SUPPLEMENTAL 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.:	**295-8263**
SRP Section:	**16 – Technical Specifications**
Application Section:	**16.3.3**
Date of RAI Issue:	**11/05/2015**

Question No. 16-112

The applicant is requested to consider the following suggested clarifications and corrections to the “Background” section of the Bases for generic TS 3.3.5:

1. On page B 3.3.5-4, second paragraph under the heading “ESFAS Logic”, the fourth sentence should end with the phrase “coincidence logic state” not “coincidence logics state.” The applicant is requested to remove the letter “s” from “logics” for clarity, or otherwise revise the sentence to clarify the intended meaning.

2. On page B 3.3.5-5, the applicant is requested to revise the first two paragraphs consistent with the following suggested markup by the staff:

The actuation logic in each channel of ESF-CCS takes part in actuating the equipment of the corresponding ESFAS train. Each ESFAS Function has individual actuation logic in each channel of the ESF-CCS.

The initiation logic performs the logical “OR” of selective 2-out-of-4 logic (logical "OR"; channel A or C AND channel B or D; but not channels A and C OR channels B and D) on the LCL outputs for each ESFAS Function, to generate the ESF actuation signal and sends the ESFAS signal to the ESF-CCS component control logic.

3. On page B 3.3.5-5, the third paragraph uses the phrase “serial data link for group and loop controllers.” A word search of DCD Chapter 16 found no other instances of the use of the terms “group controller(s)” and “loop controller(s).”

Staff understands that, for each channel (Division A, B, C, or D) of an ESFAS Function, the Engineered Safety Features Component Control System (ESF-CCS) includes:

Two redundant Group Controllers (GC1 and GC2) that independently perform the “initiation logic” function—the ‘‘selective 2-out-of-4 logic” processing of the coincidence logic output signals received from the Local Coincidence Logic (LCL) processors in all four Plant Protection System (PPS) channels. For example, for ESFAS Division A, the coincidence logic trip signals received from the four PPS channels are labeled A1, B1, C1, and D1, and for ESFAS Division B, they are labeled A2, B2, C2, and D2. The selective 2-out-of-4 logic in Division A is “A1 or C1 AND B1 or D1”; and in Division B, it is “A2 or C2 AND B2 or D2.”

A Loop Controller (LC), with a primary and a backup processor module (PM1 and PM2), that processes the GC1 and GC2 ESF actuation signals, respectively, with the ESF component control logic to generate and send component control signals to the component interface module (CIM) of each actuated device in the respective ESF train.

a. The applicant is requested to verify the accuracy of the above description of the LCL for coincidence logic, the GC for initiation logic, and the LC for actuation logic; the actuation logic is apparently considered by Table 3.3.6-1 to include the ESFAS Division’s component control logic.

b. The applicant is requested to describe the functions and purposes of the equipment listed in the subject paragraph by expanding the subject Bases paragraph, which confusingly states:

The ESF-CCS comprises power supply, manual switch, latching logic and serial data link for group and loop controllers.

4. The fourth paragraph on page B 3.3.5-5 is confusing and appears to be inaccurate. It states:

Each ESFAS Function has sub groups and each sub group is in charge of one- or more ESFAS Functions. The initiation and actuation logics to the sub groups are identified in LCO 3.3.6.

The “ESFAS function sub groups” do not appear to be listed or defined in any kind of detail anywhere in the DCD, the Safety I&C TeR, or the Bases for generic TS 3.3.6. Therefore, the applicant is requested to (1) add this information to the APR1400 DC application; and (2) revise the above paragraph so it is accurate, clear, and informative regarding ESFAS function sub groups.

5. The applicant is requested to revise the fifth paragraph on page B 3.3.5-5 for clarity beginning with the fourth sentence, consistent with the following markup:

Bypassing the same parameter in more than one channel is restricted by the administrative procedure. The coincidence logic becomes 2-out-of-3 coincidence logic. All-bypass The all-bypass function for bypassing all parameters in the an ESFAS channel is interlocked in the LCL algorithm to prevent simultaneous bypass of more than one channel. The all-bypass function interlock is implemented based on with an analog circuit through and hardwired cable between the LCLs in all channels. The purpose of the all-bypass function is to support testing

and maintenance of the BP, whereas the trip channel bypass is used against in case of sensor failure.

6. The applicant is requested to revise the seventh paragraph on page B 3.3.5-5 for clarity, consistent with the following markup:

An enabled operating Operating bypass function does not block protects the output of trip and alarm signals from the bistable processor to the IPS and QIAS-N. The Pressurizer Pressure – Low input to the SIAS shares an operating bypass with the Pressurizer Pressure – Low reactor trip.

Response

The following changes will be made to the “Background” section of the Bases for generic TS 3.3.5:

1. The phrase “coincidence logics state” described on page B 3.3.5-4 will be changed to “coincidence logic state” along with those on pages B 3.3.1-8, B 3.3.4-3, and B 3.3.6-2.

2. The local coincidence logic (LCL) and initiation logic are sequentially located in the LCL processor. The LCL performs the 2-out-of-4 logic and then the initiation logic receiving the LCL outputs performs the “OR” logic to generate the ESF actuation signal to the ESF-CCS actuation logic. Therefore, the first two paragraphs on page B 3.3.5-5 will be changed as follows:

“The actuation logic in each channel of ESF-CCS takes part in actuating the equipment of the corresponding ESF train. Each ESFAS Function has individual actuation logic in each channel of the ESF-CCS.

The initiation logic performs the logical “OR” of LCL outputs for each ESFAS Function, to generate the ESF actuation signal to the ESF-CCS actuation logic.

3.a Two redundant Group Controllers (GC1 and GC2) located in each ESF-CCS cabinet independently perform the “actuation logic” function that processes the “selective 2-out-of-4 logic” using the initiation logic output signals from the LCL processors in all four PPS channels. The description pertaining to the Loop Controller (LC) is correct. The additional detailed information regarding the ESF-CCS is described in DCD Tier 2, Section 7.3, “Engineered safety Features Systems”.

3.b Since the detailed ESF-CCS configuration is described in DCD Tier 2, Section 7.3 and is not directly related to the safety functions covered in Technical Specification, the third paragraph will be deleted.

4. The information regarding the ESFAS subgroups is stated in Section 7.3.2.5 of DCD Tier 2 and Section 4.4.2 of the Safety I&C TeR.

The fourth paragraph on page B 3.3.5-5 will be revised to be consistent with the information stated in Section 7.3.2.5 of DCD Tier 2 and Section 4.4.2 of the Safety I&C TeR as follows:

Each ESFAS Function has an associated group of outputs. Each group of outputs is divided into subgroups. Outputs within a subgroup are tested concurrently and are selectively arranged so that concurrent actuation does not adversely affect plant operations. The initiation and actuation logics to the subgroups are addressed in LCO 3.3.6.

5. The fifth paragraph on page B 3.3.5-5 will be revised to be consistent with the proposed markup provided in the request.

6. Since an enabled operating bypass function does block the output of trip and alarm signals from the bistable processor, the seventh paragraph on page B 3.3.5-5 will be revised as follows:

An enabled operating bypass function blocks the output of trip and alarm signals from the bistable processor to the LCL, IPS, and QIAS-N. The Pressurizer Pressure – Low input to the SIAS shares an operating bypass with the Pressurizer Pressure – Low reactor trip.

Supplemental Response

Supplemental response to 4th question: Actuation Logic Testing required by SR 3.3.6.1 is performed to test the selective 2/4 logic in the GC. This test is performed for one channel, one GC, one ESFAS function at a time. The output of the GC under Actuation Logic Testing is blocked for the ESFAS function to ensure that the components are not affected by the testing. The testing block is removed when a valid ESFAS signal is received during testing even if it is under testing. Therefore, the ESF Actuation Logic Testing does not adversely affect plant operations.

The purpose of individual subgroup test required by SR 3.3.6.2 to verify the operability of the component control logic and component. This test is performed for, one channel, one GC, and one subgroup at a time. The individual subgroup test does not cause system level ESFAS actuation.

The prior revisions of the RAI response were incorporated into Rev. 1 of the DCD.

Impact on DCD

There is no impact on the DCD

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.

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RAI No.:	**295-8263**
SRP Section:	**16 – Technical Specifications**
Application Section:	**16.3.3**
Date of RAI Issue:	**11/05/2015**

Question No. 16-115

The applicant is requested to consider the following suggested clarifications and corrections to the Bases for generic TS 3.3.6; please explain and correct any errors in the suggested changes:

1. Generic TS SR 3.3.6.2 verifies that each subgroup can actuate ESFAS equipment when actuational output of each subgroup is generated; surveillance column Note 2 says "Subgroup of Actuation Logic channel A, C and B, D shall be tested on a staggered basis." The "Background" section of the Bases for generic TS 3.3.6 does not describe in any detail the ESFAS Actuation Logic subgroups and trip legs so that the Required Actions and Surveillance Requirements may be understood. Suggest inserting into the SR 3.3.6.2 Bases discussion consistent with the following information describing the ESF-CCS actuation logic from TeR APR1400-Z-J-NR-14001-P, Rev.0:

   > For each ESF actuation function, each group of outputs is divided into subgroups. Outputs within a subgroup are tested concurrently and are selectively arranged so that concurrent actuation does not adversely affect plant operations. (Page 60, Section 4.4.3, last paragraph, **TS**)
   >
   > The ESFAS initiation signals from the PPS are sent to separate ESF-CCS cabinets. Each cabinet contains the actuation logic for only one division; therefore, a failure in one cabinet cannot affect the circuitry and actuated equipment of the other divisions. (Page A9)
   >
   > Single failures of the actuation (or control) logic will cause, at worst, only a failure of a component, group of components, or one entire redundant train; actuation of the remaining redundant division is sufficient for the protective action. (Page A10)

In the above TeR quotations, when the word “division” means either electrical power Division I or Division II, or Actuation Logic division (A, B, C, or D), staff requests applicant to so indicate to improve the clarity of the discussion in the TeR, and in the Bases for generic TS 3.3.6.

2. In order for NRC staff to verify the TeR quotations in item 1 above, for each ESFAS subgroup (“subgroup for Actuation signal of each Actuation Logic channel”), the applicant is requested to provide, in response to this question, a list of components (motor, air, and solenoid operated valves, pumps, dampers, and fans) by equipment designator and name, for all six NSSS ESFAS Functions, and all three BOP ESFAS Functions. For each component indicate (a) the supporting electrical power division (also indicate whether dc or ac power), (b) the associated safety train (A, B, C, or D), and the associated ESFAS Actuation Logic division. For each containment penetration flow path, indicate which isolation valve is inside and which isolation valve is outside containment. Also indicate the same information, where applicable, for the pressurizer power operated safety relief valves, the steam generator atmospheric steam dump valves and block valves, the CVCS isolation valves, the SCS valves, the steam generator blowdown system isolation valves, and the RCS leak detection system instrumentation, and the post accident monitoring instrumentation (AMI) for Type A, B, and C parameters.

3. The “Actions” section of the Bases for generic TS 3.3.6 uses the term ‘trip leg’ in the discussion of Required Actions B.1 and B.2. The CE System 80+ DCD Chapter 16, Section 1.1 defines “trip leg” as follows:

> A TRIP LEG is defined as the "logical or" combination of channel states which represent half of a Selective two-out-of-four Logic function. When both TRIP LEGS of a Selective two-out-of-four Logic function assume a true state, the output of the Selective two-out-of-four Logic function assumes a true state (e.g., in a Selective two-out-of-four Logic [(A "or" C) "and" (B "or" D) = N]; the term (A "or" C) is a TRIP LEG, the term (B "or" D) is a TRIP LEG, and N is the output).

In the CE System 80+ DCD, the generic TS use the term TRIP LEG in the “Background” and “Actions” sections of the Bases for TS 3.3.4, RPS Logic and Trip Initiation, and in the “Actions” section of the Bases for TS 3.3.6, ESFAS Logic and Manual Initiation. The applicant is requested to discuss what is meant by an ESFAS “trip leg” in the “Background” section of the Bases on page B 3.3.5-4 and page B 3.3.6-3.

4. In the “Background” section of the Bases for TS 3.3.5 and TS 3.3.6,

   a. First paragraph, replace reactor coolant system with Reactor Coolant System.

   b. On pages B 3.3.5-1 and B 3.3.6-1, apply STS ordered list format convention to list of ESFAS functions; that is, end each item with a comma except end last item with a period, and append “and” to the next to last item. Note that this may be considered a global comment for all ordered lists in the “Background” section of each generic TS Subsection Bases.

c. Fourth paragraph on pages B 3.3.5-1 and B 3.3.6-1, the applicant is requested to revise for clarity and for acronym definition and usage consistency, as indicated in the following markup; please explain and correct any errors in the suggested changes:

The ~~engineered safety features (ESF)~~ ~~system~~ **Engineered Safety Features (ESF) Actuation System (ESFAS)** consists of four channels of sensors, **auxiliary process cabinets – safety (**APC-S**)** ~~cabinets~~, the ESF**AS signal** ~~initiation~~ **generation** portion of the **Plant Protection System (**PPS**)** cabinets and **the ESF Component Control System (**ESF-CCS**)**.

d. On pages B 3.3.5-1 & 2, and page B 3.3.6-2, the applicant is requested to revise the following three paragraphs for clarity as indicated by the following markup; please explain and correct any errors in the suggested changes::

The devices and circuitry that generate the above ESFAS signals are grouped into the following interconnected parts. These parts are:
~~The ESFAS function is performed through the below portions in the ESF system.~~

~~a.~~• Measurement channels**,**

~~b.~~• Bistable logic **processor channels,**

~~c.~~• ESFAS logic **channels**:

— Coincidence Logic**,**

— Initiation Logic **(trip paths), and**

— Actuation Logic**.**

[For B 3.3.6] This LCO addresses **the** ESFAS logic **channels**. Bistable logic **processor channels** and measurement channel**s** are addressed in . . .

[For B 3.3.5] This LCO addresses measurement channels and bistable logic **processor channels**. **ESFAS logic** ~~Logic is~~ **channels**~~. and~~ are addressed in . . .

[For B 3.3.6] The role**s** of the measurement channel**s** and bistable logic **processor channels** ~~is~~ **are** described in LCO 3.3.5. The role of the ESFAS logic is described below.

[For B 3.3.5] The role of each of these ~~functions~~ **interconnected parts of** ~~in~~ the ESFAS, including the **ESFAS** logic**, which is also described in** ~~of~~ LCO 3.3.6, is discussed below.

e. On pages B 3.3.5-2 & 3, for consistency in terminology, the applicant is requested to revise the heading “Bistable Logics” to “Bistable Logic Processors.”

f. On page B 3.3.6-2, for clarity the applicant is requested to revise the paragraph under the heading “ESFAS Logic” as indicated; please explain and correct any errors in the suggested changes:

> The ESFAS logic, consisting of coincidence, initiation and actuation logic, employs a scheme that provides an ESF**AS** actuation **signal from all** ~~of~~ four **PPS** divisions **to the component control logic of all trains of the associated ESF systems** when ~~bistables in~~ any two of the four **bistable logic processor** channels sense **that** the same input parameter **has satisfied the ESFAS Function’s** trip **setpoint on the input parameter**. This **logic scheme** is called a two-out-of-four trip logic.

On page B 3.3.5-4, for clarity the applicant is requested to revise the paragraph under the heading “ESFAS Logic” as indicated:

> The ESFAS logic, consisting of **coincidence,** initiation ~~logic channel~~ and actuation logic, employs a scheme that provides an ESF**AS** actuation **signal from all four PPS divisions to the component control logic** of all trains **of the associated ESF systems** when ~~bistables in~~ any two of the four **bistable logic processor** channels **sense that** ~~sensing~~ the same input parameter **has satisfied the ESFAS Function’s** trip **setpoint on the input parameter**. This **logic scheme** is called a two-out-of-four trip logic.
>
> The applicant is requested to compare corresponding paragraphs in the “Background” sections of the Bases for all generic TS Section 3.3 Subsections, and make repeated information consistent in both phrasing and terminology.

g. On pages B 3.3.6-2 and -3, for clarity the applicant is requested to revise the paragraph under the heading “Coincidence Logic” as indicated; please explain and correct any errors in the suggested changes:

> There is one local coincidence logic (LCL) associated with each trip bistable logic of each channel **of a given ESFAS instrument Function**. Each LCL receives four trip signals, one **from the trip** ~~for its associated~~ bistable logic in the **associated** channel and one from each **trip** ~~of the equivalent~~ bistable logic located in the other three channels **of the affected ESFAS instrument Function**. The LCL **also** receives the trip channel bypass status **signal** associated with each of the ~~above mentioned bistables~~**bistable signals**. The function of the LCL is to generate a coincidence logic trip **signal** whenever two or more like bistables are in a tripped condition. ~~The LCL takes into consideration the trip bypass input state when determining the coincidence logics state.~~ **Each LCL automatically changes the state of each of the four coincidence logic channels based on the state of the trip channel**

bypass Function in each channel. For example, a 2-out-of-4 trip logic goes to 2-out-of-3 if one trip bistable logic channel is bypassed.

Designating the protection channels as A, B, C, D, with no trip **channel** bypass **signal** present, the LCL will produce a coincidence logic trip signal for any of the following trip inputs: AB, AC, AD, BC, BD, CD, ABC, ABD, ACD, BCD, ABCD. These represent all possible two- or more out-of-four trip combinations of the four protection channels. Should a trip **channel** bypass be present, the logic will provide a coincidence logic trip signal when two or more of the three un-bypassed **trip bistable logic channels** ~~bistables~~ are in a tripped condition.

h. On pages B 3.3.6-3, for clarity the applicant is requested to revise the paragraph under the headings “Initiation Logic,” “Actuation Logic,” and “Manual Trip,” as indicated; please explain and correct any errors in the suggested changes:

Initiation Logic

The initiation logic is designed to **be** fail-safe. ~~This~~ **Failure of one initiation logic channel** will result in a partial trip (1 of 4) in the two-out-of-four (**one-out-of-two-taken-twice** ESFAS **selective** actuation logic. The partial trip will be alarmed the same as a full ESF**AS** trip and will be indicated by the **Qualified Indication and Alarm System - Safety (**QIAS**-P)** and **the Information Processing System (**IPS**)**; the partial trip cannot be bypassed.

Actuation Logic

The four initiation logic ~~in~~ **signals from** the PPS ~~actuate~~ **are used to generate** a two-out-of-four **selective** logic ~~in~~ **actuation signal in each division of** the ESF-CCS. In the actuation logic, each signal also sets a latch when the two-out-of-four **selective** logic actuates to assure that the **ESF actuation** signal is not automatically reset once it has been ~~initiated~~ **generated**.

Receipt of two ~~engineered safety system~~ **ESFAS** initiation **logic** channel signals will generate the actuation ~~channel~~ **logic division** signals. This is done independently in each ESF-CCS cabinet, generating division A and division B **actuation signals**, and where required **for ESF systems with four trains**, division C and division D **actuation** signals.

Manual Trip

ESFAS Manual ~~ESFAS~~ Trip capability is provided to permit the operator to manually actuate an ESF system when necessary.

Two sets of two push buttons (in the MCR) for each ESF function are provided, and each set actuates **all trains provided for that ESF Function, either two or four.** ~~the ESF of four trains (or two trains).~~ Each manual trip push button signal is **sent** ~~inputted~~ to the actuation logic ~~of~~ **in the** ESF-CCS **cabinets** via **the** control panel multiplexer (CPM). By arranging the push buttons in two sets of two, such that both push buttons in a set must be depressed, it is possible to ensure that manual trip will not be prevented in the event of a single random failure **in the signal path associated with one set of push buttons**.

5. Regarding Diverse Manual ESF Actuation, the applicant is requested to add in the APR1400 generic TS Bases equivalent discussions with the same level of detail as provided in CE System 80+ DCD Chapter 16, since no such discussion are included:

   a. The “Background’ section of the Bases for generic TS 3.3.6, “ESFAS Logic and Manual Initiation,” of the CE System 80+ DCD Chapter 16 includes a discussion of Diverse Manual ESF Actuation. The APR1400 generic TS 3.3.6 Bases “Background” section contains no discussion of ESFAS Function 7, “Diverse Manual ESF Actuation Signal.” The appliocant is requested to add discussion of this function in “Background” section of Bases for generic TS 3.3.6.

   b. The “Applicable Safety Analyses” section of the Bases for generic TS 3.3.6, “ESFAS Logic and Manual Initiation,” of the CE System 80+ DCD Chapter 16 includes a discussion of “Diverse Manual ESF Actuation Interface to ESF Components.” The applicant is requested to add an equivalent discussion of this function in the “Applicable Safety Analyses” section of Bases for generic TS 3.3.6.

   c. The “LCO” section of the Bases for generic TS 3.3.6, “ESFAS Logic and Manual Initiation,” of the CE System 80+ DCD Chapter 16 includes a discussion of “Diverse Manual ESF Actuation Interface to ESF Components.” The applicant is requested to add an equivalent discussion of this function in the “LCO” section of Bases for generic TS 3.3.6.

   d. The “Applicability” section of the Bases for generic TS 3.3.6, “ESFAS Logic and Manual Initiation,” of the CE System 80+ DCD Chapter 16 includes a discussion of “Diverse Manual ESF Actuation Interface to ESF Components.” The applicant is requested to add an equivalent discussion of this function in the “Applicability” section of Bases for generic TS 3.3.6.

6. The applicant is requested to explain why automatic Diverse ESF Actuation Functions are not included in an LCO based on LCO Selection Criterion 4, and why the manual Diverse ESF Actuation Functions are included in LCO 3.3.6 (as in System 80+) instead of in a separate LCO in generic TS Section 3.3.

Response

1. The following sentences will be inserted into the SR 3.3.6.2 Bases to be consistent with TeR APR1400-Z-J-NR-14001-P, Rev.0.

Each ESFAS Function has an associated group of outputs. Each group of outputs is divided into subgroups. Outputs within a subgroup are tested concurrently and are selectively arranged so that concurrent actuation does not adversely affect plant operations.

The ESFAS initiation signals from the PPS are sent to separate ESF-CCS cabinets. Each cabinet contains the actuation logic for only one division. Therefore, a failure in one cabinet cannot affect the circuitry and actuated equipment of the other divisions.

Single failures of the actuation logic will cause, at worst, only a failure of a component, group of components, or one entire redundant train. The actuation of the remaining redundant division is sufficient for the protective action.

In accordance with the IEEE Std. 603-1991, the channel loses its identity where single protective action signals are combined. Therefore, TeR APR1400-Z-J-NR-14001-P, Rev.0 uses the word “division” for the portion of the circuit from the local coincidence logic to the actuation logic. This approach is consistent with DCD Tier 2 Chapter 7. However, generic TS LCOs 3.3.4 and 3.3.6 use the word “channel” instead of “division” for the same portion of the circuit; from the local coincidence logic to the actuation logic, in accordance with the definitions of channel check, channel functional test, and channel calibration stated in Section 1.1 of NUREG 1432. As a result, the words “channel” and “division” are interchangeable regarding the portion from the local coincidence logic to the actuation logic.

2. A list of all BOP and NSSS components in the ESF-CCS ESFAS Actuation Logic Division Functions for the groups and subgroups is included as Attachment 2.

3. Since the reactor trip switchgear system (RTSS) is composed of full two-out-of-four logic, the term “trip leg” is not necessary to be used for the ACTIONS of LCO 3.3.4. Therefore, Condition C of LCO 3.3.4 will be deleted along with the corresponding TS Bases.

   The Actuation Logic in the ESF-CCS Group Controller is composed of selective two-out-of-four logic. The ESFAS “trip leg” which represents half of a selective two-out-of-four logic function pertains to one portion of the “logical OR” combination of PPS channel A or C and PPS channel B or D. Therefore, the following paragraph will be added under the heading “Actuation Logic” in the “Background” section of the Bases on page B 3.3.6-3.

   > A trip leg is defined as the "logical or" combination of channel states which represent half of a selective two-out-of-four logic function. When both trip leg of a selective two-out-of-four logic function assume a true state, the output of the selective two-out-of-four logic function assumes a true state (e.g., in a selective two-out-of-four logic [(A "or" C) "and" (B "or" D) = N]; the term (A "or" C) is a trip leg, the term (B "or" D) is a trip leg, and N is the output).

4. The following responses are provided pertaining to the “Background” section of the Bases for TS 3.3.5 and TS 3.3.6.

   a. The phrase “reactor coolant system” stated in the first paragraph will be replaced with

"Reactor Coolant System."

b. Each item in the ESFAS Function list will be ended with a comma except the last item which will be ended with a period and the word "and" will be appended to the next to the last item with a comma.

c. The fourth paragraph on pages B 3.3.5-1 and B 3.3.6-1 will be revised for clarity as follows:

> The Engineered Safety Features (ESF) Actuation System (ESFAS) consists of four channels of sensors, auxiliary process cabinets – safety (APC-S), the ESFAS signal generation portion of the Plant Protection System (PPS) cabinets and the ESF Component Control System (ESF-CCS).

d. The following paragraphs in the Background sections of the Bases on pages B 3.3.5-1 & 2, and page B 3.3.6-2 will be revised as follows:

> The devices and circuitry that generate the above ESFAS signals are grouped into the following interconnected parts. These parts are:
>
> • Measurement channels,
>
> • Bistable logic processor channels,
>
> • ESFAS logic channels:
>
> — Coincidence Logic,
>
> — Initiation Logic (trip paths), and
>
> — Actuation Logic.
>
> [For B 3.3.5] This LCO addresses measurement channels and bistable logic processor channels. ESFAS logic channels are addressed in . . .
>
> [For B 3.3.6] This LCO addresses the ESFAS logic channels. Bistable logic processor channels and measurement channels are addressed in . . .
>
> [For B 3.3.5] The role of each of these interconnected parts of the ESFAS, including the ESFAS logic, which is also described in LCO 3.3.6, is discussed below.
>
> [For B 3.3.6] The roles of the measurement channels and bistable logic processor channels are described in LCO 3.3.5. The role of the ESFAS logic is described below.

e. The heading “Bistable Logics” stated on page B 3.3.5-3 will be changed to “Bistable Logic Processors” for consistency in terminology.

f. The paragraph under the heading “ESFAS Logic” stated on page B 3.3.6-2 will be revised for clarity as follows:

> The ESFAS logic, consisting of coincidence, initiation and actuation logic, employs a scheme that provides an ESFAS actuation signal from all four PPS divisions to the component control logic of all trains of the associated ESF systems when any two of the four bistable logic processor channels sense that the same input parameter has satisfied the ESFAS Function’s trip setpoint on the input parameter. This logic scheme is called a two-out-of-four trip logic.

The paragraph under the heading “ESFAS Logic” stated on page B 3.3.5-4 will be revised for clarity as follows:

> The ESFAS logic, consisting of coincidence, initiation and actuation logic, employs a scheme that provides an ESFAS actuation signal from all four PPS divisions to the component control logic of all trains of the associated ESF systems when any two of the four bistable logic processor channels sense that the same input parameter has satisfied the ESFAS Function’s trip setpoint on the input parameter. This logic scheme is called a two-out-of-four trip logic.

Other generic TS Subsections in 3.3 do not have a corresponding paragraph in their “Background” sections of the Bases.

g. The paragraph under the heading “Coincidence Logic” stated on pages B 3.3.6-2 and -3 will be revised as follows:

> There is one local coincidence logic (LCL) associated with each trip bistable logic of each channel of a given ESFAS instrument Function. Each LCL receives four trip signals, one from the trip bistable logic in the associated channel and one from each trip bistable logic located in the other three channels of the affected ESFAS instrument Function. The LCL also receives the trip channel bypass status signal associated with each of the bistable signals. The function of the LCL is to generate a coincidence logic trip signal whenever two or more like bistables are in a tripped condition. Each LCL automatically changes the state of each of the four coincidence logic channels based on the state of the trip channel bypass Function in each channel. For example, a 2-out-of-4 trip logic goes to 2-out-of-3 if one trip bistable logic channel is bypassed.
>
> Designating the protection channels as A, B, C, D, with no trip channel bypass signal present, the LCL will produce a coincidence logic trip signal for any of the following trip inputs: AB, AC, AD, BC, BD, CD, ABC, ABD, ACD, BCD, ABCD. These represent all possible two- or more out-

of-four trip combinations of the four protection channels. Should a trip channel bypass be present, the logic will provide a coincidence logic trip signal when two or more of the three un-bypassed trip bistable logic channels are in a tripped condition.

h. The paragraph under the headings “Initiation Logic,” “Actuation Logic,” and “Manual Trip” stated on pages B 3.3.6-3 will be revised for clarity as follows:

Initiation Logic

The initiation logic is designed to be fail-safe. Failure of one initiation logic channel will result in a partial trip (1 of 4) in the two-out- of-four (one-out-of-two-taken-twice ESFAS selective actuation logic. The partial trip will be alarmed the same as a full ESFAS trip and will be indicated by the Qualified Indication and Alarm System – Safety (QIAS-P) and the Information Processing System (IPS); the partial trip cannot be bypassed.

Actuation Logic

The four initiation logic signals from the PPS are used to generate a selective two-out-of-four logic actuation signal in each division of the ESF-CCS. In the actuation logic, each signal also sets a latch when the selective two-out-of-four logic actuates to assure that the ESF actuation signal is not automatically reset once it has been generated.

A trip leg is defined as the "logical or" combination of channel states which represent half of a selective two-out-of-four logic function. When both trip leg of a selective two-out-of-four logic function assume a true state, the output of the selective two-out-of-four logic function assumes a true state (e.g., in a selective two-out-of-four logic [(A "or" C) "and" (B "or" D) = N]; the term (A "or" C) is a trip leg, the term (B "or" D) is a trip leg, and N is the output).

Receipt of two ESFAS initiation logic channel signals will generate the actuation logic division signals. This is done independently in each ESF-CCS cabinet, generating division A and division B actuation signals, and where required for ESF systems with four trains, division C and division D actuation signals.

Manual Trip

ESFAS Manual Trip capability is provided to permit the operator to manually actuate an ESF system when necessary.

Two sets of two push buttons (in the MCR) for each ESF function are provided, and each set actuates all trains provided for that ESF Function,

either two or four. Each manual trip push button signal is sent to the actuation logic in the ESF-CCS cabinets via the control panel multiplexer (CPM). By arranging the push buttons in two sets of two, such that both push buttons in a set must be depressed, it is possible to ensure that manual trip will not be prevented in the event of a single random failure in the signal path associated with one set of push buttons.

5. The discussions regarding Diverse Manual ESF Actuation will be incorporated into the APR1400 generic TS Bases as follows:

a. The following discussion will be added in the “Background” section of Bases for generic TS 3.3.6.

Diverse Manual ESF Actuation

Independent of the above design features, APR1400 implements a means for manual actuation of engineered safety feature Functions using a single channel which uses hardwired communication that bypasses all data links, network communications, and all computers with large software applications. Switches located in the main control room provide for system level actuation of safety injection, containment spray, auxiliary feedwater for each steam generator, main steam isolation per MSIV, and containment isolation.

The hardwired manual input signal from the control room switches will override input data received from the network communication interface to actuate the plant components. This feature of APR1400 design provides an additional level of protection against a postulated common mode failure of protection system software.

Provisions are made to permit periodic testing of the complete ESFAS. These tests cover the trip actions from sensor input through the protection system and actuation devices. The system test does not interfere with the protection function of the system. Overlap between individual tests exists so that the entire ESFAS can be tested. DCD Tier 2, Section 7.3 (Ref. 1) describes ESFAS testing in detail.

b. The following discussion will be added in the “Applicable Safety Analyses” section of Bases for generic TS 3.3.6.

7. Diverse Manual ESF Actuation Interface to ESF Components

The diverse manual ESF actuation interface to ESF components is a single channel which uses hardwired communication that bypasses all data links, network communications, and all computers with large software applications. Switches located in the control room provide system level actuation of safety injection, containment spray, auxiliary feedwater for each steam generator, main steam isolation per MSIV, and containment isolation.

The hardwired manual input signal from the control room switches will override input data received from the network communication interface to actuate the plant

components. The two position control room switches for safety injection, containment spray, auxiliary feedwater, main steam isolation, and containment isolation also have the ability to deactivate the associated plant components. These features of the design provide an additional level of protection against a postulated common mode failure of protection system software.

The diverse manual ESF actuation channel satisfies Criterion 4 of the NRC Policy Statement.

c. The following discussion is already described in the “LCO” section of Bases for generic TS 3.3.6.

7. Diverse Manual ESF Actuation Signal

The diverse manual ESF actuation interface to ESF components is initiated manually from switches in the MCR. The switches for safety injection, containment spray, auxiliary feedwater, main steam isolation, and containment isolation have two positions as follows: normal and actuate. When in actuate, input received from the network communication interface to actuate the components will be overridden.

This LCO requires two channels of safety injection, containment spray, auxiliary feedwater, and one channel for each main steam isolation valve and one channel for containment isolation to be OPERABLE in MODES 1, 2, 3, and 4.

d. The following discussion will be added between the second and third paragraphs in the “Applicability” section of Bases for generic TS 3.3.6.

The diverse manual ESFAS trip capability is required to be OPERABLE in the same MODES 1, 2, 3, and 4 as the manual ESFAS trip.

6. In the event of a postulated common cause failure (CCF) of the digital computer logic within the ESF-CCS, both manual and automatic logic functions are expected to be inoperable since the manual trip signal is transmitted to the digital ESF-CCS computer logic. Therefore, the diverse manual ESF actuation function that is independent of the manual and automatic ESF-CCS logic functions is required to respond to the event.

Regarding automatic Diverse ESF Actuation Functions, the Diverse Protection System (DPS), which is a non-safety and backup system, performs auxiliary feedwater actuation and safety injection actuation functions to assist the mitigation of the effects of a postulated software CCF of the digital computer logic within the PPS and ESF-CCS. Therefore, it is not necessary to include the automatic Diverse ESF Actuation Functions in an LCO. This is the same approach taken in NUREG-1432, Rev. 4 even though the alternate protection system instrumentation was included in Section 3.3.8 of the CE System 80+ DCD Chapter 16.

In addition, operating experience or probabilistic risk assessment has shown the diverse reactor trip not to be significant to public health and safety since the function is not required for safe operation of the APR1400. Therefore, the automatic Diverse ESF Actuation

Functions do not meet the LCO Selection Criterion 4.

The manual Diverse ESF Actuation Functions that address all ESFAS functions containing SIAS, MSIS, CIAS, CSAS, AFAS-1, and AFAS-2 are included in LCO 3.3.6 because the manual Diverse ESF Actuation switches in the MCR are connected to the associated component interface modules installed in the EFS-CCS.

In conclusion, the APR1400 inclusion of the manual Diverse ESF Actuation Function in TS and not the automatic Diverse ESF Actuation Functions is consistent with NUREG-1432, Rev. 4.

Supplemental Response

Supplemental response to 1st question: A statement about the interchangeability of channel and division will be added to GTS B 3.3.6 (page 3.3.6-3) as follows:

In accordance with the IEEE Std. 603-1991, the channel loses its identity where single protective action signals are combined. GTS and bases use the word “channel" or "division” for the portion of the circuit from the local coincidence logic to the actuation logic. The words “channel” and “division” are interchangeable regarding the portion from the local coincidence logic to the actuation logic.

Supplemental response to 2nd question:

All ESF components are tested based on subgroup.

SR 3.3.6.1 is channel functional test for ESFAS actuation logic in the Group Controller based on 31 days. ESFAS actuation logic means selective 2/4 logic.

SR 3.3.6.2 is an ESF subgroup test performed based on a staggered test interval which means the pair of Actuation Logic subgroup channels A and C are tested during the first interval of the staggered 31 day Frequency, and the pair of Actuation Logic subgroup channels B and D are tested during the second interval of the staggered 31 day Frequency.

ESF components in the same subgroup are tested at a time to verify the ESF components will actuate when required.

The ESF component lists were submitted as an attachment of RAI 295-8263 Q 16-122 and Q 16-115. The list of Q 16-115 shows the information about electrical power division, safety division, motive power, location, and AMI. The list of Q 16-122 includes the information for subgroups. We re-arranged the component rows based on subgroup number for easy understanding of subgrouping.

All subgroups in the same division are tested during the same duration (same month) based on a staggered testing basis. All ESF components are tested based on the subgroup in the division under testing.

To facilitate testing, ESF component are assigned to each subgroup such that the following

conditions are met:

1) A complete ESF system actuation does not occur during the test.
2) Plant equipment and operation is not adversely affected during the test.
3) System preparation and lineup changes are minimized for testing.

The prior revisions of the RAI response were incorporated into Rev. 1 of the DCD and TS; therefore this revision starts with and only contains mark-ups to Revision 1 of the TS.

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

The Bases for TS 3.3.6 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.

BASES

BACKGROUND (continued)

In accordance with the IEEE Std. 603-1991, the channel loses its identity where single protective action signals are combined. Technical Specifications and Bases use the word “channel" or "division” for the portion of the circuit from the local coincidence logic to the actuation logic. The words “channel” and “division” are interchangeable regarding the portion from the local coincidence logic to the actuation logic.

Designating the protection channels as A, B, C, D, with no trip channel bypass signal present, the LCL will produce a coincidence logic trip signal for any of the following trip inputs: AB, AC, BC, BD, CD, ABC, ABD, ACD, BCD, ABCD. These represent all possible 2- or more out-of-4 trip combinations of the four protection channels. Should a trip channel bypass be present, the logic will provide a coincidence logic trip signal when two or more of the three un-bypassed trip bistable logic channels are in a tripped condition.

Initiation Logic

The initiation logic is designed to be fail-safe. Failure of one initiation logic channel will result in a partial trip (1 of 4) in the 1-out-of-2 taken twice ESFAS selective actuation logic. The partial trip will be alarmed the same as a full ESFAS trip and will be indicated by the Qualified Indication and Alarm System – Safety (QIAS-P) and the Information Processing System (IPS); the partial trip cannot be bypassed.

Actuation Logic

The four initiation logic signals from the PPS are used to generate a selective 2-out-of-4 logic actuation signal in each division of the ESF-CCS. In the actuation logic, each signal also sets a latch when the selective two-out-of-four logic actuates to assure that the ESF actuation signal is not automatically reset once it has been generated.

and represents

A trip leg is defined as the “logical or” combination of channel states ~~which represent~~ half of a selective 2-out-of-4 logic function. When both trip ~~leg~~ of a selective 2-out-of-4 logic function assume a true state, the output of the selective 2-out-of-4 logic function assumes a true state (e.g., in a selective 2-out-of-4 logic [(A “or” C) “and” (B “or” D) = N]; the term (A “or” C) is a trip leg, the term (B “or” D) is a trip leg, and N is the output).

legs

Receipt of two ESFAS initiation logic channel signals will generate the actuation logic division signals. This is done independently in each ESF-CCS cabinet, generating division A and division B signals, and where required for ESF Systems with four trains, division C and division D actuation signals.

Manual Trip

ESFAS Manual Trip capability is provided to permit the operator to manually actuate an ESF System when necessary.

SUPPLEMENTAL 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.:	**295-8263**
SRP Section:	**16 – Technical Specifications**
Application Section:	**16.3.3**
Date of RAI Issue:	**11/05/2015**

Question No. 16-117

DCD Tier 2 Section 7.3.1.3 Actuation Logic, below the heading "ESFAS Function" beginning on page 7.3-5, makes the following statements:

> The SIAS is also initiated by a loss of power to two PPS divisions. The SIAS also actuates the EDG.
>
> The CSAS is also initiated by a loss of power to two PPS divisions.
>
> The CIAS is also initiated by a loss of power to two PPS divisions. The MSIS is also initiated by a loss of power to two PPS divisions.
>
> The AFAS-1 or AFAS-2 is also initiated by a loss of power to two PPS divisions.

ESFAS Functional Logic, as depicted in DCD Figure 7.3-4 SIAS, Figure 7.3-5 CSAS, Figure 7.3-6 CIAS, Figure 7.3-7 MSIS, and Figure 7.3-8 AFAS, does not appear to illustrate the effect of a loss of vital ac power to two PPS divisions on the coincidence logic, initiation logic, and actuation logic for these EFSAS Functions. In addition to an SIAS coincidence logic output signal, the EDG of the associated Class 1E electrical safety train also gets a start signal from the CSAS, AFAS-1, and AFAS-2 coincidence logic output signals, according to Figure 7.3-21 EDG Loading Sequencer – Control logic Diagram. The applicant is requested to:

(1) Describe how loss of (vital ac) electrical power to two PPS divisions generates ESF actuation signals to all ESF trains of equipment;

(2) Describe how loss of (vital ac) electrical power to two PPS divisions would affect an enabled operating bypass, including when the operating bypass is in a denergized PPS division, and when it is in an unaffected PPS division;

(3) Revise the Bases for generic TS subsection 3.3.6 ESFAS Logic and Manual Trip, and DCD Tier 2 Chapters 7 and 8, to explain how a loss of (vital ac) electrical power to two PPS divisions generates ESF actuation signals to all ESF trains of equipment, in terms of the ESFAS Functional Logic design;

(4) Revise the Bases for generic TS subsection 3.3.6 ESFAS Logic and Manual Trip and subsection 3.3.7 EDG ─ LOVS to clarify how SIAS, CSAS, and AFAS signals initiate an EDG start, and that this actuation logic is required by LCO 3.3.6 and tested by a Channel Functional Test surveillance; and

(5) Revise as appropriate the operating bypass discussions in the generic TS Section 3.3 Bases to clarify how an enabled operating bypass is affected when its associated PPS division loses ac electrical power.

Response

The following responses are provided regarding the loss of (vital ac) electrical power to two PPS divisions:

(1) Each ESF-CCS division receives an NSSS ESF initiation signal from all four divisions of the PPS and generates ESF actuation signals by means of the selective 2-out-of-4 coincidence logic. The loss of (vital ac) electrical power to two PPS divisions causes the inputs from both PPS divisions to go to a failed (i.e., safe) state. The ESF-CCS recognizes the failed input signals as actuated state in the group controllers (GCs). Accordingly, the selective 2-out-of 4 coincidence logic in the ESF-CCS GC generates the ESF actuation signals to all ESF trains of equipment.

(2) The operating bypass inhibits the trip and pre-trip outputs from the trip and pre-trip algorithms in the bistable processor. The loss of (vital ac) electrical power to two PPS divisions generates ESF actuation signals to all ESF trains of equipment due to the ESF-CCS receiving two failed state NSSS ESF initiation signals from the two PPS divisions. At that time, the enabled operating bypass in the deenergized PPS division returns to normal (disabled). An enabled operating bypass in an unaffected PPS division (power remains) will stay in the bypassed state. In both cases, the plant will be in a safe condition since it will have tripped due to deenergization of one PPS division level output.

(3) The statements regarding the generation of ESF actuation signals to all ESF trains of equipment on a loss of (vital ac) electrical power to two PPS divisions will be inserted into the Bases for TS 3.3.6, Actions Section for B.1 and B.2 and also in DCD Section 7.3. The statements are not related to Chapter 8.

(4) The statements to clarify how SIAS, CSAS, and AFAS signals initiate an EDG start will be inserted into the Bases for TS 3.3.6 and 3.3.7, including that it is tested by a Channel Functional Test in SR 3.3.6.2.

(5) The statements regarding the effect of an enabled operating bypass caused by PPS division’s ac electrical power will be inserted into the Background section of Bases for TS 3.3.1 RPS Instrumentation and 3.3.5 ESFAS Instrumentation.

Supplemental Response

Supplemental response to 2nd question: The statement “the enabled operating bypass in the deenergized PPS division returns to normal (disabled)” means that a failed state NSSS ESF initiation signal is resulted from the deenergized PPS division. The statement “An enabled operating bypass in an unaffected PPS division (power remains) will stay in the bypassed state” means that no NSSS ESF initiation signal is resulted from the unaffected PPS division. The phrase “one PPS division level output” should be changed to “two PPS divisions”

The item (2) will be revised to clearly state as follows:

(2) The operating bypass inhibits the trip and pre-trip outputs from the trip and pre-trip algorithms in the bistable processor. The loss of (vital ac) electrical power to two PPS divisions generates ESF initiation signals provided to each division of GC in the ESF-CCS. At that time, an enabled operating bypass in a deenergized PPS division returns to the normal state (disabled). An enabled operating bypass in an unaffected PPS division (power remains) will stay in the bypassed state. In both cases, the plant will be in a safe condition since the deenergization of two PPS divisions causes the ESF equipment to be actuated if the selective 2/4 coincidence logic in the ESF-CCS GC is met.

Supplemental response to 3rd question: The statement in section 7.3 will be revised to incorporate following description:

The loss of (vital ac) electrical power to two PPS divisions causes the inputs from both PPS divisions to go to a failed (i.e., safe) state. The ESF-CCS recognizes the failed input signals as actuated states in the GCs. Accordingly, if the selective 2-out-of-4 coincidence logic in the ESF-CCS GC is met, the ESF-CCS GC generates the ESF actuation signals to the component control logic in the LC.

Also, the statement in the bases for the TS 3.3.6 will be revised to incorporate following description:

The failure of vital electrical power to two PPS divisions which excludes the same trip leg of the selective 2-out-of 4 actuation logic causes the inputs from both PPS divisions to go to a failed (i.e., safe)state. The ESF-CCS recognizes the failed input signals as actuated states in the actuation logic. Therefore, a loss of vital electrical power to two PPS divisions generates ESF actuation signals to the component control
logic in the LC when the selective 2-out-of-4 coincidence logic in the ESF-CCS GC is met.

Supplemental response to 4th question: The statement in the bases for SR 3.3.6.2 will be revised to incorporate following description:

A CHANNEL FUNCTION TEST also verifies that an EDG start is separately actuated by SIAS, CSAS, and AFAS signals.

Supplemental response to 5th question: The statement in the bases for the TS 3.3.1 will be revised to incorporate following description:

An enabled operating bypass inhibits the trip and pre-trip outputs from trip and pre-trip algorithms in the associated bistable processor. A loss of vital electrical power to a PPS division removes an enabled operating bypass, since this deenergizes the bistable processor.

Supplemental response to 6th question: The phrase “each division of LCL in the EFS-CCS” that the staff suggested should be changed to “each division of GC in the ESF-CCS,” since the LCL is not located in the ESF-CCS but in the PPS. Therefore, “The loss of (vital ac) electrical power to two PPS divisions generates ESF actuation signals to all ESF trains of equipment due to each division of LCL in the ESF-CCS receiving two failed state NSSS ESF initiation signals from the two deenergized PPS divisions” should be changed to “The loss of (vital ac) electrical power to two PPS divisions generates ESF initiation signals provided to each division of GC in the ESF-CCS.”

The prior revisions of the RAI response were incorporated into Rev. 1 of the DCD and TS; therefore this revision starts with and only contains mark-ups to Revision 1 of the DCD and TS.

Impact on DCD

DCD Tier 2 Section 7.3 will be revised as indicated in the Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

The Bases for TS 3.3.1, 3.3.5 and 3.3.6 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.

BASES

BACKGROUND (continued)

The actuation logic in each channel of ESF-CCS takes part in actuating the equipment of the corresponding ESF train. Each ESFAS Function has individual actuation logic in each channel of the ESF-CCS.

The initiation logic performs the logical "OR" of LCL outputs for each ESFAS Function, to generate the ESF actuation signal to the ESF-CCS actuation logic.

Each ESFAS Function has an associated group of outputs. Each group of outputs is divided into subgroups. Outputs within a subgroup are tested concurrently and are selectively arranged so that concurrent actuation does not adversely affect plant operations. The initiation and actuation logics to the subgroups are addressed in LCO 3.3.6.

By trip channel bypassing one input parameter for a channel, the 2-out-of-4 ESFAS coincidence logic shall be converted to 2-out-of-3. Though the bypass produces trip indication and alarm in the bistable processor, the LCL does not accept the corresponding input signal as an input for actuation. Different parameters may be simultaneously bypassed, either in one channel or in different channels. Bypassing the same parameter in more than one channel is restricted by administrative procedure. The coincidence logic becomes 2-out-of-3 coincidence logic. The all-bypass function for bypassing all parameters in an ESFAS channel is interlocked in the LCL algorithm to prevent simultaneous bypass of more than one channel. The all-bypass function interlock is implemented with an analog circuit and hardwired cable between the LCLs in all channels. The purpose of all-bypass function is to support testing and maintenance of the bistable processor (BP) whereas the trip channel bypass is used in case of sensor failure.

In addition to the trip channel bypasses, there are also operating bypasses for ESFAS actuation trip. These bypasses are enabled manually, in all four channels, when plant conditions do not warrant the specific trip protection. All operating bypasses are automatically removed when enabling bypass conditions are no longer satisfied.

An enabled operating bypass function blocks the output of trip and alarm signals from the bistable processor to the LCL, Information Processing System (IPS), and Qualified Indication and Alarm System - Non-Safety (QIAS-N). The Pressurizer Pressure – Low input to the SIAS shares an operating bypass with the Pressurizer Pressure – Low reactor trip.

~~The operating bypass inhibits the trip and pre-trip outputs from the trip and pre-trip algorithms in the bistable processor. The loss of (vital ac) electrical power to two PPS divisions generates ESF actuation signals to all ESF trains of equipment due to the ESF-CCS receiving two failed state~~

The operating bypass inhibits the trip and pre-trip outputs from the trip and pre-trip algorithms in the bistable processor. The loss of (vital ac) electrical power to two PPS divisions generates ESF initiation signals provided to each division of GC in the ESF-CCS. At that time, an enabled operating bypass in a deenergized PPS division returns to the normal state (disabled). An enabled operating bypass in an unaffected PPS division (power remains) will stay in the bypassed state. In both cases, the plant will be in a safe condition since the deenergization of two PPS divisions causes the ESF equipment to be actuated if the selective 2/4 coincidence logic in the ESF-CCS GC is met.

BASES

BACKGROUND (continued)

~~NSSS ESF initiation signals from the two PPS divisions. At that time, the enabled operating bypass in the deenergized PPS division returns to normal (disabled). An enabled operating bypass in an unaffected PPS division (power remains) will stay in the bypassed state. In both cases, the plant will be in a safe condition since it will have tripped due to deenergization of one PPS division level output.~~

When necessary, the operator can manually actuate the ESFAS in the MCR and local panel.

APPLICABLE SAFETY ANALYSES

Each of the analyzed accidents can be detected by one or more ESFAS Functions. One of the ESFAS Functions is the primary actuation signal for that accident. An ESFAS Function can be the primary actuation signal for more than one type of accident. An ESFAS Function can also be the secondary, or backup, actuation signal for one or more other accidents.

ESFAS protection Functions are as follows:

1. Safety Injection Actuation Signal (SIAS)

   SIAS ensures acceptable consequences during large break loss of coolant accidents (LOCAs), small break LOCAs, control element assembly (CEA) ejection accidents, steam generator tube rupture, and main steam line breaks (MSLBs). To provide the required protection, either a high containment pressure or a low pressurizer pressure signal will initiate SIAS. The SIAS initiates the Safety Injection System (SIS) and actuates emergency diesel generator (EDG).

2. Containment Spray Actuation Signal (CSAS)

   CSAS actuates containment spray, preventing containment overpressurization during large break LOCAs, small break LOCAs, and MSLBs or feedwater line breaks (FWLBs) inside containment. CSAS is initiated by high containment pressure.

3. Containment Isolation Actuation Signal (CIAS)

   CIAS ensures acceptable mitigating actions during large and small break LOCAs, and MSLBs inside containment or FWLBs either inside or outside containment. CIAS is initiated by low pressurizer pressure or high containment pressure.

The ESF-CCS serves as an interface between the ESFAS portion of the PPS with the switchgear, solenoid, and MCC.

Each ESF-CCS division consists of redundant GC logic and redundant LC logic. Each ESF-CCS division receives NSSS ESFAS initiation signals from all four divisions of the PPS and performs an automatic initiation of the affected ESF system(s) when coincidence logic conditions are satisfied. The selective 2-out-of-4 coincidence logic is performed in the redundant GCs which independently receives NSSS ESFAS initiation signals from four PPS divisions (Divisions A, B, C, and D) and performs a selective 2-out-of-4 coincidence logic on the initiating signals. Valid ESF-CCS system-level initiation signals are latched and require a manual reset. Two redundant GCs are provided for improved GC availability within each ESF-CCS division.

The selective 2-out-of-4 coincidence logic in the GC processors enhances the fault tolerance to maintain system-level availability and minimize the consequences of single failures. A failure of a processor in the PPS or data communication between the PPS and ESF-CCS is tolerated by the signal quality checking logic and the coincidence logic in the GC.

states
if
the component control logic in the LC.

The loss of (vital ac) electrical power to two PPS divisions causes the inputs from both PPS divisions to go to a failed (i.e., safe) state. The ESF-CCS recognizes the failed input signals as actuated ~~state~~ in the GCs. Accordingly, the selective 2-out-of-4 coincidence logic in the ESF-CCS GC generates the ESF actuation signals to ~~all ESF trains of equipment~~.

is met, the ESF-CCS GC

The redundant GCs provide ESF actuation signals to the redundant LCs in the respective division via SDLs. Each LC receives the ESF actuation signals from the GCs. There is no additional coincidence logic downstream of the GCs. See Figure 7.3-1 for a simplified functional diagram of the ESF-CCS.

All ESF actuation signals can be initiated using manual ESF system-level actuation switches on the safety console. In the ESF actuation logic, each signal also sets a latch to provide reasonable assurance that the system-level signal is not automatically reset once it has been initiated, as shown in Figure 7.3-3. Each ESF actuation signal, excluding the cycling portion of the AFAS, can be manually reset to restore the initiation logic to the non-actuated state from the OM or MTP when ESF actuation condition is cleared.

The BOP ESFAS receives process variable signals from the safety portion of the RMS, manual ESF system-level actuation switches, and manual channel bypass switches. The

BASES

ACTIONS (continued)

A.1

Condition A applies to one manual trip, coincidence logic, or initiation logic channel inoperable.

The channel must be restored to OPERABLE status within 48 hours. Operating experience has demonstrated that the probability of a random failure in a second channel is low during any given 48 hour period.

Failure of a single initiation logic channel affects one leg of 2-out-of-4 actuation logic channel. In this case, according to the purpose of operation Technical Specification, actuation logic is not inoperable status. When initiation logic channel is failure, LCO 3.0.3 may be not entered. This Action is different from Required Action related to the RPS Manual channel inoperable because open contact of reactor trip switchgear is implemented and confirmed easily in RPS. If the channel cannot be restored to OPERABLE status with 48 hours, Condition E or F is entered.

B.1 and B.2

Condition B applies to the failure of both initiation logic channels affecting the same trip leg.

In this case, the actuation logic channels are not inoperable, since they are in one-out-of-two logic and capable of performing as required. This obviates the need to enter LCO 3.0.3 in the event of a coincidence logic or vital bus power failure.

excludes

The failure of vital electrical power to two PPS divisions which ~~exclude~~ the same trip leg of the selective 2-out-of 4 actuation logic causes the inputs from both PPS divisions to go to a failed (i.e., safe) state. The ESF-CCS recognizes the failed input signals as actuated ~~state~~ in the actuation logic. Therefore, a loss of vital electrical power to two PPS divisions generates ESF actuation signals to ~~all ESF trains of equipment~~.

states

the component control logic in the LC when the selective 2-out-of-4 coincidence logic in the ESF-CCS GC is met.

If a LCL power supply or vital instrument bus is lost, the initiation logic channels in the same trip leg will generate the initiation signal. This will open the actuation logic contacts, satisfying the Required Action to generate at least the actuation logic signal in the affected trip leg from actuation logic.

The channel must be restored to OPERABLE status within 48 hours. This provides the operator with time to take appropriate actions and still ensures that any risk involved in operating with a failed channel is acceptable. Operating experience has demonstrated that the probability of a random failure of a second initiation logic is low during any given 48 hour period.

BASES

SURVEILLANCE REQUIREMENTS (continued)

Actuation Logic Testing

Actuation logic testing verifies the OPERABILITY of the 2-out-of-4 actuation logic after the completion of initiation logic (trip path) testing. This test is performed only for one channel and one actuation logic at a time by periodic automatic test.

Manual ESF Actuation Testing

Manual ESF actuation testing is tested every 31 days to verify that manual pushbutton can actuate the actuation logic as designed.

The 31 day Surveillance period is determined by operating experience and shows that equipment can meet the Surveillance requirement condition when equipment is tested as this Surveillance period.

SR 3.3.6.2

Individual subgroup must also be tested, one at a time, to verify the individual ESFAS components will actuate when required.

Each ESFAS Function has an associated group of outputs. Each group of outputs is divided into subgroups. Outputs within a subgroup are tested concurrently and are selectively arranged so that concurrent actuation does not adversely affect plant operations.

The ESFAS initiation signals from the PPS are sent to separate ESF-CCS cabinets. Each cabinet contains the actuation logic for only one division. Therefore, a failure in one cabinet cannot affect the circuitry and actuated equipment of the other divisions.

Single failures of the actuation logic will cause, at worst, only a failure of a component, group of components, or one entire redundant train. The actuation of the remaining redundant division is sufficient for the protective action.

A CHANNEL FUNCTION TEST ~~performs to verify a~~ also verifies that an EDG start is actuated separately by SIAS, CSAS, and AFAS signals.

The 31 day Frequency on a STAGGERED TEST BASIS complies with the operating experience and ensures the problems of individual logic signal can be detected within this time frame.

BASES

BACKGROUND (continued)

It is possible to change the 2-out-of-4 RPS logic to a 2-out-of-3 logic for a given input parameter in one channel at a time by trip channel bypassing. Thus, the bistable logic will function normally, producing normal trip indication and annunciation, but a reactor trip will not occur unless two additional channels indicate a trip condition. Trip channel bypassing can be simultaneously performed on any number of parameters in any number of channels, providing each parameter is bypassed in only one channel at a time. Trip channel bypassing is normally employed during maintenance or testing.

2-out-of-3 logic also prevents inadvertent trips caused by any single channel failure in a trip condition. In addition to the trip channel bypasses, there are also operating bypasses on select RPS trips. These bypasses are enabled manually in all four RPS channels when plant conditions do not warrant the specific trip protection. All operating bypasses are automatically removed when enabling bypass conditions are no longer satisfied.

Operating bypasses are implemented in the bistable logic, so that normal trip indication is also disabled. Trips with operating bypasses include Pressurizer Pressure – Low, Logarithmic Power Level – High, and CPC (DNBR – Low and LPD – High).

An enabled

the associated

~~The~~ operating bypass inhibits the trip and pre-trip outputs from trip and pre-trip algorithms in ~~a~~ bistable processor. ~~An enabled operating bypass is removed since the~~ loss of vital electrical power to a PPS division deenergizes the bistable processor.

A

removes an enabled operating bypass, since this

Reactor Trip Circuit Breaker (RTCB)

The reactor trip switchgear, addressed in LCO 3.3.4, consists of eight RTCBs. Power input to the reactor trip switchgear comes from two full capacity MG sets operated in parallel, such that the loss of either MG set does not de-energize the CEDMs.

There are two separate CEDM power supply buses, each bus powering half of the CEDMs. The RTSS consists of one set of four RTCBs (RTSS 1) and another set of four RTCBs (RTSS 2). Each RTSS channel consists of two RTCBs. The eight RTCBs are connected in a 2-out-of-4 logic configuration.