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Your ref: Docket No. 52-006
Our ref: DCP/NRC2248

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Subject: AP1000 Response to Request for Additional Information (SRP17.4)

Westinghouse is submitting a response to the NRC requests for additional information (RAI) on SRP Section 17.4. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in the response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

A response is provided for RAI-SRP17.4-SPLA-03, as sent in an email from Mike Miernicki to Sam Adams dated April 29, 2008. This response completes all requests received to date for SRP Section 17.4. A response for RAI-SRP17.4-SPLA-01 and -02 was submitted under letter DCP/NRC2151 dated June 6, 2008.

Questions or requests for additional information related to the content and preparation of this response should be directed to Westinghouse. Please send copies of such questions or requests to the prospective applicants for combined licenses referencing the AP1000 Design Certification. A representative for each applicant is included on the cc: list of this letter.

Very truly yours,

Robert Sisk, Manager
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/Enclosure

1. Response to Request for Additional Information on SRP Section 17.4

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ENCLOSURE 1

Response to Request for Additional Information on SRP Section 17.4

RAI Response Number: RAI-SRP17.4-SPLA-03
Revision: 0

Question:

Many components were included (DCD Rev. 15) in the D-RAP (Table 17.4-1) due to their high risk importance (risk achievement worth or RAW>2). Some of these are now shown (DCD Rev. 16) as retained in the D-RAP list only due to the judgment of an expert panel (EP). It is stated that updated PRA results indicate that these components are no longer defined as "risk important" by quantitative risk importance measures. Please justify this statement for the following components:
(1) Reactor coolant pump switchgear circuit breakers
(ECS ES 31, ECS ES 32, ECS ES 41, ECS ES 42 ECS ES 51, ECS ES 52, ECS ES 61, ECS ES 62)

These breakers open automatically to allow core makeup tank (CMT) operation. Therefore, one would expect that the common cause failure of these breakers have the same risk achievement worth as the CMT itself.

(2) 125V dc 24 hour batteries, inverters, and chargers
The batteries provide power for the PMS and safety related valves.

(3) IRWST vents (PXS MT 03)
These vents provide a pathway to vent steam from the tank into the containment.

(4) ADS stage 1, 2, and 3 motor operated valves (MOVs)
A RAW value of about 44 was reported in the AP1000 design certification PRA for event ADX MV3 GO, which represents failure to open for 32 combinations of three MOVs in ADS stages 2 and 3.

Westinghouse Response:

(1) Reactor coolant pump switchgear circuit breakers
(ECS ES 31, ECS ES 32, ECS ES 41, ECS ES 42 ECS ES 51, ECS ES 52, ECS ES 61, ECS ES 62)

The failures of the RC pump switchgear circuit breakers are captured in the following events.

RC1CB051GO	PUMP A FAILS TO TRIP - BREAKER FAILS TO OPEN
RC1CB052GO	PUMP A FAILS TO TRIP - BREAKER FAILS TO OPEN
RC1CB053GO	PUMP A FAILS TO TRIP - BREAKER FAILS TO OPEN
RC1CB054GO	PUMP A FAILS TO TRIP - BREAKER FAILS TO OPEN
RC1CB061GO	PUMP B FAILS TO TRIP - BREAKER FAILS TO OPEN
RC1CB062GO	PUMP B FAILS TO TRIP - BREAKER FAILS TO OPEN
RC1CB063GO	PUMP B FAILS TO TRIP - BREAKER FAILS TO OPEN
RC1CB064GO	PUMP B FAILS TO TRIP - BREAKER FAILS TO OPEN

Common cause failure of these breakers is not modeled directly in the AP1000 PRA.

Trip of all RCPs is not required for all instances where the CMT is used early in the sequence as modeled in the PRA. CMT injection is used in some sequences after the RCS pressure has been decreased. As an example, Modeling for a Large LOCA does not rely on tripping the RCP since the pressure in the RCS has been reduced by the event. This also is true for many of the Medium LOCA events.

These basic events do not meet the criteria for inclusion in the D-RAP database using PRA concerns (risk importance). Fault tree logic requires all four pumps to shutdown; however, there are two breakers for each pump with only one of two breakers necessary to shutdown one pump. Common cause failures for the basic events shown above are not modeled separately. The rationale provided in DCD chapter 17, Table 17.4-1 (D-RAP) indicates that these are in D-RAP due to an Expert Panel (EP). This rationale is correct and requires no change to the DCD.

(2) 125V dc 24 hour batteries, inverters, and chargers
The batteries provide power for the PMS and safety related valves.

The PMS and safety related valves are provided power from class 1E power supplies. AC power to these components can be achieved with success from any of three power supplies as follows:

- Regulating transformer and AC power
- Battery and inverter
- Battery charger and inverter.

The AP1000 PRA includes this level of modeling for the AC power supply to these safety related components. The PRA basic events for common cause failure of the batteries, battery chargers, and inverters are shown below:

CCX-BC-SA	COMMON CAUSE FAILURE OF THE BATTERY CHARGERS
CCX-BY-PN	COMMON CAUSE FAILURE OF THE BATTERIES IDSA-DB-1A/1B
CCX-IV-XR	COMMON CAUSE FAILURE OF THE INVERTER

The risk significance criteria for including the inverters, batteries, and battery charges based upon the PRA modeling of common cause for these components supports inclusion in the D-RAP. The risk significance criteria are not met by the basic events for these components without considering common cause. The rational for inclusion will be changed to RAW/CCF for 125V dc 24 hour batteries, inverters, and chargers. Changes are included in the section below for DCD chapter 17, Table 17.4-1 (D-RAP)

(3) IRWST vents (PXS MT 03)

These vents provide a pathway to vent steam from the tank into the containment. The preferred vent path consists of 5 pipe vents located away from the containment wall. Pipe vents open with a low pressure drop from the IRWST to the upper compartment and do not reclose once initially opened. In addition there are 21 hooded IRWST vents which are located along the containment wall and 6 overflow vents to the refueling canal. These vents have louvers that are normally closed and open with a sufficiently higher differential pressure than the pipe vents. Once opened, the louvers close again under their own weight when the differential pressure is reduced.

By design, the flow area of the pipe vents is sufficient to relieve early reflood hydrogen releases with a low pressure drop from the IRWST to the upper compartment. During hydrogen release to the IRWST in which the steam is quenched in the IRWST water, only the pipe vents will open, preferentially releasing the hydrogen a minimum of 18-ft away from the containment shell. Under very small LOCAs, IRWST venting will include the hooded IRWST vents. However, such releases would produce a copious amount of steam that would be released through the vents along with the hydrogen, which would inert the burning at the vents.

The AP1000 level 2 PRA containment failure probability assignments for node DF are used to answer the question "Does the containment not fail from elevated temperature due to diffusion flame in the CMT room and at the IRWST vent" for each release category. Failure nodal failure probabilities are calculated separately for accident classes that require IRWST venting. Failures that are considered to result in the hooded vents opening include either of the following:

- Failure of more than one of the 5 pipe vents to open
- Failure of all of the hooded vents to re-close once open

The current level 2 PRA model, TR102, Reference 1, has these nodal probabilities modeled directly as basic events that include consideration for common cause failures. The DCD PRA, Reference 2, includes these events as event tree nodes, thus are not directly modeled using basic events. The current PRA model provides a basic event for every event tree node, therefore the assignment of risk importance is straightforward. The events are modeled in the PRA as basic events shown below:

DF-1P-1	DF: CONTAINMENT FAILS FROM ELEVATED TEMPERATURE DUE TO DIFFUSION FLAME
DF-1P-2	DF: CONTAINMENT FAILS FROM ELEVATED TEMPERATURE DUE TO DIFFUSION FLAME
DF-3D-1	DF: CONTAINMENT FAILS FROM ELEVATED TEMPERATURE DUE TO DIFFUSION FLAME
DF-3D-2	DF: CONTAINMENT FAILS FROM ELEVATED TEMPERATURE DUE TO DIFFUSION FLAME

The level 2 PRA models the IRWST vents by assigning success probabilities to containment event tree nodes. Accident class specific probabilities are assigned for the containment failure probability nodes, DF. The risk significance criteria for including the IRWST vents based upon the PRA modeling for LRF supports inclusion in the D-RAP. The rational for inclusion will be changed to RAW for the IRWST vents. Changes are included in the section below for DCD chapter 17, Table 17.4-1 (D-RAP)

(4) ADS stage 1, 2, and 3 motor operated valves (MOVs)
A RAW value of about 44 was reported in the AP1000 design certification PRA for event ADX MV3 GO, which represents failure to open for 32 combinations of three MOVs in ADS stages 2 and 3.

The criteria for including ADS stage 1, 2, and 3 MOVs based upon the PRA modeling (risk significance) of basic events before considerations for common cause for these components does not support inclusion of these MOVs in the D-RAP based solely upon the following basic events:

AD1MOD05	HARDWARE FAILUREOF ST. #1 LINE 1
AD1MOD06	HARDWARE FAILUREOF ST. #1 LINE 2
AD2MOD01	HARDWARE FAILUREOF ST. #2 LINE 1
AD2MOD02	HARDWARE FAILUREOF ST. #2 LINE 2
AD3MOD03	HARDWARE FAILUREOF ST. #3 LINE 1
AD3MOD04	HARDWARE FAILUREOF ST. #3 LINE 2
AD4MOD07	HARDWARE FAILUREOF ST. #4 LINE 1

Common cause of the ADS MOVs is modeled in two common cause groupings. These are ADX-MV3-GO and ADX-MV-GO.

ADS-MV-GO models the common cause failures of the motor-operated valves of the ADS first, second, and third stage to operate. The criteria for including ADS stage 1, 2, and 3 MOVs based upon LRF risk significance of ADX-MV-GO supports inclusion of stages 1, 2 and 3 ADS MOVs in the D-RAP.

ADX-MV3-GO models the common-cause failures of 32 combinations of three stage 2 and stage 3 MOVs to fail to operate. The criteria for including ADS stage 2, and 3 MOVs based upon CDF and LRF risk significance ADX-MV3-GO supports inclusion of stage 2 and stage 3 MOVs in the D-RAP.

The Rational for inclusion of these MOVs for D-RAP will be changed to RAW/CCF. Changes are included in DCD chapter 17, Table 17.4-1 (D-RAP)

References:

1. APP-GW-GLR- 102 (TR102), "AP1000 Probabilistic Risk Assessment Update Report"
2. APP-GW-GL-022, Revision 8, AP1000 Probabilistic Risk Assessment.

Design Control Document (DCD) Revision:

Changes are included in the section below for DCD chapter 17, Table 17.4-1 (D-RAP).

PRA Revision:

None

Technical Report (TR) Revision:

None

Table 17.4-1 (Sheet 3 of 8)

RISK-SIGNIFICANT SSCs WITHIN THE SCOPE OF D-RAP

System, Structure, or Component (SSC)(1)	Rationale(2)	Insights and Assumptions
- Main Steamline Pressure (SGS-030, -031, -032, -033, -034, -035, -036, -037) - Main Feedwater Wide-Range Flow (SGS-050A/C/E, -051A/C/E) - Startup Feedwater Flow (SGS-055A/B, -056A/B)		
CMT Level Sensors (PXS-011A/B/C/D, -012A/B/C/D, -013A/B/C/D, -014A/B/C/D)	RAW/CCF	These level sensors provide input for automatic actuation of the ADS. They also provide indications to the operator.
System: Class 1E DC Power and Uninterruptible Power System (IDS)		
125 Vdc 24-hour Batteries, Inverters, and Chargers (IDSA-DB-1A/B, IDSB-DB-1A/B, IDSC-DB-1A/B, IDSD-DB-1A/B, IDSA-DU-1, IDSB-DU-1, IDSC-DU-1, IDSD-DU-1, IDSA-DC-1, IDSB-DC-1, IDSC-DC-1, IDSD-DC-1)	~~EP~~<u>RAW/CCF</u>	The batteries provide power for the PMS and safety-related valves. The chargers are the preferred source of power for Class 1E dc loads and are the source of charging for the batteries. The inverters provide uninterruptible ac power to the I&C system.
125 Vdc and 120 Vac Distribution Panels (IDSA-DD-1, -EA-1/2, IDSB-DD-1, -EA-1/2/3, IDSC-DD-1, -EA-1/2/3, IDSD-DD-1, -EA-1/2)	RAW	These panels distribute power to components in the plant that require 1E power support.
Fused Transfer Switch Boxes (IDSA-DF-1, IDSB-DF-1, IDSC-DF-1, IDSD-DF-1)	RAW	The fused disconnect switches connect the different levels of Class 1E distribution panels.
125 Vac Motor Control Centers (IDSA-DK-1, IDSB-DK-1, IDSC-DK-1, IDSD-DK-1)	EP	These buses provide power for the PMS and safety-related valve operation.

Table 17.4-1 (Sheet 4 of 8)

RISK-SIGNIFICANT SSCs WITHIN THE SCOPE OF D-RAP

System, Structure, or Component (SSC)[1]	Rationale[2]	Insights and Assumptions
System: Passive Containment Cooling System (PCS)		
Recirculation Pumps (PCS-MP-01A/B)	EP	These pumps provide the motive force to refill the PCS water storage tank during post-72 hour support actions.
PCCWST Drain Isolation Valves (PCS-PL-V001A/B/C)	EP, L2	These valves (two AOVs and one MOV) open automatically to drain water from a water storage tank onto the outside surface of the containment shell. This water provides evaporative cooling of the containment shell following accidents.
System: Plant Control System (PLS)		
PLS Actuation Hardware (Control functions listed in Note 6)	RAW/CCF	This common cause failure event is assumed to disable all logic outputs from the PLS associated with CVS reactor makeup, RNS reactor injection, spent fuel cooling, component cooling of RNS SFS heat exchangers, service water cooling of CCS heat exchangers, standby diesel generators, and hydrogen igniters.
System: Protection and Safety Monitoring System (PMS)		
PMS Actuation Software	RAW/CCF	The PMS software provides the automatic reactor trip and ESF actuation functions listed in Tables 7.2-2 and 7.3-1.
PMS Actuation Hardware	RAW/CCF	The PMS hardware provides the automatic reactor trip and ESF actuation functions listed in Tables 7.2-2 and 7.3-1.
Main Control Room (MCR) 1E Displays and System Level Controls (OCS-JC-010, -011)	RAW/CCF	This includes the Class 1E PMS (QDPS) displays and controls. These displays and system level controls provide important plant indications to allow the operator to monitor and control the plant during accidents.
Reactor Trip Switchgear (PMS-JD-RTS A01/02, B01/02, C01/02, D01/02)	RAW/CCF	These breakers open automatically to allow insertion of the control rods.
System: Passive Core Cooling System (PXS)		
IRWST Vents (PXS-MT-03)	~~EP~~RAW/CCF	The IRWST vents provide a pathway to vent steam from the tank into the containment. The IRWST vents also have a severe accident function to prevent the formation of standing hydrogen flames close to the containment walls. This function is accomplished by designing the vents located further from the containment walls to open with less IRWST internal pressure than the other vents.

Table 17.4-1 (Sheet 6 of 8)

RISK-SIGNIFICANT SSCs WITHIN THE SCOPE OF D-RAP

System, Structure, or Component (SSC)(1)	Rationale(2)	Insights and Assumptions
IRWST Injection Check Valves (PXS-PL-V122A/B, -V124A/B)	RAW/CCF	The containment recirculation lines provide long-term core cooling following a LOCA. These check valves open when the IRWST level is reduced to approximately the same level as the containment level.
IRWST Injection Squib Valves (PXS-PL-V123A/B, -V125A/B)	RAW/CCF	The IRWST injection lines provide long-term core cooling following a LOCA. These squib valves open automatically to allow injection when the RCS pressure is reduced to below the IRWST injection head.
IRWST Gutter Bypass Isolation Valves (PXS-PL-V130A/B)	RAW/CCF	These valves direct water collected in the IRWST gutter to the IRWST. This capability extends PRHR heat exchanger operation.
System: Reactor Coolant System (RCS)		
ADS Stage 1/2/3 Valves (MOV) (RCS-PL-V001A/B, -V002A/B, -V003A/B, -V011A/B, -V012A/B, -V013A/B)	~~EP~~RAW/CCF	The ADS provides a controlled depressurization of the RCS following LOCAs to allow core cooling from the accumulator, IRWST injection, and containment recirculation. The ADS provides "bleed" capability for feed/bleed cooling of the core. The ADS also provides depressurization of the RCS to prevent a high-pressure core melt sequence.
ADS Stage 4 Valves (Squib) (RCS-PL-V004A/B/C/D)	RAW/CCF	The ADS provides a controlled depressurization of the RCS following LOCAs to allow core cooling from the accumulator, IRWST injection, and containment recirculation. The ADS provides "bleed" capability for feed/bleed cooling of the core. The ADS also provides depressurization of the RCS to prevent a high-pressure core melt sequence.
Pressurizer Safety Valves (RCS-PL-V005A/B)	EP	These valves provide overpressure protection of the RCS.
Reactor Vessel Insulation Water Inlet and Steam Vent Devices (RCS-MN-01)	EP	These devices provide an engineered flow path to promote in-vessel retention of the core in a severe accident.
Reactor Cavity Doorway Damper	EP	This device provides a flow path to promote in-vessel retention of the core in a severe accident.
Fuel Assemblies (157 assemblies with tag numbers beginning with RXS-FA)	SMA	The nuclear fuel assembly includes the fuel pellets, fuel cladding, and associated support structures. This equipment, which provides a first barrier for release of radioactivity and allows for effective core cooling, had the least margin in the seismic margin analysis.