time of Actions A, B, C, D, and E will be revised. The item on Actions F will be deleted.

The condition statement of Actions A will consider the condition on one AFW flow path in inoperable in MODE 1, 2, or 3. In case of the Condition A, Required Action is to restore AFW flow path to operable status within 7 days. The 7-day Completion Time is reasonable based on the following reasons;

a. Redundancy of the auxiliary feedwater system (AFWS) division, and

b. Availability of redundant operable AFW flow path within each division of AFWS.

The condition statement of Actions B will consider the condition on one AFW division in inoperable in MODE 1, 2, or 3. Required Action is to restore AFW division to operable status within 72 hours.

The condition statement of Actions C will consider the condition on one AFW flow path in each division in inoperable in MODE 1, 2, or 3. Required Action is to restore affected AFW flow path to operable status within 72 hours. The basis of the 72-hours Completion Time is same as Actions B.

The condition statement of Action D will consider the condition on 1) required action and associated completion time of condition A, B, or C not met or 2) three AFW flow paths to be inoperable in MODE 1, 2, or 3. Required Action D.1 is to be in MODE 3 within 6 hours, then Required Action D.2 is to be in MODE 4 within 18 hours.

The condition statement of Action E will consider the condition on 3) two AFW divisions in inoperable in MODE 1, 2, or 3 or 4) two AFW flow paths, each of which includes a motor-driven pump, in inoperable in mode 4. Required Action is to initiate immediately action to restore one AFW flow path to operable status. With two AFW divisions inoperable in MODE 1, 2, or 3, the unit is in a seriously degraded condition with no safety related means for conducting a cooldown, and only limited means for conducting a cooldown with non-safety grade equipment. In such a condition, the unit should not be perturbed by any action, including a power change, that may result in a trip. The seriousness of this condition requires that action be started immediately to restore one AFW flow path to operable status. In MODE 4, with two AFW flow paths, each of which include a motor driven pump, inoperable, Required Action is to immediately restore one flow path, which includes a motor driven pump, to operable status or to immediately verify, by administrative means, the operability of a required AFW flow path.

Since all cases of possible failure condition are considered in the revised condition statement of Actions A, B, C, D, and E, the item on Actions F will be deleted.

TS 3.7.5, 3.7.6, and Bases for TS 3.7.5 and TS 3.7.6 will be revised to reflect above description.

Impact on DCD

Same as changes described in the impact on Technical Specifications section.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

TS 3.7.5, 3.7.6, and Bases for TS 3.7.5 and TS 3.7.6 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.

3.7 PLANT SYSTEMS

3.7.5 Auxiliary Feedwater System (AFWS)

flow paths

LCO 3.7.5 Four independent auxiliary feedwater (AFW) ~~trains~~ shall be OPERABLE.

flow path

NOTE

Only one AFW ~~train~~, which includes a motor driven pump, is required to be OPERABLE in MODE 4.

APPLICABILITY: MODES 1, 2, and 3,
MODE 4 when a steam generator is relied upon for heat removal.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. ~~One turbine driven AFW train inoperable due to associated inoperable steam supply.~~ ~~OR~~ NOTE ~~Only applicable if MODE 2 has not been entered following refueling.~~ ~~One turbine driven AFW pump inoperable in Mode 3 following refueling.~~	A.1 Restore ~~affected equipment~~ to OPERABLE status. AFW flow path One AFW flow path inoperable in MODE 1, 2, or 3. division	7 days
B. ~~One AFW train inoperable in MODE 1, 2, or 3 for reasons other than Condition A.~~	B.1 Restore AFW ~~train~~ to OPERABLE status.	72 hours

One AFW division inoperable in MODE 1, 2, or 3.

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One AFW flow path in each division inoperable in MODE 1, 2, or 3.

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. ~~One turbine driven AFW train inoperable due to associated inoperable steam supply.~~ ~~AND~~ ~~One motor driven AFW train inoperable.~~	C.1 ~~Restore steam supply to turbine driven train to OPERABLE status.~~ ~~OR~~ OR C.2 ~~Restore motor driven AFW train to OPERABLE status.~~	~~48 hours~~ 72 hours ~~48 hours~~
D. Required Action and associated Completion Time of Conditions A, B, or C not met. OR Three AFW ~~trains~~ flow paths inoperable in MODE 1, 2, or 3.	D.1 Be in MODE 3. AND D.2 Be in MODE 4.	6 hours 18 hours
E. ~~Four AFW trains inoperable in MODE 1, 2, or 3.~~ Two AFW divisions inoperable in MODE 1, 2, or 3. OR Two AFW flow paths, each of which includes a motor-driven pump inoperable in MODE 4.	NOTE LCO 3.0.3 and all other LCO Required Actions requiring MODE changes are suspended until one AFW ~~train~~ is restored to OPERABLE status. flow path E.1 Initiate action to restore one AFW ~~train~~ to OPERABLE status. flow path	Immediately

Restore affected AFW flow path to OPERABLE status.

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
~~F. Required AFW train inoperable in MODE 4.~~	~~NOTE~~ ~~LCO 3.0.3 and all other LCO Required Actions requiring MODE changes are suspended until one AFW train is restored to OPERABLE status.~~ ~~F.1 Initiate action to restore one AFW train to OPERABLE status.~~	~~Immediately~~

SURVEILLANCE REQUIREMENTS

	SURVEILLANCE	FREQUENCY
SR 3.7.5.1	Verify each AFW manual, power-operated, and automatic valve in the flow path and in each steam supply flow path to the turbine-driven pumps, that is not locked, sealed, or otherwise secured in position, is in correct position.	31 days
SR 3.7.5.2	NOTE Not required to be performed for the turbine driven AFW pump until 24 hours after reaching 985 psig in steam generators. Verify developed head of each AFW pump at flow test point is greater than or equal to required developed head.	In accordance with Inservice Testing Program

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.7.5.3	NOTE a. Not required to be performed for turbine driven AFW pump until 24 hours after reaching 69.25 kg/cm^{2}G (985 psig) in steam generators. b. Not required to be met in MODE 4 when steam generator is relied upon for heat removal. Verify each AFW automatic valve that is not locked, sealed, or otherwise secured in position, actuates to correct position on an actual or simulated actuation signal.	18 months
SR 3.7.5.4	NOTE a. Not required to be performed for turbine driven AFW pump until 24 hours after reaching 69.25 kg/cm^{2}G (985 psig) in steam generators. b. Not required to be met in MODE 4 when steam generator is relied upon for heat removal. Verify each AFW pump starts automatically on an actual or simulated actuation ~~signal when in MODE 1, 2, or 3.~~ signal.	18 months
SR 3.7.5.5	Verify proper alignment of required AFW flow paths by verifying flow from auxiliary feedwater storage tank to each steam generator.	Prior to entering MODE 2 whenever a unit has been in MODE 5, 6, or defueled for a cumulative period of > 30 days.

3.7 PLANT SYSTEMS

3.7.6 Auxiliary Feedwater Storage Tank (AFWST)

LCO 3.7.6 ~~One~~ Each AFWST shall be OPERABLE.

APPLICABILITY: MODES 1, 2, and 3,
MODE 4 when a steam generator is relied upon for heat removal.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One AFWST inoperable.	A.1 Verify OPERABILITY of other AFWST. AND A.2 Restore AFWST to OPERABLE status.	4 hours AND Once per 12 hours thereafter 7 days
B. Required Action and associated Completion Time not met.	B.1 Be in MODE 3. AND B.2 Be in MODE 4 without reliance on steam generator for heat removal.	6 hours 24 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.7.6.1	Verify each AFWST level is ≥ 1,524,165 L (400,000 gal).	12 hours

B 3.7 PLANT SYSTEMS

B 3.7.5 Auxiliary Feedwater System (AFWS)

BASES

BACKGROUND

The AFWS automatically supplies feedwater to the steam generators to remove decay heat from the reactor coolant system upon the loss of normal feedwater supply. The auxiliary feedwater (AFW) pumps take suction through separate and independent suction lines from the auxiliary feedwater storage tanks (AFWSTs) (LCO 3.7.6) and pump to the steam generator secondary side via a separate and independent connection to the main feedwater (MFW) piping inside containment. The steam generator functions as a heat sink for core decay heat. The heat load is dissipated by releasing steam to the atmosphere from the steam generators via the main steam safety valves (MSSVs) (LCO 3.7.1) or main steam atmospheric dump valves (MSADVs) (LCO 3.7.4). If the main condenser is available, steam may be released to the main condenser via the turbine bypass valves.

The AFWS is configured into two separate mechanical divisions. Each division consists of one motor driven AFW pump and one turbine driven AFW pump.

~~The AFWS consists of two motor driven AFW pumps and two steam turbine driven pumps configured into four trains.~~ Each motor driven pump provides 100 % of AFW flow capacity and each turbine driven pump provides 100 % of the required capacity to its respective steam generator as assumed in the accident analysis. The pumps are equipped with independent recirculation lines to prevent pump operation against close system.

Each motor driven AFW pump is powered from an independent Class 1E power supply, and feeds one steam generator. One pump at full flow is sufficient to remove decay heat and cool the unit to shutdown cooling system (SCS) entry conditions.

Each turbine driven AFW pump receives steam from an independent main steam line, upstream of the main steam isolation valve (MSIV). Each of the steam feed lines will supply 100 % of the requirements of the turbine driven AFW pump. The turbine driven AFW pump supplies feedwater to the steam generator which provides driving steam, with DC-powered control valves actuated by the auxiliary feedwater actuation signal (AFAS).

Each division has two flow paths which are the motor driven AFW pump flow and the turbine driven AFW pump flow, respectively. Each division supplies AFW to the dedicated steam generator.

BASES

APPLICABLE SAFETY ANALYSES (continued)

The AFWS design is such that it can perform its function following an FWLB between the main feed water isolation valve and containment, combined with a loss of offsite power following turbine trip, and a single active failure of the turbine driven AFW pump. The AFW flow to the faulted steam generator is terminated manually by the operator action. Sufficient flow would be delivered to the intact steam generator by the redundant AFW pump.

The AFWS satisfies Criterion 3 of 10 CFR 50.36(c)(2)(ii).

LCO

The LCO requires that four independent AFW ~~trains~~ flow paths be OPERABLE to ensure that the AFWS will perform the design safety function to mitigate the consequences of accidents that could result in overpressurization of the reactor coolant pressure boundary. Four independent AFW pumps, ~~in four diverse trains,~~ two divisions, ensure availability of residual heat removal capability for all events accomplished by a loss of offsite power and a single failure. This is accomplished by powering ~~two pumps~~ a motor driven pump in each from independent emergency buses. ~~The third and fourth AFW pumps are~~ The remainder of the AFW pumps in each division is powered by a diverse means, ~~two steam driven turbines~~ a steam driven turbine supplied with steam from an independent source not isolated by the closure of the MSIVs.

The AFWS is considered to be OPERABLE when the components and flow paths required to provide AFW flow to the steam generators are OPERABLE. This requires that the two motor driven AFW pumps be OPERABLE in two diverse paths, each supplying AFW flow to a separate steam generator. Two turbine driven AFW pumps shall be OPERABLE with steam supplies from the main steam lines upstream of the MSIVs, and each capable of supplying AFW flow to ~~the~~ steam generators which provides driving steam. The piping, valves, instrumentation, and controls in the required flow paths shall also be OPERABLE.

The LCO is modified by a Note indicating that one AFW ~~train,~~ the dedicated flow path, which includes a motor driven pump, is required to be OPERABLE in MODE 4 when a steam generator is relied upon for heat removal. This is because of reduced heat removal requirements, the short period of time in MODE 4 during which AFW is required, and the insufficient steam supply available in MODE 4 to power the turbine driven AFW pump.

BASES

APPLICABILITY

In MODES 1, 2, and 3, the AFWS is required to be OPERABLE and to function in the event that the main feed water is lost. In addition, the AFWS is required to supply enough makeup water to replace steam generator secondary inventory, lost as the unit cools to MODE 4 conditions.

In MODE 4, the AFWS may be used for heat removal via a steam generator.

In MODES 5 and 6, the steam generators are not normally used for decay heat removal, and the AFWS is not required.

ACTIONS

A.1

AFW flow path is inoperable,

If one ~~turbine driven AFW pump is inoperable due to inoperable steam supply, or if a turbine driven pump is inoperable for any reason while in MODE 3 immediately following refueling,~~ action must be taken to restore ~~the inoperable equipment~~ to an OPERABLE status within 7 days. The 7-day Completion Time is reasonable based on the following reasons:

the flow path

a. ~~For the inoperability of one turbine driven AFW pump due to associated inoperable steam supply, the 7-day Completion Time is reasonable due to the redundancy afforded by the remaining OPERABLE turbine driven train.~~

b. ~~For the inoperability of a turbine driven AFW pump while in MODE 3 immediately subsequent to a refueling outage, the 7-day Completion Time is reasonable due to the minimal decay heat levels in this situation.~~

c. ~~For both the inoperability of one turbine driven pump due to inoperable steam supply and an inoperable turbine driven AFW pump while in MODE 3 immediately following a refueling outage, the 7-day Completion Time is reasonable due to the availability of redundant OPERABLE motor driven AFW pumps and due to the low probability of an event requiring the use of the turbine driven AFW pumps.~~

~~Condition A is modified by a Note which limits the applicability of the Condition for an inoperable turbine driven AFW pump in MODE 3 to when the unit has not entered MODE 2 following a refueling. Condition A allows one AFW train to be inoperable for 7 days vice the 72-hour Completion Time in Condition B.~~

Redundancy of the AFWS division, and

Availability of redundant OPERABLE AFW flow path within each division of AFWS.

BASES

ACTIONS (continued)

~~This longer Completion Time is based on the reduced decay heat following refueling and prior to the reactor being critical.~~

B.1

divisions (pump or flow path) inoperable,

With one of the required AFW ~~trains (pump or flow path) inoperable in MODE 1, 2, or 3 for reasons other than Condition A,~~ action must be taken to restore OPERABLE status within 72 hours. The 72-hour Completion Time is reasonable based on the redundant capabilities afforded by the AFWS, the time needed for repairs, and the low probability of a DBA event occurring during this period. ~~Three~~ AFW pumps and flow paths remain to supply feedwater to the steam generators.

Two

C.1 ~~and C.2~~

~~With one of the required motor driven AFW trains (pump or flow path) inoperable and one required turbine driven AFW train inoperable due to associated inoperable steam supply, action must be taken to restore the affected equipment to OPERABLE status within 48 hours. Assuming no single active failures when in this condition, the accident (a FLB or MSLB) could result in the loss of the steam supply to the remaining turbine driven AFW pump due to the faulted steam generator (SG). In this condition, the AFWS may no longer be able to meet the required flow to the SGs assumed in the safety analysis, either due to the analysis requiring flow from two AFW pumps or due to the remaining AFW pump having to feed a faulted SG.~~

~~The 48-hour Completion Time is reasonable based on the fact that the remaining motor driven AFW train is capable of providing 100 % of the AFW flow requirements and the low probability of an event occurring that would challenge the AFWS.~~

D.1 and D.2

A.1, B.1, or C.1

When Required Action ~~A.1, B.1, C.1, or C.2~~ cannot be completed within the required Completion Time, the unit must be placed in a MODE in which the LCO does not apply. To achieve this status, the unit must be placed in at least MODE 3 within 6 hours, and MODE 4 within 18 hours.

The allowed Completion Times are reasonable, based on operating experience, to reach the required unit conditions from full power conditions in an orderly manner and without challenging unit systems.

If one AFW flow path in each division is inoperable in MODES 1, 2, and 3, action must be taken to restore an AFW flow path to OPERABLE status within 72 hours. The 72-hours Completion Time is reasonable based on the redundant capabilities afforded by the AFWS, the time needed for repairs, and the low probability of a DBA event occurring during this period.
One AFW flow path in each division remains to supply feedwater to the steam generators.

BASES

ACTIONS (continued)

~~In MODE 4, with three AFW trains inoperable in MODE 1, 2, or 3, operation is allowed to continue because only one motor driven AFW pump is required in accordance with the Note that modifies the LCO. Although it is not required, the unit may continue to cool down and start Shutdown Cooling.~~

E.1

or power reductions are suspended until one AFW flow path

Required Action E.1 is modified by a Note indicating that all required MODE changes ~~are suspended until one AFW train~~ is restored to OPERABLE status.

two AFW divisions

With ~~all four AFW trains~~ inoperable in MODES 1, 2, or 3, the unit is in a seriously degraded condition with no safety related means for conducting a cooldown, and only limited means for conducting a cooldown with non-safety grade equipment. In such a condition, the unit should not be perturbed by any action, including a power change, that may result in a trip. The seriousness of this condition requires that action be started immediately to restore one AFW ~~train~~ to OPERABLE status. LCO 3.0.3 is not applicable as it could force the unit into a less safe condition.

~~F.1~~

flow path

~~Required Action F.1 is modified by a Note indicating that all required MODE changes or power reductions are suspended until one AFW train is restored to OPERABLE status.~~

~~With one AFW train inoperable, action must be taken to immediately restore the inoperable train to OPERABLE status or to immediately verify, by administrative means, the OPERABILITY of a second train. LCO 3.0.3 is not applicable, as it could force the unit into a less safe condition.~~

~~In MODE 4, either the reactor coolant pumps or the SC loops can be used to provide forced circulation as discussed in LCO 3.4.6, "RCS Loops – MODE 4."~~

In MODE 4, with two AFW flow paths, each of which include a motor driven pump, inoperable, action must be taken to immediately restore one flow path, which includes a motor driven pump, to OPERABLE status or to immediately verify, by administrative means, the OPERABILITY of a required AFW flow path.

BASES

SURVEILLANCE REQUIREMENTS (continued)

The Frequency is reasonable, based on engineering judgment, and other administrative controls to ensure that flow paths remain OPERABLE. To further ensure AFWS alignment, the OPERABILITY of the flow paths is verified following extended outages to determine that no misalignment of valves has occurred. This SR ensures that the flow path from the AFWST to the steam generators is properly aligned by requiring a verification of minimum flow capacity of 650 gpm at 1,240 psia. ~~(This SR is not required by those units that use AFW for normal startup and shutdown.)~~

REFERENCES

1. DCD Tier 2, Subsection 10.4.9.
2. ASME OM Code.