WCAP-14538

RESPONSE TO NRC QUESTIONS ON BACKUP FUNCTIONS' ENVIRONMENTAL ALLOWANCE TERMS

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WESTINGHOUSE ELECTRIC CORPORATION
ENERGY SYSTEMS BUSINESS UNIT
P.O. BOX 355
PITTSBURGH, PENNSYLVANIA 15230

EXECUTIVE SUMMARY

This document contains responses to two requests for additional information resulting from the NRC System Based Instrumentation & Controls (SBIC) audit of Donald C. Cook Nuclear Plant Units 1 and 2. The requested information concerns the inclusion, or lack thereof, of Environmental Allowance terms in the RPS/ESFAS protection function uncertainty calculations for backup trip and actuation functions. Specifically, responses to question number 2 and question number 3 from the Request for Additional Information in Support of the Staff Review of TAC M88892/M88893 TIA DC Cook I&C System Based Inspection (50-315/316-93-012) are provided in this document. The questions are repeated below:

Question 2: Provide a discussion on the exclusion of environmental allowances (pressure, temperature and seismic) for those functional units/loops considered as back-up or secondary. For example; pressurizer pressure high reactor trip, low reactor trip, low safety injection, steam generator water level low, level low-low and level high-high, and main steam flow high/feedwater flow low mismatch. Inspection report item #3.1.1.

Question 3: Discuss the need to include environmental allowances due to a harsh environment (including cable resistance effects) for the main steam flow/feedwater flow mismatch trip channels. Inspection report item #3.2.1a.

Donald C. Cook Nuclear Plant RAI

Question 2. Provide a discussion on the exclusion of environmental allowances (pressure, temperature and seismic) for those functional units/loops considered as back-up or secondary. For example; pressurizer pressure high reactor trip, low reactor trip, low safety injection, steam generator water level low, level low-low and level high-high, and main steam flow high/feedwater flow low mismatch. Inspection report item #3.1.1

Suggested Response:

1.0 Introduction

The Westinghouse philosophy with respect to protection systems is [ ]$^{+a,c}$, placing emphasis on appropriate design and [

]$^{+a,c}$. It is Westinghouse practice to design the protection system with the primary trip and actuation functions meeting necessary and required design criteria, e.g., redundancy, equipment qualification and testability. Westinghouse verifies through various reviews and analyses that the primary trip and actuation functions provide the means of satisfying the appropriate criteria for termination and mitigation of Anticipated Operational Occurrences (AOO) and Design Basis Events (DBE) required as part of the normal plant licensing process. Westinghouse has determined to the extent practicable, for a postulated common mode failure of the primary trip or actuation function, that an appropriate and reasonable diverse backup trip and actuation function exists. However, as the regulations and NRC guidance on the requirements of diverse backup functions are vague, Westinghouse has applied a separate set of criteria on these functions.

2.0 Regulations and Reports

2.1 Regulations

The primary references cited for regulation in this area for the Donald C. Cook Nuclear Plant are the draft design criteria, noted as Appendix H of the UFSAR, Criterion 20 - Protection Systems Redundancy and Independence and Criterion 23 - Protection Against Multiple Disability for Protection Systems.

Criterion 20

"Redundancy and independence designed into protection systems shall be sufficient to assure that no single failure or removal from service of any component or channel of a system will result in loss of the protection function. The redundancy provided shall include, as a minimum, two channels of protection for each protection function to be served."

Criterion 23

"The effects of adverse conditions to which redundant channels or protection systems might be exposed in common, either under normal conditions or those of an accident, shall not result in loss of the protection function."

2.2 Regulatory Reports

A regulatory report issued by the NRC which notes some requirements on diversity design is NUREG-0493, "A Defense-in-Depth and Diversity Assessment of the RESAR-414 Integrated Protection System," issued as part of the review of the Westinghouse RESAR-414[1] design.

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[1] Reference Safety Analysis Report - Westinghouse four loop, 3820 MWt NSSS design SAR submitted to the NRC for generic application and approval.

"Sufficient diversity should be provided in the design so that, for each anticipated operational occurrence in the design basis ... occurring in conjunction with each single CMF[2] postulated ..., the plant response calculated using conservative analyses should not result in a non-coolable geometry of the core or violation of the integrity of the primary coolant pressure boundary or violation of the integrity of the containment."

2.3 Westinghouse Documents

One of the principle Westinghouse documents supporting the design of the protection system is [

]$^{+a,c}$. This WCAP was issued in 1969 and is a summary of the analysis that was performed as part of Westinghouse commitments made to the AEC and ACRS during meetings held in 1968 and 1969 on protection system design. This document demonstrates that the protection system design provides adequate functional diversity such that "failed fission product barriers" do not occur as a result of postulated initiating events even if the protection system primary trip or actuation function is not assumed to actuate during the course of the event. Demonstration of this capability was sufficient to convince the regulatory organization that total and physical separation of the control and protection systems were not required as part of the Westinghouse design.

3.0 Westinghouse Protection System Diversity Bases

Westinghouse utilizes five guidelines in determining the acceptability of the diversity in the protection system trip and actuation functions. [

]$^{+a,c}$ Thus all portions of the protection system are classified as 1E and qualified for up to 103 °F (process racks) or 130 °F

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[2] Common Mode Failure

(sensor/transmitters) environmental and SSE seismic conditions. [

]$^{+a,c}$

a) Where technically feasible, each AOO and DBE should have a qualified primary and backup (diverse) protection function identified.

b) The diverse protection function is not required to meet the same licensing criteria as the primary protection function, i.e., a less conservative safety limit may be applied.

As noted in NUREG-0493, "Sufficient diversity should be provided in the design so that, for each anticipated operational occurrence in the design basis ... occurring in conjunction with each single CMF[3] postulated ..., the plant response calculated using conservative analyses should not result in a non-coolable geometry of the core or violation of the integrity of the primary coolant pressure boundary or violation of the integrity of the containment."

It is also noted in [

]$^{+a,c}$.

c) Manual operator action may be assumed as a means of meeting the protection system diversity criteria. Various guidelines have been promulgated for this purpose. For operating plants, the reference cited most often is ANSI/ANS 58.8-1984, "Time Response Design Criteria for Nuclear Safety Related Operation Actions."

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[3] Common Mode Failure

d) The protection functions identified as diverse protection functions are qualified as Class 1E systems for the environment they are nominally expected to perform in. Functions which are credited as primary actuators for adverse environmental conditions are qualified for that environment and EA terms included in the uncertainty calculations.

It should be noted that for a diverse protection function, Westinghouse [

]$^{+a,c}$.

e) The primary protection function inputs, to the extent feasible and practical, shall be derived from signals that are a direct measure of the desired variables. The primary protection function is defined as the first protection function whose setpoint is reached and is assumed to mitigate the postulated AOO or DBE.

The diverse protection function inputs [

]$^{+a,c}$. This is consistent with the requirements stated in IEEE 279-1971 Section 4.8.

4.0 Summary

From the above, the following can be summarized,

1) Westinghouse has a primary and backup protection function for each AOO and DBE.

2) Diverse protection functions may not meet the same licensing acceptance criteria as the primary protection functions.

3) Manual operator action may be assumed as a means of meeting diversity criteria.

4) Diverse protection functions are qualified Class 1E systems [

]$^{+a,c}$.

5) Diverse protection functions [

]$^{+a,c}$.

In general Westinghouse will attempt to utilize a backup protection function that is environmentally qualified. However, when this is not possible, [

]$^{+a,c}$. The inclusion of adverse environmental condition allowances in diverse protection function setpoints is [

]$^{+a,c}$.

Although inclusion of adverse environmental allowances is not required, Westinghouse has evaluated the AOOs and DBEs listed in Chapter 14 of the Donald C. Cook Nuclear Plant UFSAR with respect to primary and secondary system response versus the inclusion of EA terms. For each AOO or DBE whose primary system response is required to function in adverse environmental conditions, one of two evaluation conclusions has been reached:

1) There exists [ ]$^{+a,c}$ which is environmentally qualified and includes an EA term (evaluated to be sufficient in magnitude) in the setpoint uncertainty calculation.

or

2) There exists [

]$^{+a,c}$ and thus does not require an EA term in the setpoint uncertainty calculation.

5.0 Evaluation of Donald C. Cook Nuclear Plant Protection Functions

Westinghouse has reviewed Chapter 14 of the Donald C. Cook Nuclear Plant UFSAR and has noted those AOOs and DBEs which generate potentially adverse environmental conditions in the plant regions about the sensor transmitters, impulse lines or instrument cabling. The guidelines used for this evaluation are noted below:

1) For those events that do not result in a release of primary or secondary side coolant, no elevated ambient temperatures are expected and thus Environmental Allowance (EA) terms are not required in the setpoint uncertainty calculations for either a primary or backup protection function.

2) For those events that result in the release of primary or secondary side coolant, elevated ambient temperatures may be expected and an EA term may be appropriate in the setpoint uncertainty calculations.

3) For secondary side breaks, no significant radiation is expected to be released and thus no radiation components are required in the EA terms.

4) For primary side breaks with significant radiation release potential, radiation components are included in the EA terms. [

]$^{+a,c}$

5) Westinghouse does not perform AOO or DBE safety analyses in coincidence with a seismic event.

Table 1 notes the AOOs and DBEs listed in Chapter 14 of the Donald C. Cook Nuclear Plant UFSAR (Column 1) which were evaluated for primary and secondary system response and the expectation for adverse environmental conditions (Column 2). If adverse environmental

conditions are expected, then the primary trip or actuation function identified in the safety analyses is noted (Column 3). Appropriate pages in Chapter 14 of the UFSAR are referenced to provide where in the UFSAR the primary trip or actuation function is identified, or can be inferred from the limiting safety analyses reported. Possible diverse protection functions are identified in the event the primary function is disabled (Column 4). The location of the diverse protection function with respect to the presence of adverse environmental conditions is noted (Column 5). Finally, for each possible diverse protection function the presence (or absence) of an EA term in the uncertainty calculations is noted (Column 6).

TABLE 1

ANTICIPATED OPERATIONAL OCCURENCE / DESIGN BASIS EVENT (COLUMN 1)	ADVERSE CONDITIONS GENERATED? (COLUMN 2)	PRIMARY PROTECTION FUNCTION NOTED IN SAFETY ANALYSES (COLUMN 3)	DIVERSE PROTECTION FUNCTIONS AVAILABLE (COLUMN 4)	DIVERSE PROTECTION FUNCTION LOCATED IN ADVERSE ENVIRONMENT? (COLUMN 5)	EA TERM IN DIVERSE SETPOINT? (COLUMN 6)
RCCA Bank Withdrawal - Subcritical	NO	[			] +a,c
RCCA Bank Withdrawal - at Power	NO				
RCCA Misalignment	NO				
Uncontrolled Boron Dilution	NO				
Loss of RCS Flow	NO				
Startup of an Inactive RCS Loop	NO				
Loss of External Load	NO				
Loss of Normal Feedwater	NO				
Feedwater System Malfunction	NO				
Excessive Load Increase	NO				
Loss of Offsite Power	NO				
Turbine-Generator Overspeed	NO				
Fuel Handling Accident	NO				
Waste Liquid Release	NO				
Waste Gas Release	NO				
Steam Generator Tube Rupture	NO	]			]

ANTICIPATED OPERATIONAL OCCURENCE / DESIGN BASIS EVENT (COLUMN 1)	ADVERSE CONDITIONS GENERATED? (COLUMN 2)	PRIMARY PROTECTION FUNCTION NOTED IN SAFETY ANALYSES (COLUMN 3)	DIVERSE PROTECTION FUNCTIONS AVAILABLE (COLUMN 4)	DIVERSE PROTECTION FUNCTION LOCATED IN ADVERSE ENVIRONMENT? (COLUMN 5)	EA TERM IN DIVERSE SETPOINT? (COLUMN 6)
Steam Pipe Rupture (core response) - Inside Containment	YES	[			] +a,c
		]			

[4] Steam Flow in Two Steamlines - High coincident with Low Steamline Pressure generates Steamline Isolation and SI for Unit 1. Low Steamline Pressure by itself generates Steamline Isolation and SI for Unit 2.

[5] Unit 1 - see page 14.2.5-6, Results paragraph 3 of UFSAR. Unit 2 - see page 14.2.5-8, Results paragraph 3 of UFSAR.

ANTICIPATED OPERATIONAL OCCURENCE / DESIGN BASIS EVENT (COLUMN 1)	ADVERSE CONDITIONS GENERATED? (COLUMN 2)	PRIMARY PROTECTION FUNCTION NOTED IN SAFETY ANALYSES (COLUMN 3)	DIVERSE PROTECTION FUNCTIONS AVAILABLE (COLUMN 4)	DIVERSE PROTECTION FUNCTION LOCATED IN ADVERSE ENVIRONMENT? (COLUMN 5)	EA TERM IN DIVERSE SETPOINT? (COLUMN 6)
		[			+a,c]
Steam Pipe Rupture (core response) - Outside Containment	YES				
		]			

[6] Steam Flow in Two Steamlines - High coincident with Low Steamline Pressure generates Steamline Isolation and SI for Unit 1. Low Steamline Pressure by itself generates Steamline Isolation and SI for Unit 2.

[7] Unit 1 - see page 14.2.5-6, Results paragraph 3 of UFSAR. Unit 2 - see page 14.2.5-8, Results paragraph 3 of UFSAR.

ANTICIPATED OPERATIONAL OCCURENCE / DESIGN BASIS EVENT (COLUMN 1)	ADVERSE CONDITIONS GENERATED? (COLUMN 2)	PRIMARY PROTECTION FUNCTION NOTED IN SAFETY ANALYSES (COLUMN 3)	DIVERSE PROTECTION FUNCTIONS AVAILABLE (COLUMN 4)	DIVERSE PROTECTION FUNCTION LOCATED IN ADVERSE ENVIRONMENT? (COLUMN 5)	EA TERM IN DIVERSE SETPOINT? (COLUMN 6)
		[			]+a,c
CRDM Housing Failure - RCCA Ejection	YES[8]				

[8] While the CRDM Housing Failure - RCCA Ejection results in some elevation of ambient temperatures, Westinghouse has evaluated the transient and has determined that the event power transient is [

]+a,c of the power transient.

[9] Unit 1 - see page 14.2.6-3, Reactor Protection paragraph 1 of UFSAR. Unit 2 - see page 14.2.6-3, Reactor Protection paragraph 1 of UFSAR.

ANTICIPATED OPERATIONAL OCCURENCE / DESIGN BASIS EVENT (COLUMN 1)	ADVERSE CONDITIONS GENERATED? (COLUMN 2)	PRIMARY PROTECTION FUNCTION NOTED IN SAFETY ANALYSES (COLUMN 3)	DIVERSE PROTECTION FUNCTIONS AVAILABLE (COLUMN 4)	DIVERSE PROTECTION FUNCTION LOCATED IN ADVERSE ENVIRONMENT? (COLUMN 5)	EA TERM IN DIVERSE SETPOINT? (COLUMN 6)
Feedwater Pipe Rupture - Inside Containment	YES	[			] +a,c
		]			

[10] Unit 1 - see page 14.2.8-3, Method of Analysis item 7 of UFSAR. (Note Feedwater Pipe Rupture is not part of the licensing basis for Unit 1 and is provided for information purposes only.) Unit 2 - see page 14.2.8-4, Method of Analysis item G of UFSAR.

ANTICIPATED OPERATIONAL OCCURENCE / DESIGN BASIS EVENT (COLUMN 1)	ADVERSE CONDITIONS GENERATED? (COLUMN 2)	PRIMARY PROTECTION FUNCTION NOTED IN SAFETY ANALYSES (COLUMN 3)	DIVERSE PROTECTION FUNCTIONS AVAILABLE (COLUMN 4)	DIVERSE PROTECTION FUNCTION LOCATED IN ADVERSE ENVIRONMENT? (COLUMN 5)	EA TERM IN DIVERSE SETPOINT? (COLUMN 6)
		[			+a,c]
Feedwater Pipe Rupture - Outside Containment	YES				
		]			

[11] See Note [4].

[12] Unit 1 - see page 14.2.8-3, Method of Analysis item 7 of UFSAR. (Note Feedwater Pipe Rupture is not part of the licensing basis for Unit 1 and is provided for information purposes only.) Unit 2 - see page 14.2.8-4, Method of Analysis item G of UFSAR.

ANTICIPATED OPERATIONAL OCCURENCE / DESIGN BASIS EVENT (COLUMN 1)	ADVERSE CONDITIONS GENERATED? (COLUMN 2)	PRIMARY PROTECTION FUNCTION NOTED IN SAFETY ANALYSES (COLUMN 3)	DIVERSE PROTECTION FUNCTIONS AVAILABLE (COLUMN 4)	DIVERSE PROTECTION FUNCTION LOCATED IN ADVERSE ENVIRONMENT? (COLUMN 5)	EA TERM IN DIVERSE SETPOINT? (COLUMN 6)
		[			+2,0]
Large Break LOCA	YES	]			

[13] See note [4].

[14] While reactor trip is noted, for reactivity purposes, the control rods are not assumed to fall in a Large Break LOCA. The reactor is shutdown on voids and remains shutdown based on the boron content of the coolant supplied by the ESFAS. Therefore, no EA term is necessary for reactor trip. Unit 1 - see page 14.3.1-2, paragraph 1 of UFSAR. Unit 2 - see page 14.3.1-3, paragraph 2 of UFSAR.

ANTICIPATED OPERATIONAL OCCURENCE / DESIGN BASIS EVENT (COLUMN 1)	ADVERSE CONDITIONS GENERATED? (COLUMN 2)	PRIMARY PROTECTION FUNCTION NOTED IN SAFETY ANALYSES (COLUMN 3)	DIVERSE PROTECTION FUNCTIONS AVAILABLE (COLUMN 4)	DIVERSE PROTECTION FUNCTION LOCATED IN ADVERSE ENVIRONMENT? (COLUMN 5)	EA TERM IN DIVERSE SETPOINT? (COLUMN 6)
		[			]+a,c
Small Break LOCA	YES[15]				

[15] While the Small Break LOCA results in some elevation of ambient temperatures, Westinghouse has evaluated the [ ]+a,c is included in the uncertainty calculation for the primary reactor trip function for this event.

[16] Unit 1 - see pages 14.3.2-11 and 13, Tables 14.3.2-4 and 6 respectively, and Figures 14.3.2-3, 11, 19, 25 and 33 of UFSAR. Unit 2 - see pages 14.3.2-9, 10, 11 and 15, Tables 14.3.2-1, 2, 3 and 7 respectively, and Figures 14.3.2-2, 11, 19, 27, 35, 43 and 51 of UFSAR.

6.0 Conclusion

A review of Table 1 will note that for those AOO/DBEs that generate adverse environmental conditions, there is at least one diverse protection function that is either; 1) qualified for that environment and includes an EA term in the uncertainty calculation for that function, or 2) is located in an area that is not affected by the event and thus does not experience elevated temperatures requiring the inclusion of an EA term for that event. Such a review would also note that for each event there is generally more than one diverse protection function available for backup. It is believed that the requirements of draft design criteria 20 and 23 as noted in Appendix H of the UFSAR and IEEE-279 are satisfied by the protection system and that adverse environmental allowance terms have been included in the protection function uncertainty calculations when appropriate.

Question 3 Discuss the need to include environmental allowances due to a harsh environment (including cable resistance effects) for the main steam flow/feedwater flow mismatch trip channels. Inspection report item #3.2.1a

Suggested Response:

As noted in the response to Question 2, Westinghouse includes environmental allowance (EA) terms in the uncertainty calculations only for those protection functions that are utilized to generate a primary trip or actuation for AAO/DBEs that generate elevated ambient temperatures or radiation releases. The Steam Flow/Feedwater Flow Mismatch coincident with Steam Generator Water Level - Low is not noted in the Donald C. Cook Nuclear Plant UFSAR as a primary trip or actuation protection function. This protection function serves [

]$^{+a,c}$. An event of this nature does not involve a break in a high energy pipe resulting in an elevation of ambient temperatures. Thus there is no defined requirement to include adverse environment EA terms in an uncertainty calculation for this protection function.