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Your ref: Docket No. 52-006
Our ref: DCP_NRC_002722

December 17, 2009

Subject: AP1000 Response to Proposed Open Item (Chapter 19)

Westinghouse is submitting the following responses to the NRC open item (OI) on Chapter 19. These proposed open item response are submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in these responses is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

Enclosure 1 provides the response for the following proposed Open Item(s):

OI-SRP19.0-SPLA-13 R1

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
Licensing and Customer Interface
Regulatory Affairs and Standardization

/Enclosure

1. Response to Proposed Open Item (Chapter 19)

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NRO

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ENCLOSURE 1

AP1000 Response to Proposed Open Item (Chapter 19)

AP1000 DCD SER Open Item REVIEW

Open Item Resolution

OI Response Number: OI-SRP19.0-SPLA-13
Revision: 1

Question:

The staff is looking for more information related to Westinghouse's response to RAI-SRP19.0-SPLA-13.

Providing a revised DCD description of the sequences contributing most to shutdown risk.

(Email Chris Procter to Thom Ray, 2/5/09, "Preliminary draft list of Chapter 19 Open Items")

Westinghouse Response:

TR-102 has been revised to include results of the requantified low power/ shutdown PRA as discussed in RAI-SRP19.0-SPLA-13. There have been additional changes addressed for the "current model", referred to in this question. All of these changes are captured in the revision to the AP1000 low power/ shutdown PRA documented in TR102 Revision 1 and are incorporated in revisions to References 1, 2 and 3 (identified in the original response to OI-SRP19.0-SPLA-13). The DCD will be modified to reflect the AP1000 low power/ shutdown PRA documented in TR102 Revision 1.

Design Control Document (DCD) Revision:

19.59.5 Core Damage and Severe Release Frequency from Events at Shutdown

19.59.5.1 Summary of Shutdown Level 1 Results

As shown by the dominant cutsets of the AP600 and AP1000 shutdown models the risk profiles of these plants for events during shutdown conditions are almost identical. The results indicate that the three events dominating the CDF are loss of component cooling/service water during drained condition, loss of RNS during drained condition, and loss of offsite power during drained condition. The AP1000 and AP600 initiating event core damage contributions are similar for the two plants.

The dominant _sequences are described in the subsections that follow. The dominant accident sequences comprise 95.3 percent of the level 1 shutdown PRA core damage frequency. These dominant sequences consist of:

- Loss of component cooling or service water system initiating event during drained condition with a contribution of 76.7 percent of the CDF
- Loss of RNS initiating event during drained condition with a contribution of 10.4 percent of the CDF
- Loss of offsite power initiating event during drained condition with a contribution of 8.2 percent of the CDF

Loss of Component Cooling or Service Water System Initiating Event During Drained Condition

These sequences are described as the loss of decay heat removal initiated by failure of the component cooling water or service water system during drained condition. The loss of decay heat removal occurs following loss of component cooling water system (CCS) or service water system (SWS) during mid-loop/vessel flange operation, which has an estimated duration of 120 hours per 18 months refueling cycle.

The major contributors to risk due to loss of CCS or SWS during drained condition are the following:

- Hardware failures of both service water pumps or common cause failure of digital input/output modules from the protection and monitoring system (PMS).
- Common cause failure of the ADS 4th stage squib valves
- Common cause failure of the recirculation line squib valves
- Common cause failure of the IRWST injection squib valves
- Common cause failure of the strainers in the IRWST tank
- Common cause failure of the recirculation sump strainers

Loss of RNS Initiating Event During Drained Condition

This sequence is described as the loss of decay heat removal initiated by failure of the RNS during drained condition. The loss of decay heat removal occurs following loss of RNS during mid-loop/vessel flange operation, which has an estimated duration of 120 hours per 18 months refueling cycle.
The major contributors to risk due to loss of RNS during drained condition are the following:

- Common cause failure of the RNS pumps to run
- Common cause failure of the recirculation line squib valves
- Common cause failure of the ADS 4th stage squib valves
- Common cause failure of the IRWST injection squib valves
- Common cause failure of the strainers in the IRWST tank
- Common cause failure of the recirculation sump strainers

Loss of Offsite Power Initiating Event During Drained Condition (with failure of grid recovery within 1 hour)

This sequence is initiated by loss of offsite power during mid-loop/vessel flange operation, which has an estimated duration of 120 hours per 18 months refueling cycle. Following this initiating event, the RNS does not restart automatically, and the grid is not recovered within 1 hour.
The major contributors to risk given loss of offsite power (without grid recovery) are the following:

- Failure of the RNS pump to run or restart
- Failure of the diesel generator to start or run
- Failure of the main breaker to open
- Failure to recover ac power within 1 hour
- Failure of ovation digital output modules for RNS_V055
- Common cause failure of the ADS 4th stage squib valves
- Common cause failure of batteries IDSA-DB-1A/1B
- Common cause failure to start engine driven fuel pumps
- Common cause failure of the IRWST injection squib valves
- Common cause failure of the strainers in the IRWST tank
- Common cause failure of the recirculation sump strainers

Loss of Offsite Power Initiating Event During Drained Condition (with success of grid recovery within 1 hour)

This sequence is initiated by loss of offsite power during mid-loop/vessel flange operation which has an estimated duration of 120 hours per 18 months refueling cycle. Following this initiating event, the RNS does not restart automatically, the grid is recovered within 1 hour but manual RNS restart after grid recovery fails.
The major contributors to risk, given loss of offsite power (with grid recovery), are the following:

- Failure of the RNS pump to run or restart

- Common cause failure of the ADS 4th stage squib valves
- Failure of ovation digital output modules for RNS_V055
- Common cause failure of the recirculation line squib valves
- Common cause failure of the IRWST injection squib valves
- Common cause failure of the strainers in the IRWST tank
- Common cause failure of the recirculation sump strainers

Conclusions

The conclusions drawn from the shutdown Level 1 study are as follows:

- The overall shutdown core damage frequency is very small (1.03E-07/year).

- Initiating events during reactor coolant system drained conditions contribute approximately 95 percent of the total shutdown core damage frequency. Loss of decay heat removal capability (during drained condition) due to failure of the component cooling water system or service water system are the initiating events with the greatest contribution (approximately 77 percent of the shutdown core damage frequency).

- Common cause failures of in-containment refueling water storage tank components contribute approximately 56 percent of the total shutdown core damage frequency. Common cause failure of the in-containment refueling water storage tank valves contributes approximately 45 percent of the total shutdown core damage frequency.

- Common cause failures of the automatic depressurization system stage 4 squib valves contribute approximately 26 percent to the total shutdown core damage frequency. The function of the automatic depressurization system is important to preclude the effects of surge line flooding. This indicates that maintaining the reliability of the automatic depressurization system is important.

- Common cause failures of the containment sump recirculation squib valves contribute approximately 22 percent to the total shutdown core damage frequency. This function is important during drained conditions. This indicates that maintaining the reliability of the recirculation line squib valves is important.

- Human errors are not overly important to shutdown core damage frequency. There is no particular dominant contributor. Sensitivity results show that the shutdown core damage frequency would remain very low even with little credit for operator actions.

- One action, operator failure to recognize the need for reactor coolant system depressurization during safe/cold shutdown conditions, is identified as having a significant risk increase value. This indicates it is important that the procedures include this action and the operators understand and are appropriately trained for it.

- Individual component failures are not significant contributors to shutdown core damage frequency, and there is no particular dominant contributor. This confirms the at-power conclusion that single independent component failures do not have a large impact on core damage frequency for AP1000 and reflects the redundancy and diversity of protection at shutdown as well.

- The in-containment refueling water storage tank provides a significant benefit during shutdown because it serves as a passive backup to the normal residual heat removal system.

19.59.5.2 Large Release Frequency for Shutdown and Low-Power Events

The baseline PRA shutdown large release frequency for AP600 was calculated to be 1.5E-08 per reactor-year, associated with a shutdown CDF of 9.0E-08 per year. The AP1000 LRF is estimated to be 1.72E-08 per year, with the same risk profile as that of AP600 (see Table 19.59-15). This LRF compares well with the at-power LRF of 1.95E-08 per year.

19.59.5.3 Shutdown Results Summary

The results of the low-power and shutdown assessment show that the AP1000 design includes redundancy and diversity at shutdown not found in current plants. In particular, the in-containment refueling water storage tank provides a unique safety backup to the normal residual heat removal system. Maintenance at shutdown has less impact on the defense-in-depth features for AP1000 than for current plants. In accordance with plant technical specifications, safety-related system planned maintenance is performed only during those shutdown modes when the protection provided by the safety-related system is not required. Further, maintenance of nonsafety systems, such as the normal residual heat removal system, component cooling water system, and service water system, is performed at power to avoid adversely affecting shutdown risk. These contribute to the extremely low shutdown core damage frequency and the low large release frequency.

Table 19.59-15 SUMMARY OF AP1000 PRA RESULTS				
Events	Core Damage Frequency (per year)		Large Release Frequency (per year)	
	At-Power	Shutdown	At-Power	Shutdown
Internal Events	2.41E-07	1.03E-07	1.95E-08	1.72E-08
Internal Flood	8.82E-10	3.22E-09	7.14E-11	5.37E-10
Internal Fire	5.61E-08	8.5E-08[1]	4.54E-09	1.43E-08
Sum =	2.97E-07	1.91E-07	2.41E-08	3.20E-08

Note:
1. Internal fire during shutdown is evaluated quantitatively as a response to an NRC question and is not reported elsewhere in this document.

PRA Revision:
None

Technical Report (TR) Revision:

TR102 Revision 1 updates the results of the LPSD PRA model.