AP1000 DOCUMENT COVER SHEET

TDC: _____ Permanent File: _____ S _____

RFS#: RFS ITEM #:

AP1000 DOCUMENT NO.	REVISION NO.		ASSIGNED TO
APP-GW-GL-011	0	Page 1 of 71	W-Winters

ALTERNATE DOCUMENT NUMBER: WCAP-16555 WORK BREAKDOWN #:

ORIGINATING ORGANIZATION: Westinghouse

TITLE: **AP1000 Identification of Critical Human Actions and Risk Important Tasks**

ATTACHMENTS:	DCP #/REV. INCORPORATED IN THIS DOCUMENT REVISION: none
CALCULATION/ANALYSIS REFERENCE: none	

ELECTRONIC FILENAME	ELECTRONIC FILE FORMAT	ELECTRONIC FILE DESCRIPTION
APP-GW-GL-011 R0.doc	WORD	

(C) WESTINGHOUSE ELECTRIC COMPANY LLC – 2006

☐ WESTINGHOUSE PROPRIETARY CLASS 2

This document is the property of and contains Proprietary Information owned by Westinghouse Electric Company LLC and/or its subcontractors and suppliers. It is transmitted to you in confidence and trust, and you agree to treat this document in strict accordance with the terms and conditions of the agreement under which it was provided to you.

☒ WESTINGHOUSE CLASS 3 (NON-PROPRIETARY)

ORIGINATOR	SIGNATURE/DATE	
T.L. Schulz	** *Electronically Approved*	
REVIEWERS	SIGNATURE/DATE	
C.S. Brockhoff	** *Electronically Approved*	
T.P. Hayes	** *Electronically Approved*	
INDEPENDENT VERIFIER	SIGNATURE/DATE	VERIFICATION METHOD
G.L. Morrison	** *Electronically Approved*	Reviewed against WCAP 14651 process
AP1000 RESPONSIBLE MANAGER	SIGNATURE*	APPROVAL DATE
J.W. Winters	** *Electronically Approved*	

*Approval of the responsible manager signifies that document is complete, all required reviews are complete, electronic file is attached and document is released for use.

*** Electronically approved records are authenticated in the Electronic Document Management System.*

WESTINGHOUSE NON-PROPRIETARY CLASS 3

WCAP-16555, Revision 0

AP1000 Identification of Critical Human Actions and Risk Important Tasks

March 2006

AP1000 Document: APP-GW-GL-011

Westinghouse Electric Company LLC
P.O. Box 355
Pittsburgh, PA 15230-0355

©2005 Westinghouse Electric Company LLC
All Rights Reserved

Table of Contents

1.0 Introduction

2.0 Human Action Importance Evaluation Criteria

- 2.1 Critical Human Actions
- 2.2 Risk Important Human Actions

3.0 AP1000 Human Action Importance Evaluation

- 3.1 AP1000 Critical Human Actions
- 3.2 AP1000 Risk Important Human Actions, Post-Accident
- 3.3 AP1000 Risk Important Human Actions, Pre-Accident

4.0 Summary of Results

5.0 References

List of Acronyms

ADS	Automatic Depressurization System
AOV	Air Operated Valve
ATWS	Anticipated Transient Without Scram
CCS	Component Cooling System
CDF	Core Damage Frequency
CMT	Core Makeup Tank
CNS	Containment System
CVS	Chemical and Volume Control System
DAS	Diverse Actuation System
DCD	Design Control Document
D-RAP	Design Reliability Assurance Program
ECS	Main AC Power System
FWS	Main and Startup Feedwater System
HFE	Human Factors Engineering
HRA	Human Reliability Analysis
HSI	Human System Interface Design
IDS	Class 1E DC and UPS System
IRWST	In-containment Refueling Water Storage Tank
IST	Inservice Test
LOCA	Loss of Coolant Accident
LRF	Large Release Frequency
MCC	Motor Control Center
MTIS	Maintenance, Test, Inspection and Surveillance
MOV	Motor Operated Valve
PCS	Passive Containment Cooling System
PCCWST	Passive Containment Cooling Water Storage Tank
PHV	Pneumatic-Hydraulic Valve
PLS	Plant Control System
PMS	Protection and Monitoring System
PRA	Probabilistic Risk Assessment

PRHR HX	Passive Residual Heat Removal Heat Exchanger
PXS	Passive Core Cooling System
RAW	Risk Achievement Worth
RCP	Reactor Coolant Pump
RCS	Reactor Coolant System
RNS	Normal Residual Heat Removal System
RRW	Risk Reduction Worth
RTCOT	Reactor Trip Channel Operational Test
RTNSS	Regulatory Treatment of Nonsafety Systems
SFS	Spent Fuel Cooling System
SGS	Steam Generator System
SGTR	Steam Generator Tube Rupture
SSC	Systems, Structures and Components
SSD	System Specification Document
SWS	Service Water System
STAC	Short-Term Availability Controls
Ta	Time estimated for human action to occur
TADOT	Trip Actuating Device Operational Test
TS	Technical Specification
Tw	Time window available for human action
VBS	Nuclear Island Nonradioactive Ventilation System
VFS	Containment Air Filtration System
VWS	Central Chilled Water System
WLS	Liquid Radwaste System
ZOS	Onsite Standby Power System

1.0 Introduction

This document provides the results of an evaluation of the AP1000 PRA/HRA to identify critical human actions and risk important tasks. This evaluation was performed to implement the initial steps of the HRA/HFE integration plan described in WCAP-14651 (reference 5.1).

The evaluation was performed on the AP1000 to identify the:

- Critical human actions for post-accident mitigation
- Risk-important human actions for
    - Post-accident mitigation
    - Maintenance, test, inspection and surveillance (MTIS) support

2.0 Evaluation Criteria

WCAP-14651 identifies criteria that should be considered in identifying critical and risk-important human actions. These criteria are summarized below.

2.1 Critical Human Actions

Two criteria are used to identify critical human actions used to mitigate accidents (reference 5.1). These criteria are:

- **Deterministic Criteria** – Any human action that is required to prevent core damage or severe release in licensing design basis accidents.

- **PRA Criteria** – Any one human action that if assumed to fail would result in a core damage frequency greater than 1E-4 or a severe release frequency greater than 1E-5.

  The evaluation considered the baseline PRA quantitative results, including at-power and shutdown initial conditions and internal, fire, and flood events. WCAP-14651 also specifies that seismic events be considered. However this is not possible for AP1000 because seismic margins were evaluated for and as a result CDF / LRF along with human action RAW / RRW values are not available for seismic events.

2.2 Risk-Important Human Actions

The criteria used to define risk important human actions considers both post accident mitigation and human actions required for MTIS support.

2.2.1 Post-Accident Risk-Important Human Actions

Risk-important human actions used to mitigate an accident are identified using both quantified PRA importance measures and an expert panel.

The quantified PRA importance measures include evaluating both the Risk-Achievement worth (RAW) and Risk-Reduction worth (RRW) caused by the human action.

1. Risk-Achievement Worth: This measure examines the increase in risk that would result if a single human action were to fail. The CDF and LRF are requantified for each human action by setting its failure probability to 1. The RAW value is then calculated as the percentage increase in CDF or LRF due to the human failure. WCAP 14651 establishes RAW limits for identifying risk-important tasks. For the baseline PRA study, a human action is considered risk-important if the CDF or LRF increase is 200%, i.e. the RAW is $\geq$ 3.0. For the "focused" PRA study (with assumed failure of nonsafety mitigating features), a human action is considered risk-important if the percentage increase is 100%, i.e. the RAW is $\geq$ 2.0. Any value below these criteria is considered to be not risk-important.

2. Risk-Reduction Worth: This measure examines the decrease in risk that would result if a human action were made perfectly reliable. The CDF and LRF are requantified for each

human action by setting its failure probability to 0. The RRW value is then calculated as the percentage decrease in CDF or LRF. WCAP 14651 establishes RRW limits for identifying risk-important tasks. For the baseline PRA study, a human action is considered risk-important if the CDF or LRF decreases by more than 10%, i.e. the RRW is $\geq$ 1.1. For the "focused" PRA study (with assumed failure of nonsafety mitigating features), a human action is considered risk-important if the percentage decrease is 5%, i.e. the RRW is $\geq$ 1.05. Any value below these criteria is considered to be not risk-important.

WCAP-14651 requires that these importance measures be determined for the following initial conditions and events:

		CDF	LRF
Baseline:	At-Power – internal	yes	yes
	- fire	yes	-
	- flood	yes	-
	Shutdown – internal	yes	yes
Focused:	At-Power – internal	yes	yes
	- fire	yes	-
	- flood	yes	-
	Shutdown – internal	yes	yes

In addition to the quantified risk importance measures, an expert panel is required to review the human action RAW / RRW values and to determine if any actions not meeting the quantitative screening criteria should be included. In making this determination, the following factors are to be considered (reference 5.1):

- If the RAW / RRW values were less than but close to the criteria and
  - The time available for the operator to act is close to the available time
  - The actions are complex, unique, or potentially challenging
  - The actions are needed to prevent conflicting safety goals
- Actions that are judged to be risk-important by the panel based on their experience

Note that in general, the greater the difference between the RAW / RRW values and the criteria, the more qualitative considerations were required to include an human action.

The WCAP also identifies that the expert panel should have representatives from HRA/PRA, systems engineering design, HSI design, and HFE.

2.2.2 Risk-Important Human Actions for MTIS Support

WCAP-14651 discusses using qualitative criteria to identify risk-important human actions associated with maintenance, test, inspection and surveillance (MTIS) activities for risk significant Systems, Structures and Components (SSC). The process involves identifying risk-important SSCs. This is done for the Design Reliability Assurance Program and the results are tabularized in

the Design Certification Document (reference 5.4). For the HRA integration effort, this list was evaluated to define a set of MTIS activities for these risk-important SSC. The MTIS activities were reviewed by representatives from HRA/PRA, systems engineering, HSI design and HFE.

3.0 AP1000 Human Action Importance Evaluation

The following sections document the results of the evaluation performed on the AP1000 to determine the critical and risk-important human actions in accordance with WCAP-14651 (reference 5.1).

3.1 AP1000 Critical Human Actions

The criteria in section 2.1 has been applied to the AP1000. As shown in the following paragraphs, no critical human actions have been identified by either deterministic or PRA criteria. This is not surprising given the reduced dependence on human actions in the AP1000.

Deterministic Criteria:

As shown in the AP1000 DCD (reference 5.4) section 7.5.3.1, there are no "type A" post accident instruments. This is justified because there are no human actions that are required to mitigate design basis accidents. This capability is more conservative than the criteria in WCAP 14651 which is no human action required to prevent core damage or a severe accident following a licensing design basis event.

PRA Criteria:

The most risk important human actions are shown in Tables 3-1 and 3-2. These tables show the basic event probabilities from the PRA (reference 5.5) and the re-calculated CDF or LRF values that result by assuming the failure of an human action. Note that these tables also show RAW / RRW values although they are not used in to determine "critical" human actions. Table 3-1 shows the top 10 sequences with the highest CDF. Table 3-2 shows the top 10 sequences with the highest LRF. None of the resulting CDF or LRF is above the criteria listed in section 2.1 (CDF > 1E-4/yr or LRF > 1E-5/yr).

Since neither of the criteria is satisfied, the AP1000 has no "critical" human actions.

Table 3-1
AP1000 Human Actions Sorted by Resulting CDF (Baseline PRA)

Basic Event ID	Basic Event Description	B Event Prob.	Resulting CDF	Criteria for CDF
LPM-MAN05	Failure to recognize the need for RCS depressurization during a shutdown condition with failure of CMT and the RNS	6.83E-04	1.57E-06	<1.0E-4
CIB-MAN00	Failure to diagnose a steam generator tube rupture event	1.84E-03	1.53E-06	<1.0E-4
ADN-MAN01	Failure to actuate the ADS for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation	3.02E-03	1.02E-06	<1.0E-4
REN-MAN04	Failure to recognize the need and failure to open the recirculation valves during a loss-of-coolant accident or transient, if the IRWST low-level signal fails - preventing automatic actuation of sump recirculation	1.00E-02	9.37E-07	<1.0E-4
IWN-MAN00	Failure to recognize the need and failure to manually open IRWST squib valves during shutdown conditions with the RNS unavailable	1.15E-03	9.19E-07	<1.0E-4
REC-MANDAS	Failure to detect the need to perform an activity by using the cues provided by diverse actuation system, or the probability to perform an activity by using the controls that are DAS related	1.16E-02	8.19E-07	<1.0E-4
CIB-MAN01	Failure to close main steam isolation valve to isolate the faulted steam generator, given a steam generator tube rupture event	1.34E-03	7.95E-07	<1.0E-4
LPM-MAN02	Failure to recognize the need for RCS depressurization during a medium LOCA	3.30E-03	6.96E-07	<1.0E-4
LPM-MAN01	Failure to recognize the need for RCS depressurization during a small LOCA or loss of high-pressure heat removal system	1.34E-03	5.49E-07	<1.0E-4
CVN-MAN00	Failure to align the CVS in the auxiliary spray mode following a steam generator tube rupture event	3.10E-03	5.09E-07	<1.0E-4

Table 3-2
AP1000 Human Actions Sorted by Resulting LRF (Baseline PRA)

Basic Event ID	Basic Event Description	B Event Prob.	Resulting LRF	Criteria for LRF
CIB-MAN00	Failure to diagnose a steam generator tube rupture event	1.84E-03	2.15E-07	<1.0E-5
REC-MANDAS	Failure to detect the need to perform an activity by using the cues provided by diverse actuation system, or the probability to perform an activity by using the controls that are DAS related	1.16E-02	1.72E-07	<1.0E-5
REN-MAN03	Failure to recognize the need and failure to open recirculation valves to flood reactor cavity after core damage	3.40E-03	1.63E-07	<1.0E-5
ATW-MAN05	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in seven minutes, given ATWS	5.20E-03	1.58E-07	<1.0E-5
CIB-MAN01	Failure to close main steam isolation valve to isolate the faulted steam generator, given a steam generator tube rupture event	1.34E-03	1.34E-07	<1.0E-5
LPM-MAN01	Failure to recognize the need for RCS depressurization during a small LOCA or loss of high-pressure heat removal system	1.34E-03	1.02E-07	<1.0E-5
ADN-MAN01	Failure to actuate the ADS for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation	3.02E-03	9.56E-08	<1.0E-5
ATW-MAN03	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in one minute, given ATWS	5.20E-02	8.21E-08	<1.0E-5
REN-MAN04	Failure to recognize the need and failure to open the recirculation valves during a loss-of-coolant accident or transient, if the IRWST low-level signal fails - preventing automatic actuation of sump recirculation	1.00E-02	6.88E-08	<1.0E-5
CVN-MAN00	Failure to align the CVS in the auxiliary spray mode following a steam generator tube rupture event	3.10E-03	5.01E-08	<1.0E-5

3.2 Risk-Important Human Actions, Post Accident

Risk-important human actions used to mitigate accident are identified using both quantified PRA importance measures and an expert panel.

As discussed in section 2.2.1, the risk importance measures are expressed as RAW and RRW values. These values have been calculated for the following initial conditions and accidents; the results are shown in the tables indicated (reference 5.2):

		CDF	LRF
Base:	At-Power – internal	A-1, A-2	A-3, A-4
	- fire	A-5, A-6 (1)	-
	- flood	(2)	-
	Shutdown – internal	A-7, A-8	(3)
Focused:	At-Power – internal	A-9, A-10	A-11, A-12
	- fire	(4)	-
	- flood	(5)	-
	Shutdown – internal	A-13, A-14	(6)

The items with a "-" are not required as indicated in section 2.2.1. Note that some of the required RAW / RRW values could not be calculated from the AP1000 PRA because of simplifications that were made in calculating some of the PRA results. The acceptability of not calculating these items is justified in the following footnotes.

Footnotes:

1) The human action RAW / RRWs for baseline PRA, at-power, fire CDF were calculated from the AP1000 baseline PRA for human actions unique to the fire event, but not for other human actions. This is acceptable since the unique fire human actions are included in the evaluation and the other human actions were included in the baseline PRA, at-power, internal events. Note that the baseline PRA, at-power fire events has a lower CDF as shown in Table 3.2-1 which will make the other human actions less important than in the baseline PRA, at-power, internal events.

2) The human action RAW / RRWs for baseline PRA, at-power, flood CDF could not be calculated from the AP1000 baseline PRA. This is acceptable since the CDF for floods at power is very low, a factor of ~ 270 less than that for at-power internal events.

3) The human action RAW / RRWs for baseline PRA, shutdown, internal event LRF could not be calculated from the baseline AP1000 PRA. This is acceptable since there are few ways that the containment can be bypassed other than failing to be isolated. Failure to close the containment (equipment hatch, personnel doors, etc) was added as a risk-important human action by the expert panel.

4) The human action RAW / RRWs for focused PRA, at-power, fire CDF could not be calculated from the focused AP1000 PRA. This is acceptable since the unique human

actions related to the fire event have been reviewed in the at-power fire event. In addition the CDF for fires at shutdown is lower than that for shutdown internal events.

5) The human action RAW / RRWs for focused PRA, flood CDF could not be calculated from the focused AP1000 PRA. This is acceptable since the CDF for floods at-power are very low, a factor of ~ 270 less than that for at-power internal events.

6) The human action RAW / RRWs for focused PRA, shutdown, internal event LRF could not be calculated from the focused AP1000 PRA. This is acceptable for the same reasons discussed in foot note 3).

3.2.1 RAW / RRW Input Data

The RAW / RRW data calculation used for the evaluation are provided in Tables A-1 through A-14. Each of these tables contains the following information:

- Rank – the CDF / LRF ranking in the Baseline / Focused PRA.
- Basic Event ID – the identifying label of the human action used in the PRA.
- Basic Event Description – description of the human action.
- PSF – the performance shaping factors used in calculating the human action reliability. Includes length of procedure (SHORT, LONG), operator stress level (MODERATE, HIGH), and time available to complete the action (Tw) vs estimated time required for operator to perform action (Ta). Refer to reference 5.3 for additional details of these calculations including the cues available to the operators to diagnose the event.
- Basic Event Prob. – reliability of human action calculated for PRA based on PSF. Refer to reference 5.3 for details of calculation of these reliabilities including the cues available to guide the human actions.
- RAW or RRW – calculated value based on baseline CDF or LRF and human action reliability.

These tables have been sorted based on the calculated RAW / RRW from high to low and the human actions that meet the screening criteria have been highlighted. The actions captured by the quantitative RAW / RRW criteria are shaded a darker solid; those actions that were added by the expert panel are shaded lighter with slanted lines.

An expert panel reviewed these RAW / RRW values to determine if any of the human actions not identified by the quantitative criteria should be included. The expert panel was made up of engineers representing the following technical areas:

Systems design,
Plant operations,
PRA,

HRA,
Severe Accidents,
Human System Interface Design,
Human Factors Engineering.

The above expert panel met on 6/1/04 and reviewed the attached tables A-1 through A-14. The criteria listed in section 2.2.1 was considered for including additional human actions. As a result of the expert panel the following human actions were added.

1. Failure to recognize the need and failure to isolate the RNS system, given rupture of the RNS piping when the plant is at hot/cold conditions (RHN-MAN04). This action was added because of the short time available for the operator to act and the conflicting goals (maintaining core cooling by the RNS vs isolating a leak / break in the RNS piping).

2. Failure to recognize the need and failure to actuate the hydrogen control system, given core damage following a LOCA (VLN-MAN01). This action was added because its limiting RAW is relatively close to the criteria. For the baseline PRA, internal events, LRF case, the RAW is 2.2 vs the criteria or 3.0. In addition, this function is RTNSS important.

3. Failure to close equipment hatch and personnel airlocks following core damage during shutdown event. This action was added because human action importance could not be calculated for shutdown, internal events, LRF. It was judged by the expert panel that under these conditions that the largest risk of LRF would come from failure to close the containment. Closing the containment under these conditions may involve closing the equipment hatch, personnel hatches and temporary penetrations. Note that other containment bypass means that are important at-power, such as SGTR, ATWS, and over pressurization of RNS, are not possible or are greatly reduced at shutdown.

Table 3.2-2 lists the AP1000 post-accident risk-important human actions. The human actions are listed alphabetically by basic event ID. A total of 22 risk-important human actions are listed in this table. Three of them were added by the expert panel; the other 19 actions were identified by the RAW / RRW criteria. These actions are shaded in the same manor as are the Appendix tables are. Those actions captured by the quantitative criteria are shaded darker solid; those actions that were added by the expert panel are shaded lighter with slanted lines.

Table 3.2-1 AP1000 PRA Results

	Core Melt Frequency		Large Release Frequency	
	At-Power	Shutdown	At-Power	Shutdown
Internal Events	2.41E-07 /yr	1.23E-07 /yr	1.95E-08 /yr	2.05E-08 /yr
Internal Fires	5.61E-08 /yr	8.52E-08 /yr	4.54E-09 /yr	1.40E-08 /yr
Internal Floods	8.80E-10 /yr	3.22E-09 /yr	7.10E-11 /yr	5.40E-10 /yr
Sub-Totals	2.98E-07 /yr	2.11E-07 /yr	2.41E-08 /yr	3.50E-08 /yr
Grand-Totals	5.09E-07 /yr		5.92E-08 /yr	
NRC Safety Goals	1.00E-04 /yr		1.00E-06 /yr	

Table 3.2-2 - AP1000 Risk Important Human Actions, Sorted by Basic Event ID										
	Basic Event ID	Basic Event Description	Baseline PRA				Focused PRA			
			CDF		LRF		CDF		LRF	
			RAW (>3.0)	RRW (>1.1)	RAW (>3.0)	RRW (>1.1)	RAW (>2.0)	RRW (>1.05)	RAW (>2.0)	RRW (>1.05)
1	ADF-MAN01	Failure to depressurize the RCS to stop RCS leak using the first stage ADS valves, given failure of aux spray during SGTR	-	-	-	-	-	1.15	-	1.10
2	ADN-MAN01	Failure to actuate the ADS for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation	4.3	-	4.9	-	2.3	-	4.3	-
3	ADN-MAN01C	Conditional probability of ADN-MAN01	-	-	-	-	-	1.14	-	1.10
4	ATW-MAN03	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in one minute, given ATWS	-	-	4.2	1.21	-	-	2.2	1.07
5	ATW-MAN04C	Conditional probability of ATW-MAN04	-	-	-	1.21	-	-	-	1.07
6	ATW-MAN05	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in seven minutes, given ATWS	-	-	8.1	-	-	-	-	-
7	CIB-MAN00	Failure to diagnose a steam generator tube rupture event	6.3	-	11.0	-	-	-	2.7	-
8	CIB-MAN01	Failure to close main steam isolation valve to isolate the faulted steam generator, given a steam generator tube rupture event	3.8	-	6.9	-	-	-	2.5	-
9	IWN-MAN00	Failure to recognize the need and failure to manually open IRWST squib valves during shutdown conditions with the RNS unavailable	7.5	-	-	-	-	-	-	-
10	IWN-MAN00C	Conditional probability of IWN-MAN00C	-	-	-	-	-	1.06	-	-

Table 3.2-2 - AP1000 Risk Important Human Actions, Sorted by Basic Event ID										
Basic Event ID		Basic Event Description	Baseline PRA				Focused PRA			
			CDF		LRF		CDF		LRF	
			RAW (>3.0)	RRW (>1.1)	RAW (>3.0)	RRW (>1.1)	RAW (>2.0)	RRW (>1.05)	RAW (>2.0)	RRW (>1.05)
11	LPM-MAN01	Failure to recognize the need for RCS depressurization during a small LOCA or loss of high-pressure heat removal system	[illegible]	[illegible]	5.2	[illegible]	[illegible]	[illegible]	4.4	[illegible]
12	LPM-MAN05	Failure to recognize the need for RCS depressurization during a shutdown condition with failure of CMT and the RNS	12.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13	OPA-1	Operator fails to deactivate the Protection and Safety Monitoring System (PMS) division involved in the fire	3.9	1.11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14	PDS6-MANADS	Failure to perform ADS as recovery from failure of automatic actuation or manual actuation in later phases of SGTR event	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.09
15	REC-MANDAS	Failure to detect the need to perform an activity by using the cues provided by diverse actuation system or the probability to perform an activity by using the controls that are DAS related	14.6	1.20	8.8	1.10	3.5	[illegible]	15.5	1.21
16	REC-MANDASC	Conditional probability of REC-MANDAS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.15	[illegible]	1.21
17	REN-MAN03	Failure to recognize the need and failure to open recirculation valves to flood reactor cavity after core damage	[illegible]	[illegible]	8.4	[illegible]	[illegible]	[illegible]	5.4	[illegible]
18	REN-MAN04	Failure to recognize the need and failure to open the recirculation valves during a loss-of-coolant accident or transient if the IRWST low-level signal fails - preventing automatic actuation of sump recirculation	3.9	[illegible]	3.5	[illegible]	2.8	[illegible]	[illegible]	[illegible]

Table 3.2-2 - AP1000 Risk Important Human Actions, Sorted by Basic Event ID											
Basic Event ID		Basic Event Description	Baseline PRA				Focused PRA				
			CDF		LRF		CDF		LRF		
			RAW (>3.0)	RRW (>1.1)	RAW (>3.0)	RRW (>1.1)	RAW (>2.0)	RRW (>1.05)	RAW (>2.0)	RRW (>1.05)	
19	RHN-MAN04	Failure to recognize the need and failure to isolate the RNS system, given rupture of the RNS piping when the plant is at hot/cold conditions	1.9	1.06	-	-	-	-	-	-	(1)
20	RHN-MAN05	Failure to recognize the need and failure to initiate gravity injection via RNS hot leg connection during shutdown events	3.1	-	-	-	-	-	-	-	
21	VLN-MAN01	Failure to recognize the need and failure to actuate the hydrogen control system, given core damage following a LOCA	-	-	2.2	1.00	1.1	-	-	1.00	(1)
22	na	Failure to close equipment hatch and personnel airlocks following core damage during shutdown event	-	-	na	-	-	-	-	-	(1)

Notes:

1. These human actions were added by the expert panel although they did not meet the RAW / RRW criteria. Refer to section 3.2 for the basis for adding these actions.

3.3 Risk-Important Human Actions for MTIS

The following is the approach used to identify the list of Maintenance, Test, Inspection, and Surveillance (MTIS) human activities for risk important SSCs. Identifying these MTIS related human activities is required by WCAP-14651 (reference 5.1). The output from this activity is a set of SSCs with defined human activities for use in the task analysis.

WCAP-14651 recommends starting with the D-RAP table from the DCD. Note that DCD D-RAP Table was created using PRA importance measures and an expert panel.

The process used to select the list of risk-significant SSC's and representative MTIS activities is:

1. The AP1000 DCD D-RAP Table (17.4-1) is used for the initial list of SSCs to be considered.
2. The addition of other components that may be risk important and have interfaces with the control room, but were not included in the D-RAP table, are considered. If any components are added, the reason is documented. It is recognized that there are some components that may have risk importance that are not in the D-RAP table because their only importance is to remain in their normal / initial position. Typically these components are screened out of the PRA quantification because of administrative controls and / or status indications. For example, there are several manual and motor-operated valves in this category. If these valves have control room interfaces (controls, position sensors / alarms, etc) they should be considered for this activity. The inservice tests in the DCD (Table 3.9-16) should also be reviewed to identify if other SSCs should be added to the list.
3. The combined list from items 1 and 2 above is shown in Table 3.3-1. The SSCs in this table are reviewed to determine if they require any control room support for their MTIS activities. SSCs that do not require such support should be eliminated from further consideration. This information is also captured in Table 3.3-1.
4. For the remaining SSCs, the MTIS activities that require operator support are identified, including planned / unplanned maintenance, inservice test, inservice inspection, and technical specification surveillance. Only activities that require support from the control room are considered. Note that testing that would be performed following planned maintenance is not listed in this table unless the testing involves different operator activities from those performed for IST or STAC. The following were reviewed:
   a. Inservice tests (DCD Table 3.9-16 and Table 3.9-17)
   b. Technical Specifications (DCD Section 16.1)
   c. Investment Protection Short-Term Availability Controls (DCD Table 16.3-2)
   d. PRA System Notebooks (PRA Chapters 8 - 28)
   e. System Specification Documents
5. The plant MODEs or conditions during which MTIS activity occurs are identified, including power operation, shutdown, refueling, etc. Generally these modes are identified in the DCD sections on Technical Specifications and the Investment Protection Short Term Availability Controls.
6. Document reference to MTIS requirement in SSD, DCD, PRA, and other documents.

7 For the SSCs selected, define the control room operator actions required to support the MTIS activity. Some examples are:

"Operator exercises the valve over full range using control room manual controls."

"Monitor valve travel between full open and full close positions."

"Verify correct valve alignment for normal operation."

"Verify that valve power is available."

"Switch operating mode from the primary to backup pump."

8 WCAP-14651 (Reference 5.1) indicates that "representative" MTIS activities should be identified. Where the same MTIS activity is repeated for different SSCs, one of those activities will be selected as "representative". Table 3.3-1, is also used to capture this information, including:

a. Component – components included in this evaluation.
b. Type – identifies type of component
   i. MOV – motor operated valve
   ii. AOV – air operated valve
   iii. Check – check valve
   iv. Squib – squib valve
   v. Pump 1 – electric motor driven pump
   vi. Pump 2 – electric motor driven pump with oil lube system
c. CR Interface – indicates (yes / no) if a component has a control room interface including start/stop, open/close, position or other.
d. D-RAP Table – indicates (yes / no) if a component is listed in DCD Table 17.4-1, "Risk-Significant SSCs Within the Scope of D-RAP". Each "no" must include a note that justifies why the component is being added to the table.
e. Operator Activity – lists operator activities associated with the component. Includes MTIS during all normal operating MODES.
f. Plant MODE – technical specification operating MODES:
   1 – power operation
   2 – low power
   3 – hot shutdown
   4 – safe shutdown
   5 – cold shutdown
   6 – refueling shutdown
g. Ref. – reference for the specific operator activity. Use the following abbreviations:
   TS – technical specifications, DCD section 16.1
   SSD – System Specification Document
   DCD – Design Control Document
   STAC – Short-Term Availability Controls, DCD section 16.3
h. Representative – indicates (yes / no) if the component MTIS activity is included in the "representative" list. If no, then the component MTIS activity that bounds it is listed.

9 WCAP-14651 (reference 5.1), indicates that "representative" MTIS activities should be identified. Where the same MTIS activity is repeated for different SSCs, one of those activities will be selected as "representative". Table 3.3-2 lists the "representative" MTIS activities which are screened from Table 3.3-1.

The MTIS activities were developed in accordance with the above guidance by AP100 system designers representing mechanical, electrical and I&C design. 12 SSCs were added to the D-RAP SSCs in accordance with Item 2 above. These SSCs include:

- CMT inlet MOVs (PXS-PL-V002A & -V002B)
- CMT outlet manual valves (PXS-PL-V013A & V013B)
- PRHR HX inlet MOV (PXS-PL-V027A & V027B)
- PRHR HX outlet manual valve (PXS-PL-V101)
- Accumulator outlet MOVs (PXS-PL-V109A/B)
- Containment Recirculation Block MOVs (PXS-PL-V117A & 117B)
- IRWST Line Isolation MOVs (PXS-PL-V121A & V121B)

After these tables were drafted, they were reviewed by a group of engineers representing the following technical areas:

Systems Design,
Plant Operations,
PRA,
HRA,
Severe Accidents,
Human System Interface Design,
Human Factors Engineering.

Tables 3.3-1 and 3.3-2 incorporate comments from these reviewers.

Table 3.3-2 lists the "representative" AP1000 MTIS related human actions. The human actions are listed alphabetically by basic event ID. Approximately 38 "representative" AP1000 MTIS related human actions are listed in this table.

Table 3.3-1 – Risk Significant Components With Control Room Interfaces for MTIS

Component	Tag Number(s)	Type	CR Interface	D-RAP Table	Operator Activity	Plant MODE	Reference	Representative [Bounded by Component / Operator activity]
System: Component Cooling Water (CCS)								
1. Component Cooling Water Pumps	CCS-MP-01A/B	Pump 1	Yes	Yes	a. Switch normally operating pump	1,2,3,4,5,6	CCS SSD	Yes
					b. Start second pump for plant shutdowns	3,4,5,6	STAC 2.3	Yes
System: Containment System (CNS)								
2. Containment Vessel	CNS-MV-01	Vessel	No (1)	Yes				
3. CVS Letdown Containment Isolation Valves	CVS-PL-V045, -047	AOV	Yes	Yes	a. Monitor normal valve position (closed)	1,2,3,4,5,6	CVS SSD	No
					b. Open valve to provide RCS letdown	1,2,3,4,5,6	CVS SSD	No
					c. Exercise valve for IST, monitoring position	5,6	DCD 3.9.6	No
					d. Containment isolation valve leak test	5,6	DCD 3.9.6	Yes
4. WLS Sump Discharge Containment Isolation Valves	WLS-PL-V055, -057	AOV	Yes	Yes	a. Monitor normal valve position (closed)	1,2,3,4,5,6	WLS SSD	No
					b. Open valve to empty containment sump	1,2,3,4,5,6	WLS SSD	No
					c. Exercise valve for IST, monitoring position	1,2,3,4,5,6	DCD 3.9.6	No
					d. Containment isolation valve leak test	5,6	DCD 3.9.6	No
5. Containment Purge Supply and Exhaust Containment Isolation Valves	VFS-PL-003, -004, -009, -010	AOV	Yes	Yes	a. Monitor normal valve position (closed)	1,2,3,4	TS 3.6.3	No
					b. Open valve for containment atmosphere control	1,2,3,4,5,6	VFS SSD	No
					c. Exercise valve for IST, monitoring position	1,2,3,4,5,6	DCD 3.9.6	No
					d. Containment isolation valve leak test	5,6	DCD 3.9.6	No
6. Hydrogen Igniters	VLS-EH-1 through -64	Igniters	Yes	Yes	a. Operate to perform required surveillance	6	STAC 2.8	Yes
System: Chemical and Volume Control System (CVS)								
7. Makeup Pumps	CVS-MP-01A/B	Pump 2	Yes	Yes	a. Align one pump designated for automatic makeup control	1,2,3,4,5,6	CVS SSD	Yes
8. Makeup Pump Suction and Discharge Check Valves	CVS-PL-V113, -V160A/B	Check	No (1)	Yes				
System: Diverse Actuation System (DAS)								
9. DAS automatic	DAS-JD-001, 0002	Cabinet	Yes	Yes	a. Perform channel check	1,2,3,4,5,6	STAC 1.1, 1.2	Yes
10. DAS manual	OCS-JC-020	Cabinet	Yes	Yes	a. Perform operational test	6	TS 3.3.5	No
11. Rod drive MG set breakers	PLS-MG-01A/B	Breaker	Yes	Yes	a. Open the MG set breakers and verify operation	6	STAC 1.1	Yes

Table 3.3-1 – Risk Significant Components With Control Room Interfaces for MTIS

Component	Tag Number(s)	Type	CR Interface	D-RAP Table	Operator Activity	Plant MODE	Reference	Representative [Bounded by Component / Operator activity]
12. Non-Class 1E dc and UPS power to DAS	EDS1-EA-1, 14	Panel	No (1)	Yes				
	EDS2-EA-1, 14	Panel	No (1)	Yes				
System: Maintac Power System (ECS)								
13. RCP switchgear	ECS-ES-31, 32, 41, 42, 51, 52, 61, 62	Breaker	Yes	Yes	a. Open RCP trip breakers and verify operation	6	TSs 3.3.1 and 3.3.2	Yes
14. Ancillary diesel generator	ECS-MS-01, 02	Misc	No (1)	Yes				
15. Medium voltage bus	ECS-ES-1, 2	Bus	Yes	Yes	None (7)			No
System: Main and Startup Feedwater System (FWS)								
16. Startup Feedwater Pumps	FWS-MP-03A/B	Pump 1	Yes	Yes	a. Start pumps for plant shutdown	3	FWS SSD	No
System: General I&C (4)								
17. Reactor trip instrumentation	Various	Instrumentation	Yes	Yes	a. Channel check	1,2,3,4,5	TS 3.3.1	Yes
					b. Compare heat balance to NI output	1,2	TS 3.3.1	Yes
					c. Compare incore detectors to axial difference	1,2	TS 3.3.1	Yes
					d. Calibrate excore channels	1,2	TS 3.3.1	Yes
					e. Perform TADOT for manual reactor trip	6	TS 3.3.1	Yes
					f. Perform RTCOT	1,2,3,4,5	TS 3.3.1	Yes
					g. Perform channel calibration	6	TS 3.3.1	Yes
					h. Verify RTS response time	6	TS 3.3.1	Yes
18. ESFAS instrumentation (Note 6)	Various	Instrumentation	Yes	Yes	a. Channel check	1,2,3,4,5,6	TS 3.3.2	No
					b. Perform actuation logic test	1,2,3,4,5,6	TS 3.3.2	Yes
					c. Perform TADOT	6	TS 3.3.2	No
					d. Perform channel calibration	6	TS 3.3.2	No
					e. Perform channel operational test	1,2,3,4,5,6		Yes
					f. Verify ESFAS response times	6	TS 3.3.2	Yes
					g. Perform actuation device test	6	TS 3.3.2	Yes
					h. Perform actuation test for squib valves	6	TS 3.3.2	Yes
System: Class 1E DC Power and Uninterruptible Power System (IDS)								
19. Class 1E Batteries	IDSA-DB-1A/B	Battery	Yes	Yes	a. Verify terminal voltage	1,2,3,4,5,6	TS 3.8.1	Yes
	IDSB-DB-1A/B				b. Verify battery float current	1,2,3,4,5,6	TS 3.8.7	Yes
	IDSC-DB-1A/B				c. Verify pilot cell voltage	1,2,3,4,5,6	TS 3.8.7	Yes
	IDSD-DB-1A/B				d. Capacity test (8)			No
20. Class 1E Battery Chargers	IDSA-DC-1	Charger	No (1)	Yes				
	IDSB-DC-1							
	IDSC-DC-1							

Table 3.3-1 – Risk Significant Components With Control Room Interfaces for MTIS

Component	Tag Number(s)	Type	CR Interface	D-RAP Table	Operator Activity	Plant MODE	Reference	Representative [Bounded by Component / Operator activity]
	IDSD-DC-1							
21. Class 1E Inverters	IDSA-DU-1	Inverter	No (1)	Yes				
	IDSB-DU-1							
	IDSC-DU-1							
	IDSD-DU-1							
22. Class 1E ac and dc distribution	IDSA-DF-1	Misc	No (1)	Yes				
	IDSB-DF-1							
	IDSC-DF-1							
	IDSD-DF-1							
	IDSA-DK-1							
	IDSB-DK-1							
	IDSC-DK-1							
	IDSD-DK-1							
	IDSA-DD-1							
	IDSB-DD-1							
	IDSC-DD-1							
	IDSD-DD-1							
	IDSA-EA-1, 2							
	IDSB-EA-1, 2, 3							
	IDSC-EA-1, 2, 3							
	IDSD-EA-1, 2							
System: Passive Containment Cooling System (PCS)								
23. Recirculation Pumps	PCS-MP-01A/B	Pump 1	Yes	Yes	a. Start pump for normal circulation operation	1,2,3,4,5,6	PCS SSD, STAC 2.5	No
24. PCCWST Drain Isolation Valves	PCS-PL-V001A/B/C	V001A/B (AOV), V001C (MOV)	Yes	Yes	a. Monitor normal valve position (closed)	1,2,3,4,5,6	TSs 3.6.6 and 3.6.7	No
					b. Exercise valve for IST, monitoring position	1,2,3,4,5,6	DCD 3.9.6	No
25. PCCWST Drain Series Isolation Valves	PCS-PL-V002A/B/C	MOV	Yes	No (3)	a. Monitor normal valve position (open)	1,2,3,4,5,6	TSs 3.6.6 and 3.6.7	No
					b. Close valve to allow IST of PCCWST discharge valve (5)	1,2,3,4,5,6	DCD 3.9.6	No
					c. Close valve to block PCCWST operation during PCS and containment shell maintenance	5,6	PCS SSD	No
System: Plant Control System (PLS)								
26. PLS actuation hardware	Various	Actuation circuits	Yes	Yes	None (9)			na

Table 3.3-1 – Risk Significant Components With Control Room Interfaces for MTIS								
Component	Tag Number(s)	Type	CR Interface	D-RAP Table	Operator Activity	Plant MODE	Reference	Representative [Bounded by Component / Operator activity]
System: Protection and Safety Monitoring System (PMS)								
27. Post Accident Monitoring Instrumentation	Various	Instrumentation	Yes	Yes	a. Channel check	1, 2, 3	TS 3.3.3	No
					b. Perform channel calibration	6	TS 3.3.3	No
28. Reactor trip breakers	PMS-JD-RTSA01/2 PMS-JD-RTSB01/2 PMS-JD-RTSC01/2 PMS-JD-RTSD01/2	Breaker	Yes	Yes	a. Perform TADOT	1,2,3,4,5	TS 3.3.1	No
System: Passive Core Cooling System (PXS)								
29. IRWST Vents	PXS-MY-abb	Vents	No (1)	Yes				
30. IRWST Screens	PXS-MY-Y01A/B	Screens	No (1)	Yes				
31. Containment Recirculation Screens	PXS-MY-Y02A/B	Screens	No (1)	Yes				
32. CMT Inlet Isolation Valves	PXS-PL-V002A/B	MOV	Yes	No (3)	a. Monitor normal valve position (open)	1,2,3,4,5	TSs 3.5.2 and 3.5.3	No
					b. Close valve to allow IST of CMT discharge valves (5)	1,2,3,4,5	TSs 3.5.2 and 3.5.3, DCD 3.9.6	No
					c. Close valve to block CMT operation during RCS drained maintenance or CMT maintenance	5,6	PXS SSD	No
33. CMT Discharge Isolation Valves	PXS-PL-V014A/B, PXS-PL-V015A/B	AOV	Yes	Yes	a. Monitor normal valve position (closed)	1,2,3,4,5	PXS SSD	Yes
					b. Exercise valve for IST, monitoring position	1,2,3,4,5	TSs 3.5.2 and 3.5.3, DCD 3.9.6	Yes
34. CMT Discharge Check Valves	PXS-PL-V016A/B, PXS-PL-V017A/B	Check	Yes (2)	Yes	a. Monitor normal valve position (open)		TSs 3.5.2 and 3.5.3	No
					b. Exercise valve for IST, monitoring position	1,2,3,4,5	DCD 3.9.6	No
35. CMT Discharge Manual Isolation Valve	PXS-V013A/B	Manual	Yes	No (3)	a. Monitor normal valve position (open)	1,2,3,4,5	TSs 3.5.2 and 3.5.3	No
					b. Close valve to isolate CMT during RCS drained maintenance or CMT maintenance	5,6	PXS SSD	No
36. Accumulator Discharge Isolation Valve	PXS-V027A/B	MOV	Yes	No (3)	a. Monitor normal valve position (open)	1,2,3,4	TS 3.5.1	No
					b. Monitor MCC power removed from valve operator	1,2,3,4	TS 3.5.1	Yes
					c. Restore power, close, and remove power to isolate accumulators during plant shutdown and perform reverse procedure on plant startup	3,4	PXS SSD	Yes
37. Accumulator Discharge Check Valves	PXS-PL-V028A/B, -V029A/B	Check	Yes	Yes	a. Monitor normal valve position (closed)	1,2,3,4,5,6	PXS SSD	No
					b. Exercise valve for IST, monitoring position	5,6	DCD 3.9.6	No

Table 3.3-1 – Risk Significant Components With Control Room Interfaces for MTIS								
Component	**Tag Number(s)**	**Type**	**CR Interface**	**D-RAP Table**	**Operator Activity**	**Plant MODE**	**Reference**	**Representative [Bounded by Component / Operator activity]**
38. PRHR Inlet Isolation Valve	PXS-PL-V101	MOV	Yes	No (3)	a. Monitor normal valve position (open)	1,2,3,4,5	TSs 3.5.4 and 3.5.5	No
					b. Monitor MCC power removed from valve operator	1,2,3,4,5	TSs 3.5.4 and 3.5.5	No
					c. Exercise valve for IST, monitoring position	5,6	DCD 3.9.6	No
					d. Close valve to allow IST of PRHR discharge valves (5)	1,2,3,4,5	TSs 3.5.4 and 3.5.5, DCD 3.9.6	No
					e. Close valve to isolate PRHR during PRHR maintenance	5,6	PXS SSD	No
39. PRHR Heat Exchanger Control Valves	PXS-PL-V108A/B	AOV	Yes	Yes	a. Monitor normal valve position (closed)	1,2,3,4,5	PXS SSD	No
					b. Exercise valve for IST, monitoring position	5,6	TSs 3.5.4 and 3.5.5	No
40. PRHR Discharge Manual Isolation Valve	PXS-V109	Manual	Yes	No (3)	a. Monitor normal valve position (open)	1,2,3,4,5	TSs 3.5.4 and 3.5.5	No
					b. Close valve to isolate PRHR during PRHR or PRHR discharge isolation valve maintenance	5,6	PXS SSD	No
41. Containment Recirculation Isolation Valves	PXS-PL-V118A/B, PXS-PL-V120A/B	Squib (4)	Yes	Yes	a. Monitor normal valve position (closed)	1,2,3,4,5,6	PXS SSD	No
					b. Perform position indication IST	5,6	DCD 3.9.6	Yes
					c. Exercise valve controls with booster assembly removed and perform continuity check after new booster assembly installed	5,6	TSs 3.5.6, 3.5.7, and 3.5.8, DCD 3.9.6	Yes
42. Containment Recirculation Block Valve	PXS-PL-V117A/B	MOV	Yes	No (3)	a. Monitor normal valve position (open)	1,2,3,4,5,6	TSs 3.5.6, 3.5.7, and 3.5.8	No
					b. Exercise valve for IST, monitoring position	1,2,3,4,5,6	TSs 3.5.6, 3.5.7, and 3.5.8, DCD 3.9.6	No
43. IRWST Injection Check Valves	PXS-PL-V122A/B, -V124A/B	Check	Yes(2)	Yes	a. Monitor normal valve position (closed)	1,2,3,4,5,6	PXS SSD	No
					b. Exercise valve for IST, monitoring position	6	TSs 3.5.6, 3.5.7, and 3.5.8, DCD 3.9.6	No
44. IRWST Injection Isolation Valves	PXS-PL-V123A/B, -V125A/B	Squib (4)	Yes	Yes	a. Monitor normal valve position (closed)	1,2,3,4,5,6	PXS SSD	No
					b. Perform position indication IST	5,6	DCD 3.9.6	No
					c. Exercise valve controls with booster assembly removed and perform continuity check after new booster assembly installed	5,6	TSs 3.5.6, 3.5.7, and 3.5.8, DCD 3.9.6	No
45. IRWST Line Isolation Valves	PXS-PL-V121A/B	MOV	Yes	No(3)	a. Monitor normal valve position (open)	1,2,3,4,5,6	TSs 3.5.6, 3.5.7, and 3.5.8	No

Table 3.3-1 – Risk Significant Components With Control Room Interfaces for MTIS								
Component	**Tag Number(s)**	**Type**	**CR Interface**	**D-RAP Table**	**Operator Activity**	**Plant MODE**	**Reference**	**Representative [Bounded by Component / Operator activity]**
					b. Monitor MCC power removed from valve operator	1,2,3,4,5,6	TSs 3.5.6, 3.5.7, and 3.5.8	No
					c. Restore power, close, and remove power to isolate accumulators during plant shutdown and perform reverse procedure on plant startup	5,6	PXS SSD	No
46. IRWST Gutter Bypass Isolation Valves	PXS-PL-V130A/B	AOV	Yes	Yes	a. Monitor normal valve position (open)	1,2,3,4,5	PXS SSD	No
					b.Exercise valve for IST, monitoring position	5,6	TSs 3.5.4 and 3.5.5, DCD 3.9.6	No
System: Reactor Coolant System (RCS)								
47. ADS Stage 1/2/3 Valves	RCS-PL-V001A/B, -V002A/B, -V003A/B, -V011A/B, -V012A/B, -V013A/B	MOV	Yes	Yes	a. Monitor normal valve position (closed)	1,2,3,4,5	PXS SSD	No
					b. Exercise valve for IST, monitoring position	5,6	TSs 3.4.11, 3.4.12, and 3.4.13, DCD 3.9.6	No
					c. Open valves to provide RCS venting during plant shutdown	5,6	TS 3.4.13	No
					d. Monitor normal valve position (open)	5,6	TS 3.4.13	No
48. ADS Stage 4 Valves	RCS-PL-V004A/B/C/D	Squib (4)	Yes	Yes	a. Monitor normal valve position (closed)	1.2.3.4.5,6	PXS SSD	No
					b. Perform position indication IST	5,6	DCD 3.9.6	No
					c. Exercise valve controls with booster assembly removed and perform continuity check after new booster assembly installed	5,6	TS 3.4.11, 3.4.12, and 3.4.13, DCD 3.9.6	No
49. ADS Stage 4 Isolation Valves	RCS-PL-014A/B/C/D	MOV	Yes	No (3)	a. Monitor normal valve position (open)	1,2,3,4,5,6	TS 3.4.11, 3.4.12, and 3.4.13	No
					b. Perform position indication IST	5,6	DCD 3.9.6	No
					c. Close valve to isolate RCS during ADS-4 valve maintenance and ADS-4 firing circuit continuity testing	5,6	RCS SSD	No
50. Pressurizer Safety Valves	RCS-PL-V005A/B	Safety Relief	Yes	Yes	a. Perform position indication IST	5,6	DCD 3.9.6	No
51. Reactor Vessel Insulation Water Inlet and Steam Vent Devices	RCS-MN-01	Vent	No (1)	Yes				

Table 3.3-1 – Risk Significant Components With Control Room Interfaces for MTIS								
Component	**Tag Number(s)**	**Type**	**CR Interface**	**D-RAP Table**	**Operator Activity**	**Plant MODE**	**Reference**	**Representative [Bounded by Component / Operator activity]**
52. Reactor Cavity Doorway Damper		Damper	No (1)	Yes				
53. Fuel Assemblies	157 core fuel assemblies (RXS-FA-xyy)	Fuel Assem-blies	Yes	Yes	a. Monitor power range excore NIs for AFD (delta-I, axial peaking) and QPTR (radial peaking)	1	PMS SSD, TSs 3.1.5, 3.1.6, and 3.2.4	Yes
					b. OPDMS core power distribution monitoring (kw/ft, Fndh, DNBR)	1	RXS and PLS SSD, TSs 3.2.1, 3.2.2, 3.2.3,	Yes
					c. Core peaking factors (OPDMS inoperable, Fq[z], Fndh)	1		Yes
					d. Monitor rod group alignment	1,2	RXS and PLS SSD, TSs 3.1.4 and 3.1.5	Yes
					e. Monitor reactor coolant chemistry and activity	1,2,3,4,5,6	RCS SSD, TS 3.4.10	Yes
System: Normal Residual Heat Removal System (RNS)								
54. Residual Heat Removal Pumps	RNS-MP-01A/B	Pump 1	Yes	Yes	a. Start pump for short-term availability control surveillance	1,2,3	RNS SSD, STAC 2.1	No
					b. Start pumps for normal shutdown cooling	4,5,6	RNS SSD, STAC 2.2	No
55. RNS Motor-Operated Valves	RNS-PL-V011, -V022, -V023, -V055	MOV	Yes	Yes	a. Monitor normal valve position (closed)	1,2,3,4,5,6	RNS SSD	No
					b. Position valves for normal shutdown cooling (10)	4,5,6	RNS SSD	No
					c. Exercise valve for IST, monitoring position (10)	1,2,3	TS 3.6.3, DCD 3.9.6	No
					d. Containment isolation leak test (10)	1,2,3	TS 3.6.3, DCD 3.9.6	No
56. RNS Check Valves	RNS-PL-V015A/B, -V007A/B	Stop Check, Check	No (1)	Yes				
57. RNS Check Valves	RNS-PL-V013, -V056	Check	No (1)	Yes				
System: Spent Fuel Cooling System (SFS)								
58. Spent Fuel Cooling Pumps	SFS-MP-01A/B	Pump 1	Yes	Yes	a. Switch normally operating pump	1,2,3,4,5	SFS SSD	No

Table 3.3-1 – Risk Significant Components With Control Room Interfaces for MTIS

Component	Tag Number(s)	Type	CR Interface	D-RAP Table	Operator Activity	Plant MODE	Reference	Representative [Bounded by Component / Operator activity]
System: Steam Generator System (SGS)								
59. Main Steam Safety Valves	SGS-PL-V030A/B, -V031A/B, -V032A/B, -V033A/B, -V034A/B, -V035A/B	Safety Valve	Yes	Yes	a. Perform valve position IST	5,6	DCD 3.9.6	No
60. Main Steam and Feedwater Isolation Valves	SGS-PL-V040A/B, -V057A/B	PHV, AOV	Yes	Yes	a. Monitor valve position (open)	1,2,3,4	SGS SSD	No
					b. Exercise valve part closed for IST, monitoring position	1,2,3,4,5,6	TS 3.7.2 and 3.7.3	Yes
System: Service Water System (SWS)								
61. Service Water Pumps and Cooling Tower Fans	SWS-MP-01A/B, SWS-MA-01A/B	Pump, Fans	Yes	Yes	a. Switch normally operating pump	1,2,3	SWS SSD	No
					b. Start second pump for plant shutdowns	3,4,5,6	STAC 2.4	No
System: Nuclear Island Nonradioactive Ventilation System (VBS)								
62. VBS MCR and I&C Rooms B/C Ancillary Fans	VBS-MA-10A/B, -11, -12	Fans	Yes	Yes	a. Start pump for STAC surveillance	1,2,3,4,5,6	VBS SSD, STAC 2.6 and 2.7	No
System: Chilled Water System (VWS)								
63. Air Cooled Chillers and Pumps	VWS-MS-02, -03, VWS-MP-02, -03	Chillers, Pumps	Yes	Yes	a. Switch normally operating pump and chiller	1,2,3,4,5,6	VWS SSD	No
System: Onsite Standby Power System (ZOS)								
64. Diesel/Generator Package	ZOS-MS-05A/B	Misc	Yes	Yes	a. Start DG for short term availability control	1,2,3,4,5,6	STAC 3.1, 3.2	Yes
65. Engine room exhaust fans	VZS-MY-V01A/B, VZS-MY-V02A/B	Fan	Yes	Yes	a. Verify fans start upon diesel generator start	1,2,3,4,5,6	STAC 3.1, 3.2	Yes

Notes:

1) These components are in D-RAP Table 17.4-1. However, they are removed from further consideration because they have no control room interface.
2) These check valves have remote position indication in the control room. Since these valves are exercise tested during refueling outages they are retained in this table.
3) These valves are not in D-RAP Table 17.4-1 because they are not required/expected to have to change position during an accident. They have been added to this table because their normal position is important to the PRA; mis-positioning of these valves is not modeled in the PRA because of the features provided to monitor and alarm their position.
4) The only control room interfaces are valve open controls and valve open sensors. The valve will not be stroked for IST or any other non-accident reason. The valves are retained in this evaluation because of IST which will disable the valve; IST is performed in accordance with the technical specifications during MODE 5 and 6 when not all of the valves are required to be operable.
5) The CMT and PRHR inlet MOVs and discharge AOVs are used in a coordinated fashion during IST; the inlet is first closed, then the discharge AOVs are cycled open / closed and finally the inlet MOV is opened. A similar approach is used for PCS IST by individually closing the normally-open upstream isolation valve in each drain path to allow IST of the normally-closed downstream actuation valve.
6) Low Pressure/DP Sensors: IRWST level sensors (PXS-045, -046, -047, 048); High Pressure/DP Sensors: RCS Hot Leg Level (RCS-160A/B), Pressurizer Pressure (RCS-191A/B/C/D), Pressurizer Level (RCS-195A/B/C/D), SG Narrow-Range Level (SGS-001, -002, -003, -004, -005, -006, -007, -008), SG Wide-Range Level (SGS-011, -012, -013, -014, -015, -016, -017, -018), 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-05A/B, -056A/B); CMT+- Level Sensors (PXS-011A/B/C/D, -012A/B/C/D, -013A/B/C/D, -014A/B/C/D)
7) Buses ECS-ES-1 and ECS-ES-2 are continuously used during normal operation. No additional surveillance or testing is needed.
8) Capacity testing of batteries is done with spare battery supplying plant needs and the battery when test offline. The capacity test does not require control room interface.

9) The PLS system is continuously used during normal operation. No additional surveillance or testing is needed for common cause failure of the system.
10) For components #55 (RNS MOVs), the operator activities b, c, and d do not apply to MOV RNS-PL-V055.

Table 3.3-2 – Representative MTIS Activities for Risk Significant Components

Component	Tag Number(s)	Type	CR Interface	Operator Activity	Plant MODE	Reference
1. Component Cooling Water Pumps	CCS-MP-01A/B	Pump 1	Yes	a. Switch normally operating pump	1,2,3,4,5,6	CCS SSD
				b. Start second pump for plant shutdowns	3,4,5,6	STAC 2.3
3. CVS Letdown Containment Isolation Valves	CVS-PL-V045, -047	AOV	Yes	d. Containment isolation valve leak test	5,6	DCD 3.9.6
6. Hydrogen Igniters	VLS-EH-1 through -64	Igniters	Yes	a. Operate to perform required surveillance	6	STAC 2.8
7. Makeup Pumps	CVS-MP-01A/B	Pump 2	Yes	a. Align one pump designated for automatic makeup control	1,2,3,4,5,6	CVS SSD
9. DAS automatic	DAS-JD-001, 0002	Cabinet	Yes	a. Perform channel check	1,2,3,4,5,6	STAC 1.1, 1.2
11. Rod drive MG set breakers	PLS-MG-01A/B	Breaker	yes	a. Open the MG set breakers and verify operation	6	STAC 1.1
13. RCP switchgear	ECS-ES-31, 32, 41, 42, 51, 52, 61, 62	Breaker	yes	a. Open RCP trip breakers and verify operation	6	TSs 3.3.1 and 3.3.2
17. Reactor trip instrumentation	Various	Instrumentation	yes	a. Channel check	1,2,3,4,5	TS 3.3.1
				b. Compare heat balance to NI output	1,2	TS 3.3.1
				c. Compare incore detectors to axial difference	1,2	TS 3.3.1
				d. Calibrate excore channels	1,2	TS 3.3.1
				e. Perform TADOT for manual reactor trip	6	TS 3.3.1
				f. Perform RTCOT	1,2,3,4,5	TS 3.3.1
				g. Perform channel calibration	6	TS 3.3.1
				h. Verify RTS response time	6	TS 3.3.1
18. ESFAS instrumentation	Various	Instrumentation	yes	b. Perform actuation logic test	1,2,3,4,5,6	TS 3.3.2
				e. Perform channel operational test	1,2,3,4,5,6	
				f. Verify ESFAS response times	6	TS 3.3.2
				g. Perform actuation device test	6	TS 3.3.2
				h. Perform actuation test for squib valves	6	TS 3.3.2
19. Class 1E Batteries	IDSA-DB-1A/B IDSB-DB-1A/B IDSB-DB-2A/B IDSC-DB-1A/B IDSC-DB-2A/B IDSD-DB-1A/B IDSS-DB-1A/B	Battery	yes	a. Verify terminal voltage	1,2,3,4,5,6	TS 3.8.1
				b. Verify battery float current	1,2,3,4,5,6	TS 3.8.7
				c. Verify pilot cell voltage	1,2,3,4,5,6	TS 3.8.7
33. CMT Discharge Isolation Valves	PXS-PL-V014A/B, PXS-PL-V015A/B	AOV	Yes	a. Monitor normal position (closed)	1,2,3,4,5	PXS SSD
				b. Exercise valve for IST, monitoring position	1,2,3,4,5	TSs 3.5.2 and 3.5.3, DCD 3.9.6

Table 3.3-2 – Representative MTIS Activities for Risk Significant Components

Component	Tag Number(s)	Type	CR Interface	Operator Activity	Plant MODE	Reference
36. Accumulator Discharge Isolation Valve	PXS-V027A/B	MOV	Yes	b. Monitor MCC power removed from valve operator	1,2,3,4	TS 3.5.1
				c. Restore power, close, and remove power to isolate accumulators during plant shutdown and perform reverse procedure on plant startup	3,4	PXS SSD
41. Containment Recirculation Isolation Valves	PXS-PL-V118A/B, PXS-PL-V120A/B	Squib (4)	Yes	b. Perform position indication IST	5,6	DCD 3.9.6
				c. Exercise valve controls with booster assembly removed and perform continuity check after new booster assembly installed	5,6	TSs 3.5.6, 3.5.7, and 3.5.8, DCD 3.9.6
53. Fuel Assemblies	157 core fuel assemblies (RXS-FA-xyy)	Fuel Assem-blies	Yes	a. Monitor power range excore NIs for AFD (delta-I, axial peaking) and QPTR (radial peaking)	1	PMS SSD, TSs 3.1.5, 3.1.6, and 3.2.4
				b. OPDMS core power distribution monitoring (kw/ft, Fndh, DNBR)	1	RXS and PLS SSD, TSs 3.2.1, 3.2.2, 3.2.3,
				c. Core peaking factors (OPDMS inoperable, Fq[z], Fndh)	1	
				d. Monitor rod group alignment	1,2	RXS and PLS SSD, TSs 3.1.4 and 3.1.5
				e. Monitor reactor coolant chemistry and activity	1,2,3,4,5,6	RCS SSD, TS 3.4.10
60. Main Steam and Feedwater Isolation Valves	SGS-PL-V040A/B, -V057A/B	PHV, AOV	Yes	b. Exercise valve part closed for IST, monitoring position	1,2,3,4,5,6	TS 3.7.2 and 3.7.3
64. Diesel/Generator Package	ZOS-MS-05A/B	Misc	yes	a. Start DG for short term availability control	1,2,3,4,5,6	STAC 3.1, 3.2
65. Engine room exhaust fans	VZS-MY-V01A/B	Fan	yes	a. Verify fans start upon diesel generator start	1,2,3,4,5,6	STAC 3.1, 3.2

4.0 Summary of Results

No "critical" human actions have been identified for the AP1000. A total of 22 post-accident risk-important human actions have been identified for the AP1000.

5.0 References

5.1 WCAP-14651, Revision 2, "Integration of Human Reliability Analysis with Human Factors Engineering Design Implementation Plan"

5.2 Letter LTR-RRA-04-47, Revision 0, 5/25/04, "AP1000 PRA Operator Action Importance Measures".

5.2 Calc note PRA-GSC-231, Revision 2, "Human Reliability Analysis for Revision 7 of the AP600 PRA"

5.3 AP1000 Design Control Document, APP-GW-GL-700, Revision 15

5.4 AP1000 Probabilistic Risk Assessment, APP-GW-GL-022, Revision 8

Attachment A – RAW / RRW Values Reviewed By Expert Panel

Table	PRA	Initial Condition	Events	Damage Basis	Risk Measure
A-1	Base	At-power	Internal	CDF	RAW
A-2	Base	At-power	Internal	CDF	RRW
A-3	Base	At-power	Internal	LRF	RAW
A-4	Base	At-power	Internal	LRF	RRW
A-5	Base	At-power	Fire	CDF	RAW
A-6	Base	At-power	Fire	CDF	RRW
A-7	Base	Shutdown	Internal	CDF	RAW
A-8	Base	Shutdown	Internal	CDF	RRW
A-9	Focused	At-power	Internal	CDF	RAW
A-10	Focused	At-power	Internal	CDF	RRW
A-11	Focused	At-power	Internal	LRF	RAW
A-12	Focused	At-power	Internal	LRF	RRW
A-13	Focused	Shutdown	Internal	CDF	RAW
A-14	Focused	Shutdown	Internal	CDF	RRW

Table A-1: Baseline PRA, At Power Internal Events CDF, RAW

Capture criteria is RAW ≥ 3.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. CDF
73	CIB-MAN00	Failure to diagnose a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.84E-03	6.84E+00	1.53E-06
93	ADN-MAN01	Failure to actuate the ADS for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	3.02E-03	4.25E+00	1.02E-06
95	REN-MAN04	Failure to recognize the need and failure to open the recirculation valves during a loss-of-coolant accident or transient, if the IRWST low-level signal fails, preventing automatic actuation on sump recirculation	Procedure - LONG Tw = 60 min Ta = 1 min Stress level - HIGH	1.00E-02	3.89E+00	9.37E-07
103	CIB-MAN01	Failure to close main steam isolation valve to isolate the faulted steam generator, given a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.34E-03	3.30E+00	7.95E-07
105	LPM-MAN02	Failure to recognize the need for RCS depressurization during a medium LOCA	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	3.30E-03	2.89E+00	6.96E-07
113	LPM-MAN01	Failure to recognize the need for RCS depressurization during a small LOCA or loss of high-pressure heat removal system	Procedure - LONG Tw = 30 min Ta = 15 min Stress level – HIGH	1.34E-03	2.28E+00	5.49E-07
117	CVN-MAN00	Failure to align the CVS in the auxiliary spray mode following a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 10 min Stress level - HIGH	3.10E-03	2.11E+00	5.09E-07
129	OTH-SDMAN	Failure to perform a controlled shutdown of the reactor during an accident	Procedure - LONG Tw = 1 hour Ta = 5 min Stress level - HIGH	7.70E-04	1.85E+00	4.46E-07

Table A-1: Baseline PRA, At Power Internal Events CDF, RAW

Capture criteria is RAW ≥ 3.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. CDF
135	RHN-MAN01	Failure to recognize the need and failure to align the NRHR system after ADS actuation, during a LOCA, LOOP, or transient in the reactor coolant system cooling mode	Procedure - LONG Tw = 20 min Ta = 15 min Stress level – HIGH	2.90E-03	1.77E+00	4.27E-07
174	REC-MANDAS	Failure to detect the need to perform an activity by using the cues provided by diverse actuation system, or the probability to perform an activity by using the controls that are DAS related	N/A	1.16E-02	1.65E+00	3.98E-07
180	ATW-MAN05	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in seven minutes, given ATWS	Procedure - SHORT Tw = 7 min Ta = 30 sec Stress level - HIGH	5.20E-03	1.57E+00	3.78E-07
208	ATW-MAN03	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in one minute, given ATWS	Procedure - SHORT Tw = 1 min Ta = 30 sec Stress level - HIGH	5.20E-02	1.28E+00	3.08E-07
313	VWN-MAN01	Failure to recognize the need and failure to align the standby chiller during a LOCA	Procedure - LONG Tw = 1 hr Ta = 30 min Stress level – HIGH	5.16E-03	1.04E+00	2.51E-07
321	REC-MANDASC	Conditional probability of REC-MANDAS	N/A	5.06E-01	1.03E+00	2.48E-07
363	DUMP-MAN01	Failure to adjust steam dump valves, given a steam generator tube rupture with success in isolating faulted steam generator	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.32E-03	1.02E+00	2.46E-07
383	CVN-MAN03	Failure to recognize the need and failure to start the CVS pump B, if pump A fails to start automatically during any accident condition that requires CVS makeup	Procedure - SHORT Tw = 30 min Ta = 10 min Stress level - HIGH	1.07E-03	1.02E+00	2.46E-07
411	ATW-MAN04C	Conditional probability of ATW-MAN04	N/A	5.26E-01	1.01E+00	2.43E-07
428	HPM-MAN01	Failure to recognize the need for high pressure decay heat removal following a loss of main feedwater, during an accident	Procedure - LONG Tw = 30 min Ta = 10 min Stress level - MODERATE	5.02E-04	1.01E+00	2.43E-07

Table A-1: Baseline PRA, At Power Internal Events CDF, RAW

Capture criteria is RAW ≥ 3.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. CDF
432	PRI-MAN01	Failure to recognize the need and failure to isolate a failed heat exchanger following PRHR tube rupture before ADS actuation	Procedure - LONG Tw = 35 min Ta = 10 min Stress level – MODERATE	4.96E-04	1.01E+00	2.43E-07
433	REG-MAN00	Failure to regulate the startup feedwater following full opening of the regulating valves after a loss of compressed air	Procedure - SHORT Tw = 50 min Ta = 30 min Stress level – HIGH	2.04E-01	1.01E+00	2.43E-07
434	ADN-MAN01C	Conditional probability of ADN-MAN01	N/A	5.00E-01	1.01E+00	2.43E-07
446	LPM-MAN01C	Conditional probability of LPM-MAN01	N/A	5.00E-01	1.01E+00	2.43E-07
452	SWN-MAN03	Failure to recognize the need and failure to refill the service water basin during a loss-of-offsite power event with subsequent loss of automatic refill capability through the raw water system	Procedure - SHORT Tw = 30 min Ta = 5 min Stress level - HIGH	4.00E-02	1.01E+00	2.43E-07
463	ADF-MAN01	Failure to depressurize the RCS to refill the pressurizer using the first stage ADS valves, given failure of aux. spray during SGTR	N/A	5.00E-01	1.00E+00	2.41E-07
488	ATW-MAN06C	Conditional probability of ATW-MAN06	N/A	5.00E-01	1.00E+00	2.41E-07
522	ATW-MAN04	Failure to manually trip the reactor (through the DAS) in one minute, given ATWS	Procedure - SHORT Tw = 1 min Ta = 40 sec Stress level - HIGH	5.20E-02	1.00E+00	2.41E-07
580	ATW-MAN01C	Conditional probability of ATW-MAN01	N/A	5.17E-01	1.00E+00	2.41E-07
581	ATW-MAN01	Failure to initiate step-in of control rods in one minute, given manual scram failure during ATWS	Procedure - SHORT Tw = 1 min Ta = 1 min Stress level - HIGH	3.30E-02	1.00E+00	2.41E-07
583	CVN-MAN02	Failure to align the CVS in the boration mode following an ATWS	Procedure - SHORT Tw = 60 min Ta = 30 min Stress level - HIGH	1.58E-03	1.00E+00	2.41E-07

Table A-1: Baseline PRA, At Power Internal Events CDF, RAW

Capture criteria is RAW ≥ 3.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. CDF
594	ATW-MAN06	Failure to manually trip the reactor (through the DAS) in seven minutes, given ATWS	Procedure - SHORT Tw = 7 min Ta = 40 sec Stress level - HIGH	5.20E-03	1.00E+00	2.41E-07

Table A-2: Baseline PRA, At Power Internal Events CDF, RRW

Capture criteria is RRW ≥ 1.1

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RRW	RESULT. CDF
17	REC-MANDASC	Conditional probability of REC-MANDAS	N/A	5.06E-01	1.03E+00	2.34E-07
19	REN-MAN04	Failure to recognize the need and failure to open the recirculation valves during a loss-of-coolant accident or transient, if the IRWST low-level signal fails - preventing automatic actuation of sump recirculation	Procedure - LONG Tw = 60 min Ta > 1 min Stress level - HIGH	1.00E-02	1.03E+00	2.34E-07
29	ATW-MAN03	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in one minute, given ATWS	Procedure - SHORT Tw = 1 min Ta = 30 sec Stress level - HIGH	5.20E-02	1.02E+00	2.36E-07
31	ATW-MAN04C	Conditional probability of ATW-MAN04	N/A	5.26E-01	1.02E+00	2.36E-07
42	CIB-MAN00	Failure to diagnose a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.84E-03	1.01E+00	2.39E-07
43	ADN-MAN01	Failure to actuate the ADS for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	3.02E-03	1.01E+00	2.39E-07
48	ADN-MAN01C	Conditional probability of ATW-MAN01	N/A	5.00E-01	1.01E+00	2.39E-07
52	REC-MANDAS	Failure to detect the need to perform an activity by using the cues provided by diverse actuation system, or the probability to perform an activity by using the controls that are DAS related	N/A	1.16E-02	1.01E+00	2.39E-07
64	LPM-MAN01C	Conditional probability of LPM-MAN01	N/A	5.00E-01	1.01E+00	2.39E-07
65	LPM-MAN02	Failure to recognize the need for RCS depressurization during a medium LOCA	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	3.30E-03	1.01E+00	2.39E-07
71	ADF-MAN01	Failure to depressurize the RCS to refill the pressurizer using the first stage ADS valves, given failure of aux. spray during SGTR	N/A	5.00E-01	1.00E+00	2.41E-07
80	CVN-MAN00	Failure to align the CVS in the auxiliary spray mode following a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 10 min	3.10E-03	1.00E+00	2.41E-07

Table A-2: Baseline PRA, At Power Internal Events CDF, RRW

Capture criteria is RRW ≥ 1.1

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RRW	RESULT. CDF
			Stress level - HIGH			
83	CIB-MAN01	Failure to close main steam isolation valve to isolate the faulted steam generator, given a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 15 min Stress level – HIGH	1.34E-03	1.00E+00	2.41E-07
85	ATW-MAN05	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in seven minutes, given ATWS	Procedure - SHORT Tw = 7 min Ta = 30 sec Stress level – HIGH	5.20E-03	1.00E+00	2.41E-07
86	ATW-MAN06C	Conditional probability of ATW-MAN06	N/A	5.00E-01	1.00E+00	2.41E-07
93	RHN-MAN01	Failure to recognize the need and failure to align the NRHR system after ADS actuation, during a LOCA, LOOP, or transient in the reactor coolant system cooling mode	Procedure - LONG Tw = 20 min Ta = 15 min Stress level – HIGH	2.90E-03	1.00E+00	2.41E-07
94	REG-MAN00	Failure to regulate the startup feedwater following full opening of the regulating valves after a loss of compressed air	Procedure - SHORT Tw = 50 min Ta = 30 min Stress level – HIGH	2.04E-01	1.00E+00	2.41E-07
102	LPM-MAN01	Failure to recognize the need for RCS depressurization during a small LOCA or loss of high-pressure heat removal system	Procedure - LONG Tw = 30 min Ta = 15 min Stress level – HIGH	1.34E-03	1.00E+00	2.41E-07
129	OTH-SDMAN	Failure to perform a controlled shutdown of the reactor during an accident	Procedure - LONG Tw = 1 hour Ta = 5 min Stress level - HIGH	7.70E-04	1.00E+00	2.41E-07
170	SWN-MAN03	Failure to recognize the need and failure to refill the service water basin during a loss-of-offsite power event with subsequent loss of automatic refill capability through the raw water system	Procedure - SHORT Tw = 30 min Ta = 5 min Stress level - HIGH	4.00E-02	1.00E+00	2.41E-07
177	VWN-MAN01	Failure to recognize the need and failure to align the standby chiller during a LOCA	Procedure - LONG Tw = 1 hr Ta = 30 min Stress level – HIGH	5.16E-03	1.00E+00	2.41E-07
198	ATW-MAN01C	Conditional probability of ATW-MAN01	N/A	5.17E-01	1.00E+00	2.41E-07

Table A-2: Baseline PRA, At Power Internal Events CDF, RRW

Capture criteria is RRW ≥ 1.1

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RRW	RESULT. CDF
261	ATW-MAN04	Failure to manually trip the reactor (through the DAS) in one minute, given ATWS	Procedure - SHORT Tw = 1 min Ta = 40 sec Stress level - HIGH	5.20E-02	1.00E+00	2.41E-07
323	DUMP-MAN01	Failure to adjust steam dump valves, given a steam generator tube rupture with success in isolating faulted steam generator	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.32E-03	1.00E+00	2.41E-07
356	CVN-MAN03	Failure to recognize the need and failure to start the CVS pump B, if pump A fails to start automatically during any accident condition that requires CVS makeup	Procedure - SHORT Tw = 30 min Ta = 10 min Stress level - HIGH	1.07E-03	1.00E+00	2.41E-07
431	HPM-MAN01	Failure to adjust steam dump valves, given a steam generator tube rupture with success in isolating faulted steam generator	Procedure - LONG Tw = 30 min Ta = 10 min Stress level - MODERATE	5.02E-04	1.00E+00	2.41E-07
434	PRI-MAN01	Failure to recognize the need and failure to isolate a failed heat exchanger following PRHR tube rupture before ADS actuation	Procedure - LONG Tw = 35 min Ta = 10 min Stress level – MODERATE	4.96E-04	1.00E+00	2.41E-07
475	ATW-MAN01	Failure to initiate step-in of control rods in one minute, given manual scram failure during ATWS	Procedure - SHORT Tw = 1 min Ta = 1 min Stress level - HIGH	3.30E-02	1.00E+00	2.41E-07
582	CVN-MAN02	Failure to align the CVS in the boration mode following an ATWS	Procedure - SHORT Tw = 60 min Ta = 30 min Stress level - HIGH	1.58E-03	1.00E+00	2.41E-07
599	ATW-MAN06	Failure to manually trip the reactor (through the DAS) in seven minutes, given ATWS	Procedure - SHORT Tw = 7 min Ta = 40 sec Stress level - HIGH	5.20E-03	1.00E+00	2.41E-07

Table A-3: Baseline PRA, At Power Internal Events LRF, RAW

Capture criteria is RAW ≥ 3.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. LRF
60	GIB-MAN00	Failure to diagnose a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.84E-03	1.10E+01	2.15E-07
71	REC-MANDAS	Failure to detect the need to perform an activity by using the cues provided by diverse actuation system, or the probability to perform an activity by using the controls that are DAS related	N/A	1.16E-02	8.81E+00	1.72E-07
72	REN-MAN03	Failure to recognize the need and failure to open recirculation valves to flood reactor cavity after core damage	Procedure - LONG Tw = 20 min Ta = 10 min Stress level - HIGH	3.40E-03	8.38E+00	1.63E-07
74	ATW-MAN05	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in seven minutes given ATWS	Procedure - SHORT Tw = 7 min Ta = 30 sec Stress level - HIGH	5.20E-03	8.11E+00	1.58E-07
81	GIB-MAN01	Failure to close main steam isolation valve to isolate the faulted steam generator given a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.34E-03	6.85E+00	1.34E-07
86	LPM-MAN01	Failure to recognize the need for RCS depressurization during a small LOCA or loss of high pressure heat removal system	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.34E-03	5.21E+00	1.02E-07
88	ADN-MAN01	Failure to actuate the ADS for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation	Procedure - LONG Tw = 15 min Ta = 8 min Stress level - HIGH	3.02E-03	4.90E+00	9.56E-08
90	ATW-MAN03	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in one minute given ATWS	Procedure - SHORT Tw = 1 min Ta = 30 sec Stress level - HIGH	5.20E-02	4.21E+00	8.21E-08

Table A-3: Baseline PRA, At Power Internal Events LRF, RAW

Capture criteria is RAW ≥ 3.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. LRF
94	LREN-MAN04	Failure to recognize the need and failure to open the RHR recirculation valves during a loss-of-coolant accident or transient if the IRWST low-level signal fails, preventing automatic actuation of sump recirculation	Procedure - LONG Tw = 60 min Ta = 14 min Stress level - HIGH	1.00E-02	3.53E+00	6.88E-08
111	CVN-MAN00	Failure to align the CVS in the auxiliary spray mode following a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 10 min Stress level - HIGH	3.10E-03	2.57E+00	5.01E-08
120	RHN-MAN01	Failure to recognize the need and failure to align the NRHR system after ADS actuation, during a LOCA, LOOP, or transient in the reactor coolant system cooling mode	Procedure - LONG Tw = 20 min Ta = 15 min Stress level – HIGH	2.90E-03	2.34E+00	4.56E-08
133	VEN-MAN01	Failure to recognize the need and failure to actuate the hydrogen control system, given core damage following a LOCA	Procedure - LONG Tw = 15 min Ta = 10 min Stress level - HIGH	1.28E-03	2.15E+00	4.19E-08
175	LPM-MAN02	Failure to recognize the need for RCS depressurization during a medium LOCA	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	3.30E-03	1.62E+00	3.16E-08
180	OTH-SDMAN	Failure to perform a controlled shutdown of the reactor during an accident	Procedure - LONG Tw = 1 hour Ta = 5 min Stress level - HIGH	7.70E-04	1.58E+00	3.08E-08
235	LPM-REC01	Failure to recognize the need for RCS depressurization during a small LOCA or transient with the loss of the PRHR and CMT success after core damage	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	5.00E-02	1.23E+00	2.40E-08
236	ADN-REC01	Failure to complete ADS actuation for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation after core damage	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	5.00E-02	1.23E+00	2.40E-08

Table A-3: Baseline PRA, At Power Internal Events LRF, RAW

Capture criteria is RAW ≥ 3.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. LRF
237	DUMP-MAN01	Failure to adjust steam dump valves, given a steam generator tube rupture with success in isolating faulted steam generator	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.32E-03	1.22E+00	2.38E-08
253	PDS6-MANADS	Failure to perform ADS as recovery from failure of automatic actuation or manual actuation in later phases of SGTR event	N/A	1.00E-01	1.18E+00	2.30E-08
258	ATW-MAN04C	Conditional probability of ATW-MAN04	N/A	5.26E-01	1.15E+00	2.24E-08
289	REC-MANDASC	Conditional probability of REC-MANDAS	N/A	5.06E-01	1.06E+00	2.07E-08
303	SWN-MAN03	Failure to recognize the need and failure to refill the service water basin during a loss-of-offsite power event with subsequent loss of automatic refill capability through the raw water system	Procedure - SHORT Tw = 30 min Ta = 5 min Stress level - HIGH	4.00E-02	1.04E+00	2.03E-08
326	ATW-MAN06C	Conditional probability of ATW-MAN06	N/A	5.00E-01	1.04E+00	2.03E-08
337	VWN-MAN01	Failure to recognize the need and failure to align the standby chiller during a LOCA	Procedure - LONG Tw = 1 hr Ta = 30 min Stress level – HIGH	5.16E-03	1.03E+00	2.01E-08
373	CVN-MAN03	Failure to recognize the need and failure to start the CVS pump B, if pump A fails to start automatically during any accident condition that requires CVS makeup	Procedure - SHORT Tw = 30 min Ta = 10 min Stress level - HIGH	1.07E-03	1.02E+00	1.99E-08
381	ADN-MAN01C	Conditional probability of ADN-MAN01	N/A	5.00E-01	1.01E+00	1.97E-08
385	CIC-MAN01	Failure to recognize the need and failure to isolate the containment, given core damage following an accident	Procedure - LONG Tw = 1 hr Ta = 30 min Stress level - HIGH	5.71E-03	1.01E+00	1.97E-08
395	LPM-MAN01C	Conditional probability of LPM-MAN01	N/A	5.00E-01	1.01E+00	1.97E-08

Table A-3: Baseline PRA, At Power Internal Events LRF, RAW

Capture criteria is RAW ≥ 3.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. LRF
400	REG-MAN00	Failure to regulate the startup feedwater following full opening of the regulating valves after a loss of compressed air	Procedure - SHORT Tw = 50 min Ta = 30 min Stress level – HIGH	2.04E-01	1.01E+00	1.97E-08
401	ADF-MAN01	Failure to depressurize the RCS to refill the pressurizer using the first stage ADS valves, given failure of aux. spray during SGTR	N/A	5.00E-01	1.01E+00	1.97E-08
445	REN-MAN02	Failure to recognize the need and failure to open the recirculation valves for IRWST low-low level, during a LOCA or transient	Procedure - LONG Tw > 60 min Ta = 10 min Stress level - HIGH	1.99E-03	1.00E+00	1.95E-08
462	ATW-MAN04	Failure to manually trip the reactor (through the DAS) in one minute, given ATWS	Procedure - SHORT Tw = 1 min Ta = 40 sec Stress level - HIGH	5.20E-02	1.00E+00	1.95E-08
493	CVN-MAN02	Failure to align the CVS in the boration mode following an ATWS	Procedure - SHORT Tw = 60 min Ta = 30 min Stress level - HIGH	1.58E-03	1.00E+00	1.95E-08
514	ATW-MAN06	Failure to manually trip the reactor (through the DAS) in seven minutes, given ATWS	Procedure - SHORT Tw = 7 min Ta = 40 sec Stress level - HIGH	5.20E-03	1.00E+00	1.95E-08
525	ATW-MAN01C	Conditional probability of ATW-MAN01	N/A	5.17E-01	1.00E+00	1.95E-08
528	ATW-MAN01	Failure to initiate step-in of control rods in one minute, given manual scram failure during ATWS	Procedure - SHORT Tw = 1 min Ta = 1 min Stress level - HIGH	3.30E-02	1.00E+00	1.95E-08
529	REC-MANDAS1	Conditional Probability of REC-MANDAS	N/A	1.00E+00	1.00E+00	1.95E-08

Table A-4: Baseline PRA, At Power Internal Events LRF, RRW

Capture criteria is RRW ≥ 1.1

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RRW	RESULT. LRF
8	ATW-MAN03	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in one minute, given ATWS	Procedure - SHORT Tw = 1 min Ta = 30 sec Stress level - HIGH	5.20E-02	1.21E+00	1.61E-08
4	ATW-MAN04C	Conditional probability of ATW-MAN04	N/A	5.26E-01	1.21E+00	1.61E-08
12	REC-MANDAS	Failure to detect the need to perform an activity by using the cues provided by diverse actuation system, or the probability to perform an activity by using the controls that are DAS related	N/A	1.16E-02	1.10E+00	1.77E-08
19	REC-MANDASC	Conditional Probability of REC-MANDAS	N/A	5.06E-01	1.06E+00	1.84E-08
28	ATW-MAN05	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in seven minutes, given ATWS	Procedure - SHORT Tw = 7 min Ta = 30 sec Stress level – HIGH	5.20E-03	1.04E+00	1.88E-08
29	ATW-MAN06C	Conditional probability of ATW-MAN06	N/A	5.00E-01	1.04E+00	1.88E-08
36	REN-MAN04	Failure to recognize the need and failure to open the recirculation valves during a loss-of-coolant accident or transient, if the IRWST low-level signal fails - preventing automatic actuation of sump recirculation	Procedure - LONG Tw = 60 min Ta > 1 min Stress level - HIGH	1.00E-02	1.03E+00	1.89E-08
37	REN-MAN03	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in one minute, given ATWS	Procedure - LONG Tw = 20 min Ta = 10 min Stress level - HIGH	3.40E-03	1.03E+00	1.89E-08
45	PDS6-MANADS	Failure to perform ADS as recovery from failure of automatic actuation or manual actuation in later phases of SGTR event	N/A	1.00E-01	1.02E+00	1.91E-08
50	CIB-MAN00	Failure to diagnose a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.84E-03	1.02E+00	1.91E-08

Table A-4: Baseline PRA, At Power Internal Events LRF, RRW

Capture criteria is RRW ≥ 1.1

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RRW	RESULT. LRF
59	LPM-REC01	Failure to recognize the need for RCS depressurization during a small LOCA or transient with the loss of the PRHR and CMT success after core damage	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	5.00E-02	1.01E+00	1.93E-08
60	ADN-REC01	Failure to complete ADS actuation for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation after core damage	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	5.00E-02	1.01E+00	1.93E-08
62	ADN-MAN01	Failure to actuate the ADS for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	3.02E-03	1.01E+00	1.93E-08
63	ADN-MAN01C	Conditional probability of ADN-MAN01	N/A	5.00E-01	1.01E+00	1.93E-08
69	LPM-MAN01C	Conditional probability of LPM-MAN01	N/A	5.00E-01	1.01E+00	1.93E-08
71	ADF-MAN01	Failure to depressurize the RCS to refill the pressurizer using the first stage ADS valves, given failure of aux. spray during SGTR	N/A	5.00E-01	1.01E+00	1.93E-08
72	CIB-MAN01	Failure to close main steam isolation valve to isolate the faulted steam generator, given a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 15 min Stress level – HIGH	1.34E-03	1.01E+00	1.93E-08
84	LPM-MAN01	Failure to recognize the need for RCS depressurization during a small LOCA or loss of high-pressure heat removal system	Procedure - LONG Tw = 30 min Ta = 15 min Stress level – HIGH	1.34E-03	1.01E+00	1.93E-08
85	REC-MANDAS1	Conditional Probability of REC-MANDAS	N/A	1.00E+00	1.01E+00	1.93E-08
89	CVN-MAN00	Failure to align the CVS in the auxiliary spray mode following a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 10 min Stress level - HIGH	3.10E-03	1.01E+00	1.93E-08
95	RHN-MAN01	Failure to recognize the need and failure to align the NRHR system after ADS actuation, during a LOCA, LOOP, or transient in the reactor coolant system cooling mode	Procedure - LONG Tw = 20 min Ta = 15 min Stress level – HIGH	2.90E-03	1.00E+00	1.95E-08

Table A-4: Baseline PRA, At Power Internal Events LRF, RRW

Capture criteria is RRW ≥ 1.1

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RRW	RESULT. LRF
112	REG-MAN00	Failure to regulate the startup feedwater following full opening of the regulating valves after a loss of compressed air	Procedure - SHORT Tw = 50 min Ta = 30 min Stress level – HIGH	2.04E-01	1.00E+00	1.95E-08
119	LPM-MAN02	Failure to recognize the need for RCS depressurization during a medium LOCA	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	3.30E-03	1.00E+00	1.95E-08
122	SWN-MAN03	Failure to recognize the need and failure to refill the service water basin during a loss-of-offsite power event with subsequent loss of automatic refill capability through the raw water system	Procedure - SHORT Tw = 30 min Ta = 5 min Stress level - HIGH	4.00E-02	1.00E+00	1.95E-08
~~134~~	~~VLN-MAN01~~	~~Failure to recognize the need and failure to actuate the hydrogen control system, given core damage following a LOCA~~	~~Procedure - LONG Tw = 15 min Ta = 10 min Stress level - HIGH~~	~~1.28E-03~~	~~1.00E+00~~	~~1.95E-08~~
199	OTH-SDMAN	Failure to perform a controlled shutdown of the reactor during an accident	Procedure - LONG Tw = 1 hour Ta = 5 min Stress level - HIGH	7.70E-04	1.00E+00	1.95E-08
213	DUMP-MAN01	Failure to adjust steam dump valves, given a steam generator tube rupture with success in isolating faulted steam generator	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.32E-03	1.00E+00	1.95E-08
250	VWN-MAN01	Failure to recognize the need and failure to align the standby chiller during a LOCA	Procedure - LONG Tw = 1 hr Ta = 30 min Stress level – HIGH	5.16E-03	1.00E+00	1.95E-08
268	ATW-MAN04	Failure to manually trip the reactor (through the DAS) in one minute, given ATWS	Procedure - SHORT Tw = 1 min Ta = 40 sec Stress level - HIGH	5.20E-02	1.00E+00	1.95E-08

Table A-4: Baseline PRA, At Power Internal Events LRF, RRW

Capture criteria is RRW ≥ 1.1

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RRW	RESULT. LRF
306	CIC-MAN01	Failure to recognize the need and failure to isolate the containment, given core damage following an accident	Procedure - LONG Tw = 1 hr Ta = 30 min Stress level - HIGH	5.71E-03	1.00E+00	1.95E-08
365	ATW-MAN01C	Conditional probability of ATW-MAN01	N/A	5.17E-01	1.00E+00	1.95E-08
370	CVN-MAN03	Failure to recognize the need and failure to start the CVS pump B, if pump A fails to start automatically during any accident condition that requires CVS makeup	Procedure - SHORT Tw = 30 min Ta = 10 min Stress level - HIGH	1.07E-03	1.00E+00	1.95E-08
403	REN-MAN02	Failure to recognize the need and failure to open the recirculation valves for IRWST low-low level, during a LOCA or transient	Procedure - LONG Tw > 60 min Ta = 10 min Stress level - HIGH	1.99E-03	1.00E+00	1.95E-08
494	CVN-MAN02	Failure to align the CVS in the boration mode following an ATWS	Procedure - SHORT Tw = 60 min Ta = 30 min Stress level - HIGH	1.58E-03	1.00E+00	1.95E-08
495	ATW-MAN06	Failure to manually trip the reactor (through the DAS) in seven minutes, given ATWS	Procedure - SHORT Tw = 7 min Ta = 40 sec Stress level - HIGH	5.20E-03	1.00E+00	1.95E-08
515	ATW-MAN01	Failure to initiate step-in of control rods in one minute, given manual scram failure during ATWS	Procedure - SHORT Tw = 1 min Ta = 1 min Stress level - HIGH	3.30E-02	1.00E+00	1.95E-08

Table A-5: Baseline PRA, At Power Fire Events CDF, RAW

Capture criteria is RAW ≥ 3.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. CDF
1	REC-MANDAS	Failure to detect the need to perform an activity by using the cues provided by diverse actuation system, or the probability to perform an activity by using the controls that are DAS related	N/A	1.16E-02	1.46E+01	8.19E-07
2	OPA-1	Operator fails to deactivate the Protection and Safety Monitoring System (PMS) division involved in the fire	N/A	3.00E-02	3.93E+00	2.20E-07
3	OPA-2	Operator fails to open the manual valve to sprinklers in containment	N/A	3.00E-02	1.63E+00	9.14E-08

Table A-6: Baseline PRA, At Power Fire Events CDF, RRW

Capture criteria is RAW ≥ 1.1

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RRW	RESULT. CDF
1	REC-MANDAS	Failure to detect the need to perform an activity by using the cues provided by diverse actuation system, or the probability to perform an activity by using the controls that are DAS related	N/A	1.16E-02	1.20E+00	4.68E-08
2	OPA-1	Operator fails to deactivate the Protection and Safety Monitoring System (PMS) division involved in the fire	N/A	3.00E-02	1.11E+00	5.05E-08
3	OPA-2	Operator fails to open the manual valve to sprinklers in containment	N/A	3.00E-02	1.03E+00	5.45E-08

Table A-7: Baseline PRA, Shutdown Internal Events CDF, RAW

Capture criteria is RAW ≥ 3.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. CDF
30	LPM-MAN05	Failure to recognize the need for RCS depressurization during a shutdown condition with failure of CVT and the NRHR	Procedure - LONG Tw = 60 min Ta = 20 min Stress level - HIGH	6.83E-04	1.28E+01	1.57E-06
35	IWN-MAN00	Failure to recognize the need and failure to manually open IRWST squib valves during shutdown conditions with the NRHR unavailable	Procedure - LONG Tw > 60 min Ta = 10 min Stress level - HIGH	3.15E-03	7.47E+00	9.19E-07
89	RHN-MAN05	Failure to recognize the need and failure to initiate gravity injection via RNS hot leg connection	Procedure - SHORT Tw = > 60 min Ta = 10 min Stress level - HIGH	1.60E-03	3.10E+00	3.81E-07
103	ADN-MAN01	Failure to actuate the ADS for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	3.02E-03	2.49E+00	3.06E-07
106	REN-MAN04	Failure to recognize the need and failure to open the recirculation valves during a loss-of-coolant accident or transient, if the IRWST low-level signal fails - preventing automatic actuation of sump recirculation	Procedure - LONG Tw = 60 min Ta > 1 min Stress level - HIGH	1.00E-02	2.41E+00	2.96E-07
129	RHN-MAN04	Failure to recognize the need and failure to isolate the NRHR system, given rupture of the RNS piping when the plant is at hot/cold conditions	Procedure - SHORT Tw = 10 min Ta = 6 min Stress level - HIGH	5.30E-02	1.93E+00	2.37E-07
133	REC-MANDAS	Failure to detect the need to perform an activity by using the cues provided by diverse actuation system, or the probability to perform an activity by using the controls that are DAS related	N/A	1.16E-02	1.61E+00	1.98E-07
142	RHN-MAN05C	Conditional probability of RHN-MAN05	N/A	1.50E-01	1.32E+00	1.62E-07
145	IWN-MAN00C	Conditional probability of IWN-MAN00	N/A	1.50E-01	1.29E+00	1.59E-07

Table A-7: Baseline PRA, Shutdown Internal Events CDF, RAW

Capture criteria is RAW ≥ 3.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. CDF
229	RHN-MAN03	Failure to recognize the need and failure to manually transfer NRHR pumps to diesel generator, or failure to restart the NRHR system pumps following grid recovery in two hours after a LOOP, and failure of both automatic and manual transfer onto a diesel generator during shutdown	Procedure - LONG Tw = 1 hr Ta = 10 min Stress level - HIGH (Tw = 30 min for drained condition)	4.17E-03	1.03E+00	1.27E-07
242	CCB-MAN01	Failure to recognize the need and start the standby component cooling water pump B, during a LOCA, transient, or loss of offsite power event	Procedure - SHORT Tw = 30 min Ta = 10 min Stress level - HIGH	1.07E-03	1.02E+00	1.25E-07
243	PRN-MAN01	Failure to align the PRHR system given a loss of main feedwater during a transient	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - MODERATE	4.08E-04	1.02E+00	1.25E-07
246	SWB-MAN02	Failure to recognize the need and failure to start the standby service water pump during a LOCA, LOOP, or transient	Procedure - SHORT Tw = 30 min Ta = 10 min Stress level - HIGH	1.60E-03	1.02E+00	1.25E-07
255	REC-MANDASC	Conditional probability of REC-MANDAS	N/A	5.06E-01	1.01E+00	1.24E-07
256	ZON-MAN01	Failure to recognize the need and failure to start the standby diesel generator during LOOP	Procedure - SHORT Tw = 30 min Ta = 10 min Stress level - HIGH	2.67E-03	1.01E+00	1.24E-07
329	ADN-MAN01C	Conditional probability of ADN-MAN01	N/A	5.00E-01	1.00E+00	1.23E-07

Table A-8: Baseline PRA, Shutdown Internal Events CDF, RRW

Capture criteria is RAW ≥ 1.1

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RRW	RESULT. CDF
12	RHN-MAN05C	Conditional probability of RHN-MAN05	N/A	1.50E-01	1.06E+00	1.16E-07
~~13~~	~~RHN-MAN04~~	~~Failure to recognize the need and failure to align the NRHR system, given rupture of the RNS piping when the plant is at hot/cold conditions~~	~~Procedure - SHORT Tw = 10 min Ta = 6 min Stress level - HIGH~~	~~5.30E-02~~	~~1.06E+00~~	~~1.16E-07~~
14	IWN-MAN00C	Conditional probability of IWN-MAN00	N/A	1.50E-01	1.05E+00	1.17E-07
21	REN-MAN04	Failure to recognize the need and failure to open the recirculation valves during a loss-of-coolant accident or transient, if the IRWST low-level signal fails - preventing automatic actuation of sump recirculation	Procedure - LONG Tw = 60 min Ta > 1 min Stress level - HIGH	1.00E-02	1.01E+00	1.22E-07
23	REC-MANDASC	Conditional probability of REC-MANDAS	N/A	5.06E-01	1.01E+00	1.22E-07
30	LPM-MAN05	Failure to recognize the need for RCS depressurization during a shutdown condition with failure of CMT and the NRHR	Procedure - LONG Tw = 60 min Ta = 20 min Stress level - HIGH	6.83E-04	1.01E+00	1.22E-07
33	IWN-MAN00	Failure to recognize the need and failure to manually open IRWST squib valves during shutdown conditions with the NRHR unavailable	Procedure - LONG Tw > 60 min Ta = 10 min Stress level - HIGH	1.15E-03	1.01E+00	1.22E-07
35	REC-MANDAS	Failure to detect the need to perform an activity by using the cues provided by diverse actuation system, or the probability to perform an activity by using the controls that are DAS related	N/A	1.16E-02	1.01E+00	1.22E-07
44	ADN-MAN01	Failure to actuate the ADS for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	3.02E-03	1.01E+00	1.22E-07

Table A-8: Baseline PRA, Shutdown Internal Events CDF, RRW

Capture criteria is RAW ≥ 1.1

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RRW	RESULT. CDF
54	RHN-MAN05	Failure to recognize the need and failure to initiate gravity injection via RNS hot leg connection	Procedure - SHORT Tw = > 60 min Ta = 10 min Stress level - HIGH	1.60E-03	1.00E+00	1.23E-07
98	ADN-MAN01C	Conditional probability of ADN-MAN01C	N/A	5.00E-01	1.00E+00	1.23E-07
144	RHN-MAN03	Failure to recognize the need and failure to manually transfer NRHR pumps to diesel generator, or failure to restart the NRHR system pumps following grid recovery in two hours after a LOOP, and failure of both automatic and manual transfer onto a diesel generator during shutdown	Procedure - LONG Tw = 1 hr Ta = 10 min Stress level - HIGH (Tw = 30 min for drained condition)	4.17E-03	1.00E+00	1.23E-07
189	ZON-MAN01	Failure to recognize the need and failure to start the standby diesel generator during LOOP	Procedure - SHORT Tw = 30 min Ta = 10 min Stress level - HIGH	2.67E-03	1.00E+00	1.23E-07
198	SWB-MAN02	Failure to recognize the need and failure to start the standby service water pump during a LOCA, LOOP, or transient	Procedure - SHORT Tw = 30 min Ta = 10 min Stress level - HIGH	1.60E-03	1.00E+00	1.23E-07
201	CCB-MAN01	Failure to recognize the need and start the standby component cooling water pump B, during a LOCA, transient, or loss of offsite power event	Procedure - SHORT Tw = 30 min Ta = 10 min Stress level - HIGH	1.07E-03	1.00E+00	1.23E-07
237	PRN-MAN01	Failure to align the PRHR system given a loss of main feedwater during a transient	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - MODERATE	4.08E-04	1.00E+00	1.23E-07

Table A-9: Focused PRA, At Power Internal Events CDF, RAW

Capture criteria is RAW ≥ 2.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. CDF
64	REC-MANDAS	Failure to detect the need to perform an activity by using the cues provided by diverse actuation system, or the probability to perform an activity by using the controls that are DAS related	N/A	1.16E-02	3.46E+00	7.34E-06
69	REN-MAN04	Failure to recognize the need and failure to open the recirculation valves during a loss of coolant accident or transient if the RWST low level signal fails - preventing automatic actuation of sump recirculation	Procedure - LONG Tw = 60 min Ta > 1 min Stress level - HIGH	1.00E-02	2.77E+00	5.87E-06
72	ADN-MAN04	Failure to actuate the ADS for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	3.02E-03	2.27E+00	4.81E-06
92	CIB-MAN00	Failure to diagnose a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.84E-03	1.87E+00	3.96E-06
94	LPM-MAN01	Failure to recognize the need for RCS depressurization during a small LOCA or loss of high-pressure heat removal system	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.34E-03	1.81E+00	3.84E-06
97	CIB-MAN01	Failure to close main steam isolation valve to isolate the faulted steam generator, given a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.34E-03	1.52E+00	3.22E-06
120	LPM-MAN02	Failure to recognize the need for RCS depressurization during a medium LOCA	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	3.30E-03	1.21E+00	2.57E-06
121	ATW-MAN03	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in one minute, given ATWS	Procedure - SHORT Tw = 1 min Ta = 30 sec Stress level - HIGH	5.20E-02	1.21E+00	2.57E-06
135	REC-MANDASC	Conditional probability of REC-MANDAS	N/A	5.06E-01	1.13E+00	2.40E-06

Table A-9: Focused PRA, At Power Internal Events CDF, RAW

Capture criteria is RAW ≥ 2.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. CDF
136	ADF-MAN01	Failure to depressurize the RCS to refill the pressurizer using the first stage ADS valves, given failure of aux. spray during SGTR	N/A	5.00E-01	1.13E+00	2.40E-06
137	ADN-MAN01C	Conditional probability of ADN-MAN01	N/A	5.00E-01	1.13E+00	2.40E-06
150	ATW-MAN05	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in seven minutes, given ATWS	Procedure - SHORT Tw = 7 min Ta = 30 sec Stress level - HIGH	5.20E-03	1.06E+00	2.25E-06
206	ATW-MAN04C	Conditional probability of ATW-MAN04	N/A	5.26E-01	1.01E+00	2.14E-06
220	ATW-MAN04	Failure to manually trip the reactor (through the DAS) in one minute, given ATWS	Procedure - SHORT Tw = 1 min Ta = 40 sec Stress level - HIGH	5.20E-02	1.01E+00	2.14E-06
295	DUMP-MAN01	Failure to adjust steam dump valves, given a steam generator tube rupture with success in isolating faulted steam generator	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.32E-03	1.00E+00	2.12E-06
311	LPM-MAN01C	Conditional probability of LPM-MAN01	N/A	5.00E-01	1.00E+00	2.12E-06
312	ATW-MAN01C	Conditional probability of ATW-MAN01	N/A	5.17E-01	1.00E+00	2.12E-06
319	ATW-MAN06C	Conditional probability of ATW-MAN06	N/A	5.00E-01	1.00E+00	2.12E-06
320	REG-MAN00	Failure to regulate the startup feedwater following full opening of the regulating valves after a loss of compressed air	Procedure - SHORT Tw = 50 min Ta = 30 min Stress level - HIGH	2.04E-01	1.00E+00	2.12E-06
359	ATW-MAN01	Failure to initiate step-in of control rods in one minute, given manual scram failure during ATWS	Procedure - SHORT Tw = 1 min Ta = 1 min Stress level - HIGH	3.30E-02	1.00E+00	2.12E-06

Table A-9: Focused PRA, At Power Internal Events CDF, RAW

Capture criteria is RAW ≥ 2.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. CDF
385	ATW-MAN06	Failure to manually trip the reactor (through the DAS) in seven minutes, given ATWS	Procedure - SHORT Tw = 7 min Ta = 40 sec Stress level - HIGH	5.20E-03	1.00E+00	2.12E-06

Table A-10: Focused PRA, At Power Internal Events CDF, RRW

Capture criteria is RAW ≥ 1.05

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. CDF
4	REC-MANDASC	Conditional probability of REC-MANDAS	N/A	5.06E-01	1.15E+00	1.84E-06
5	ADF-MAN01	Failure to depressurize the RCS to refill the pressurizer using the first stage ADS valves given failure of aux spray during SGTR	N/A	5.00E-01	1.15E+00	1.84E-06
6	ADN-MAN01C	Conditional probability of ADN-MAN01	N/A	5.00E-01	1.14E+00	1.86E-06
22	REC-MANDAS	Failure to detect the need to perform an activity by using the cues provided by diverse actuation system, or the probability to perform an activity by using the controls that are DAS related	N/A	1.16E-02	1.03E+00	2.06E-06
29	REN-MAN04	Failure to recognize the need and failure to open the recirculation valves during a loss-of-coolant accident or transient, if the IRWST low-level signal fails - preventing automatic actuation of sump recirculation	Procedure - LONG Tw = 60 min Ta > 1 min Stress level - HIGH	1.00E-02	1.02E+00	2.08E-06
36	ATW-MAN03	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in one minute, given ATWS	Procedure - SHORT Tw = 1 min Ta = 30 sec Stress level - HIGH	5.20E-02	1.01E+00	2.10E-06
37	ATW-MAN04C	Conditional probability of ATW-MAN04	N/A	5.26E-01	1.01E+00	2.10E-06
52	ADN-MAN01	Failure to actuate the ADS for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	3.02E-03	1.00E+00	2.12E-06
60	CIB-MAN00	Failure to diagnose a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.84E-03	1.00E+00	2.12E-06
70	LPM-MAN01	Failure to recognize the need for RCS depressurization during a small LOCA or loss of high-pressure heat removal system	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.34E-03	1.00E+00	2.12E-06
80	LPM-MAN01C	Conditional probability of LPM-MAN01	N/A	5.00E-01	1.00E+00	2.12E-06

Table A-10: Focused PRA, At Power Internal Events CDF, RRW

Capture criteria is RAW ≥ 1.05

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. CDF
81	LPM-MAN02	Failure to recognize the need for RCS depressurization during a medium LOCA	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	3.30E-03	1.00E+00	2.12E-06
82	CIB-MAN01	Failure to close main steam isolation valve to isolate the faulted steam generator, given a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.34E-03	1.00E+00	2.12E-06
95	ATW-MAN01C	Conditional probability of ATW-MAN01	N/A	5.17E-01	1.00E+00	2.12E-06
109	ATW-MAN04	Failure to manually trip the reactor (through the DAS) in one minute, given ATWS	Procedure - SHORT Tw = 1 min Ta = 40 sec Stress level - HIGH	5.20E-02	1.00E+00	2.12E-06
115	ATW-MAN05	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in seven minutes, given ATWS	Procedure - SHORT Tw = 7 min Ta = 30 sec Stress level - HIGH	5.20E-03	1.00E+00	2.12E-06
116	ATW-MAN06C	Conditional probability of ATW-MAN06	N/A	5.00E-01	1.00E+00	2.12E-06
144	REG-MAN00	Failure to regulate the startup feedwater following full opening of the regulating valves after a loss of compressed air	Procedure - SHORT Tw = 50 min Ta = 30 min Stress level - HIGH	2.04E-01	1.00E+00	2.12E-06
272	ATW-MAN01	Failure to initiate step-in of control rods in one minute, given manual scram failure during ATWS	Procedure - SHORT Tw = 1 min Ta = 1 min Stress level - HIGH	3.30E-02	1.00E+00	2.12E-06
273	DUMP-MAN01	Failure to adjust steam dump valves, given a steam generator tube rupture with success in isolating faulted steam generator	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.32E-03	1.00E+00	2.12E-06

Table A-10: Focused PRA, At Power Internal Events CDF, RRW

Capture criteria is RAW ≥ 1.05

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. CDF
385	ATW-MAN06	Failure to manually trip the reactor (through the DAS) in seven minutes, given ATWS	Procedure - SHORT Tw = 7 min Ta = 40 sec Stress level - HIGH	5.20E-03	1.00E+00	2.12E-06

Table A-11 Focused PRA, At Power Internal Events LRF, RAW

Capture criteria is RAW ≥ 2.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. LRF
87	REC-MANDAS	Failure to detect the need to perform an activity by using the cues provided by diverse actuation system, or the probability to perform an activity by using the controls that are DAS related	N/A	1.16E-02	1.55E+01	5.07E-06
48	REN-MAN03	Failure to recognize the need and failure to open recirculation valves to flood reactor cavity after core damage	Procedure - LONG Tw = 20 min Ta = 10 min Stress level - HIGH	3.40E-03	5.38E+00	1.76E-06
52	LPM-MAN01	Failure to recognize the need for RCS depressurization during a small LOCA or loss of high-pressure heat removal system	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.34E-03	4.36E+00	1.43E-06
53	ADN-MAN01	Failure to actuate the ADS for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	3.02E-03	4.31E+00	1.41E-06
60	CIB-MAN00	Failure to diagnose a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.84E-03	2.70E+00	8.83E-07
64	CIB-MAN01	Failure to close main steam isolation valve to isolate the faulted steam generator given a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.34E-03	2.45E+00	8.01E-07
75	ATW-MAN03	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in one minute, given ATWS	Procedure - SHORT Tw = 1 min Ta = 30 sec Stress level - HIGH	5.20E-02	2.17E+00	7.10E-07
85	PDS6-MANADS	Failure to perform ADS as recovery from failure of automatic actuation or manual actuation in later phases of SGTR event	N/A	1.00E-01	1.74E+00	5.69E-07
88	LPM-REC01	Failure to recognize the need for RCS depressurization during a small LOCA or transient with the loss of the PRHR and CMT success after core damage	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	5.00E-02	1.68E+00	5.49E-07

Table A-11 Focused PRA, At Power Internal Events LRF, RAW

Capture criteria is RAW ≥ 2.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. LRF
89	ADN-REC01	Failure to complete ADS actuation for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation after core damage	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	5.00E-02	1.68E+00	5.49E-07
100	ATW-MAN05	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in seven minutes, given ATWS	Procedure - SHORT Tw = 7 min Ta = 30 sec Stress level - HIGH	5.20E-03	1.42E+00	4.64E-07
111	REN-MAN04	Failure to recognize the need and failure to open the recirculation valves during a loss-of-coolant accident or transient, if the IRWST low-level signal fails - preventing automatic actuation of sump recirculation	Procedure - LONG Tw = 60 min Ta > 1 min Stress level - HIGH	1.00E-02	1.20E+00	3.92E-07
115	REC-MANDASC	Conditional probability of REC-MANDAS	N/A	5.06E-01	1.17E+00	3.83E-07
132	ADF-MAN01	Failure to depressurize the RCS to refill the pressurizer using the first stage ADS valves, given failure of aux. spray during SGTR	N/A	5.00E-01	1.09E+00	3.56E-07
137	ADN-MAN01C	Conditional probability of ADN-MAN01	N/A	5.00E-01	1.09E+00	3.56E-07
~~143~~	~~VLN-MAN01~~	~~Failure to recognize the need and failure to actuate the hydrogen control system, given core damage following a LOCA~~	~~Procedure - LONG Tw = 15 min Ta = 10 min Stress level - HIGH~~	~~1.28E-03~~	~~1.09E+00~~	~~3.56E-07~~
165	ATW-MAN04C	Conditional probability of ATW-MAN04	N/A	5.26E-01	1.06E+00	3.47E-07
177	LPM-MAN02	Failure to recognize the need for RCS depressurization during a medium LOCA	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	3.30E-03	1.04E+00	3.40E-07
212	ATW-MAN04	Failure to manually trip the reactor (through the DAS) in one minute, given ATWS	Procedure - SHORT Tw = 1 min Ta = 40 sec Stress level - HIGH	5.20E-02	1.01E+00	3.30E-07

Table A-11 Focused PRA, At Power Internal Events LRF, RAW

Capture criteria is RAW ≥ 2.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. LRF
261	DUMP-MAN01	Failure to adjust steam dump valves, given a steam generator tube rupture with success in isolating faulted steam generator	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.32E-03	1.00E+00	3.27E-07
287	ATW-MAN06C	Conditional probability of ATW-MAN06	N/A	5.00E-01	1.00E+00	3.27E-07
313	REG-MAN00	Failure to regulate the startup feedwater following full opening of the regulating valves after a loss of compressed air	Procedure - SHORT Tw = 50 min Ta = 30 min Stress level - HIGH	2.04E-01	1.00E+00	3.27E-07
320	CIC-MAN01	Failure to recognize the need and failure to isolate the containment, given core damage following an accident	Procedure - LONG Tw = 1 hr Ta = 30 min Stress level - HIGH	5.71E-03	1.00E+00	3.27E-07
324	LPM-MAN01C	Conditional probability of LPM-MAN01	N/A	5.00E-01	1.00E+00	3.27E-07
344	REN-MAN02	Failure to recognize the need and failure to open the recirculation valves for IRWST low-low level, during a LOCA or transient	Procedure - LONG Tw > 60 min Ta = 10 min Stress level - HIGH	1.99E-03	1.00E+00	3.27E-07
357	ATW-MAN01C	Conditional probability of ATW-MAN01	N/A	5.17E-01	1.00E+00	3.27E-07
381	VWN-MAN01	Failure to recognize the need and failure to align the standby chiller during a LOCA	Procedure - LONG Tw = 1 hr Ta = 30 min Stress level - HIGH	5.16E-03	1.00E+00	3.27E-07
389	ATW-MAN06	Failure to manually trip the reactor (through the DAS) in seven minutes, given ATWS	Procedure - SHORT Tw = 7 min Ta = 40 sec Stress level - HIGH	5.20E-03	1.00E+00	3.27E-07
400	ATW-MAN01	Failure to initiate step-in of control rods in one minute, given manual scram failure during ATWS	Procedure - SHORT Tw = 1 min Ta = 1 min Stress level - HIGH	3.30E-02	1.00E+00	3.27E-07

Table A-11 Focused PRA, At Power Internal Events LRF, RAW

Capture criteria is RAW ≥ 2.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. LRF
401	REC-MANDAS1	Conditional Probability of REC-MANDAS	N/A	1.00E+00	1.00E+00	3.27E-07

Table A-12: Focused PRA, At Power Internal Events LRF, RRW

Capture criteria is RAW ≥ 1.05

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. LRF
4	REC-MANDASC	Conditional probability of REC-MANDAS	N/A	5.06E-01	1.21E+00	2.70E-07
5	REC-MANDAS	Failure to detect the need to perform an activity by using the cues provided by diverse actuation system or the probability to perform an activity by using the controls that are DAS related	N/A	1.16E-02	1.21E+00	2.70E-07
11	ADF-MAN01	Failure to depressurize the RCS to refill the pressurizer using the first stage ADS valves, given failure of aux. spray during SGTR	N/A	5.00E-01	1.10E+00	2.97E-07
12	ADN-MAN01C	Conditional probability of ADN-MAN01	N/A	5.00E-01	1.10E+00	2.97E-07
14	PDS6-MANADS	Failure to perform ADS as recovery from failure of automatic actuation or manual actuation in later phases of SGTR event	N/A	1.00E-01	1.09E+00	3.00E-07
17	ATW-MAN03	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in one minute given ATWS	Procedure - SHORT Tw = 1 min Ta = 30 sec Stress level - HIGH	5.20E-02	1.07E+00	3.06E-07
19	ATW-MAN04C	Conditional probability of ATW-MAN04	N/A	5.26E-01	1.07E+00	3.06E-07
25	LPM-REC01	Failure to recognize the need for RCS depressurization during a small LOCA or transient with the loss of the PRHR and CMT success after core damage	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	5.00E-02	1.04E+00	3.14E-07
26	ADN-REC01	Failure to complete ADS actuation for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation after core damage	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	5.00E-02	1.04E+00	3.14E-07
41	REN-MAN03	Failure to recognize the need and failure to open recirculation valves to flood reactor cavity after core damage	Procedure - LONG Tw = 20 min Ta = 10 min Stress level - HIGH	3.40E-03	1.02E+00	3.21E-07
47	ADN-MAN01	Failure to actuate the ADS for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	3.02E-03	1.01E+00	3.24E-07

Table A-12: Focused PRA, At Power Internal Events LRF, RRW

Capture criteria is RAW ≥ 1.05

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. LRF
56	LPM-MAN01	Failure to recognize the need for RCS depressurization during a small LOCA or loss of high-pressure heat removal system	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.34E-03	1.01E+00	3.24E-07
62	CIB-MAN00	Failure to diagnose a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.84E-03	1.00E+00	3.27E-07
68	ATW-MAN05	Failure to recognize the need and failure to manually trip the reactor (through the PMS) in seven minutes, given ATWS	Procedure - SHORT Tw = 7 min Ta = 30 sec Stress level - HIGH	5.20E-03	1.00E+00	3.27E-07
69	ATW-MAN06C	Conditional probability of ATW-MAN06	N/A	5.00E-01	1.00E+00	3.27E-07
72	REN-MAN04	Failure to recognize the need and failure to open the recirculation valves during a loss-of-coolant accident or transient, if the IRWST low-level signal fails - preventing automatic actuation of sump recirculation	Procedure - LONG Tw = 60 min Ta > 1 min Stress level - HIGH	1.00E-02	1.00E+00	3.27E-07
73	CIB-MAN01	Failure to close main steam isolation valve to isolate the faulted steam generator, given a steam generator tube rupture event	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.34E-03	1.00E+00	3.27E-07
94	REC-MANDAS1	Conditional Probability of REC-MANDAS	N/A	1.00E+00	1.00E+00	3.27E-07
95	ATW-MAN04	Failure to manually trip the reactor (through the DAS) in one minute, given ATWS	Procedure - SHORT Tw = 1 min Ta = 40 sec Stress level - HIGH	5.20E-02	1.00E+00	3.27E-07
101	LPM-MAN01C	Conditional probability of LPM-MAN01	N/A	5.00E-01	1.00E+00	3.27E-07
139	REG-MAN00	Failure to regulate the startup feedwater following full opening of the regulating valves after a loss of compressed air	Procedure - SHORT Tw = 50 min Ta = 30 min Stress level - HIGH	2.04E-01	1.00E+00	3.27E-07

Table A-12: Focused PRA, At Power Internal Events LRF, RRW

Capture criteria is RAW ≥ 1.05

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. LRF
146	LPM-MAN02	Failure to recognize the need for RCS depressurization during a medium LOCA	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	3.30E-03	1.00E+00	3.27E-07
~~148~~	~~VLN-MAN01~~	~~Failure to recognize the need and failure to actuate the hydrogen control system, given core damage following a LOCA~~	~~Procedure - LONG~~ ~~Tw = 15 min~~ ~~Ta = 10 min~~ ~~Stress level - HIGH~~	~~1.28E-03~~	~~1.00E+00~~	~~3.27E-07~~
171	ATW-MAN01C	Conditional probability of ATW-MAN01	N/A	5.17E-01	1.00E+00	3.27E-07
243	DUMP-MAN01	Failure to adjust steam dump valves, given a steam generator tube rupture with success in isolating faulted steam generator	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - HIGH	1.32E-03	1.00E+00	3.27E-07
248	CIC-MAN01	Failure to recognize the need and failure to isolate the containment, given core damage following an accident	Procedure - LONG Tw = 1 hr Ta = 30 min Stress level - HIGH	5.71E-03	1.00E+00	3.27E-07
309	REN-MAN02	Failure to recognize the need and failure to open the recirculation valves for IRWST low-low level, during a LOCA or transient	Procedure - LONG Tw > 60 min Ta = 10 min Stress level - HIGH	1.99E-03	1.00E+00	3.27E-07
381	VWN-MAN01	Failure to recognize the need and failure to align the standby chiller during a LOCA	Procedure - LONG Tw = 1 hr Ta = 30 min Stress level - HIGH	5.16E-03	1.00E+00	3.27E-07
389	ATW-MAN06	Failure to manually trip the reactor (through the DAS) in seven minutes, given ATWS	Procedure - SHORT Tw = 7 min Ta = 40 sec Stress level - HIGH	5.20E-03	1.00E+00	3.27E-07
400	ATW-MAN01	Failure to initiate step-in of control rods in one minute, given manual scram failure during ATWS	Procedure - SHORT Tw = 1 min Ta = 1 min Stress level - HIGH	3.30E-02	1.00E+00	3.27E-07

Table A-13: Focused PRA, Shutdown Internal Events CDF, RAW

Capture criteria is RAW ≥ 2.0

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. CDF
43	IWN-MAN00	Failure to recognize the need and failure to manually open IRWST squib valves during shutdown conditions with the NRHR unavailable	Procedure - LONG Tw > 60 min Ta = 10 min Stress level - HIGH	1.15E-03	1.38E+00	1.34E-06
48	IWN-MAN00C	Conditional probability of IWN-MAN00.	N/A	1.50E-01	1.30E+00	1.26E-06
75	LPM-MAN05	Failure to recognize the need for RCS depressurization during a shutdown condition with failure of CMT and the NRHR	Procedure - LONG Tw = 60 min Ta = 20 min Stress level - HIGH	6.83E-04	1.11E+00	1.08E-06
78	REN-MAN04	Failure to recognize the need and failure to open the recirculation valves during a loss-of-coolant accident or transient, if the IRWST low-level signal fails - preventing automatic actuation of sump recirculation	Procedure - LONG Tw = 60 min Ta > 1 min Stress level - HIGH	1.00E-02	1.08E+00	1.05E-06
100	REC-MANDAS	Failure to detect the need to perform an activity by using the cues provided by diverse actuation system, or the probability to perform an activity by using the controls that are DAS related	N/A	1.16E-02	1.02E+00	9.92E-07
105	ADN-MAN01	Failure to actuate the ADS for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	3.02E-03	1.01E+00	9.83E-07
160	PRN-MAN01	Failure to align the PRHR system given a loss of main feedwater during a transient	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - MODERATE	4.08E-04	1.00E+00	9.73E-07
161	REC-MANDASC	Conditional probability of REC-MANDAS	N/A	5.06E-01	1.00E+00	9.73E-07
166	ADN-MAN01C	Conditional probability of ADN-MAN01	N/A	5.00E-01	1.00E+00	9.73E-07

Table A-14: Focused PRA, At Power Internal Events CDF, RRW

Capture criteria is RAW ≥ 1.05

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RRW	RESULT. CDF
8	IWN-MAN00C	Conditional probability of IWN-MAN00	N/A	1.50E-01	1.06E+00	9.18E-07
30	REN-MAN04	Failure to recognize the need and failure to open the recirculation valves during a loss-of-coolant accident or transient, if the IRWST low-level signal fails - preventing automatic actuation of sump recirculation	Procedure - LONG Tw = 60 min Ta > 1 min Stress level - HIGH	1.00E-02	1.00E+00	9.73E-07
35	IWN-MAN00	Failure to recognize the need and failure to manually open IRWST squib valves during shutdown conditions with the NRHR unavailable	Procedure - LONG Tw > 60 min Ta = 10 min Stress level – HIGH	1.15E-03	1.00E+00	9.73E-07
42	REC-MANDAS	Failure to detect the need to perform an activity by using the cues provided by diverse actuation system, or the probability to perform an activity by using the controls that are DAS related	N/A	1.16E-02	1.00E+00	9.73E-07
46	REC-MANDASC	Conditional probability of REC-MANDAS	N/A	5.06E-01	1.00E+00	9.73E-07
54	ADN-MAN01C	Conditional probability of ADN-MAN01	N/A	5.00E-01	1.00E+00	9.73E-07
58	LPM-MAN05	Failure to recognize the need for RCS depressurization during a shutdown condition with failure of CMT and the NRHR	Procedure - LONG Tw = 60 min Ta = 20 min Stress level - HIGH	6.83E-04	1.00E+00	9.73E-07
66	ADN-MAN01	Failure to actuate the ADS for RCS depressurization as recovery from failure of automatic actuation or for manual ADS actuation	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	3.02E-03	1.00E+00	9.73E-07
157	PRN-MAN01	Failure to align the PRHR system given a loss of main feedwater during a transient	Procedure - LONG Tw = 30 min Ta = 15 min Stress level - MODERATE	4.08E-04	1.00E+00	9.73E-07