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Your ref: Project Number 740
Our ref: DCP/NRC1813

February 27, 2007

Subject: AP1000 COL Response to Request for Additional Information (TR #59)

In support of Combined License application pre-application activities, Westinghouse is submitting responses to the NRC requests for additional information (RAI) on AP1000 Standard Combined License Technical Report 59, APP-GW-GLR-011, Rev. 0, Execution and Documentation of the Human Reliability Analysis/Human Factors Engineering Integration. These RAI responses are submitted as part of the NuStart Bellefonte COL Project (NRC Project Number 740). The information included in the responses is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification.

Responses are provided for requests TR59-1 through TR59-5, TR59-8, and TR59-9 transmitted in NRC letter dated November 22, 2006 from Steven D. Bloom to Andrea Sterdis, Subject: Westinghouse AP1000 Combined License (COL) Pre-application Technical Report 59 – Request for Additional Information (TAC No. MD1435).

Pursuant to 10 CFR 50.30(b), the responses to requests for additional information on Technical Report 59 numbered RAI-TR59-001 through RAI-TR59-005, and RAI-TR59-008, and RAI-TR59-009 are submitted as Enclosure 1 under the attached Oath of Affirmation. Responses to RAI-TR-006 and RAI-TR-007 were provided in letter DCP/NRC1819 on January 29, 2007.

It is expected that when the RAIs on Technical Report 59 are complete, the technical report will be revised as indicated in the responses and submitted to the NRC. The RAI responses will be included in the document.

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

D079

Very truly yours,

A. Sterdis, Manager
Licensing and Customer Interface
Regulatory Affairs and Standardization

/Attachment

1. "Oath of Affirmation," dated February 27, 2007

/Enclosure

1. Responses to Requests for Additional Information on Technical Report No. 59, RAI-TR59-001 through RAI-TR59-005, RAI-TR59-008, and RAI-TR59-009

cc:	S. Bloom	-	U.S. NRC	1E	1A
	S. Coffin	-	U.S. NRC	1E	1A
	G. Curtis	-	TVA	1E	1A
	P. Grendys	-	Westinghouse	1E	1A
	P. Hastings	-	Duke Power	1E	1A
	C. Ionescu	-	Progress Energy	1E	1A
	D. Lindgren	-	Westinghouse	1E	1A
	A. Monroe	-	SCANA	1E	1A
	M. Moran	-	Florida Power & Light	1E	1A
	C. Pierce	-	Southern Company	1E	1A
	E. Schmiech	-	Westinghouse	1E	1A
	G. Zinke	-	NuStart/Entergy	1E	1A

ATTACHMENT 1

"Oath of Affirmation"

ATTACHMENT 1

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

In the Matter of:	)
NuStart Bellefonte COL Project	)
NRC Project Number 740	)

APPLICATION FOR REVIEW OF
"AP1000 GENERAL COMBINED LICENSE INFORMATION"
FOR COL APPLICATION PRE-APPLICATION REVIEW

W. E. Cummins, being duly sworn, states that he is Vice President, Regulatory Affairs & Standardization, for Westinghouse Electric Company; that he is authorized on the part of said company to sign and file with the Nuclear Regulatory Commission this document; that all statements made and matters set forth therein are true and correct to the best of his knowledge, information and belief.

W. E. Cummins
Vice President
Regulatory Affairs & Standardization

Subscribed and sworn to
before me this 27th day
of February 2007.

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Debra McCarthy, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Aug. 31, 2009
Member, Pennsylvania Association of Notaries

Debra McCarthy
Notary Public

ENCLOSURE 1

Response to Request for Additional Information on Technical Report No. 59

RAI-TR59-001 through RAI-TR59-005, RAI-TR59-008, and RAI-TR59-009

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR59-001
Revision: 0

Question:

Sections 2 through 5 of WCAP-14651, "Integration of Human Reliability Analysis with Human Factors Engineering Design Implementation Plan," Revision 2, describe the four major aspects of the plan:

1. Section 2 – Probabilistic Risk Assessment (PRA)/Human Reliability Analysis (HRA) Identification of Critical Human Actions and Risk-Important Tasks
2. Section 3 - Task Analyses for Critical Human Actions and Risk-Important Tasks
3. Section 4 - Re-examination of Critical Human Actions and Risk-Important Tasks
4. Section 5 - Validation of HRA Performance Assumptions

Westinghouse report APP-GW-GLR-011 states that WCAP-16555, Rev. 0, provides information to close combine license COL information item 18.7-1. It also states that WCAP-16555 provides the results of an evaluation of the AP1000 PRA to identify critical human actions and risk important tasks. This evaluation by Westinghouse was performed to implement the initial steps of the HRA/human factors engineering (HFE) integration plan described in WCAP-14651. Closure of COL item 18.7-1 is based on completion of the methodology described in WCAP-14651. However, WCAP-16555 only addresses the information of Section 2 of the implementation plan. Sections 3, 4, and 5 are not addressed in the submittals. Please explain the basis for requesting closure of the full COL item.

Westinghouse Response:

WCAP-16555 provides the unique input from Human Reliability Analysis (HRA) that is required for processing and integration by other design process activities. Westinghouse acknowledges that WCAP-16555 does not perform the work outlined in Sections 3, 4, and 5 of WCAP-14651. The work of these sections is performed under other elements of the AP1000 human factors program, and it was anticipated that such work would likewise be reviewed under those elements.

The bases for the closure of this COL information item are:

(1) at COL application, a COL applicant will take responsibility for implementing the plan identified in DCD Chapter 18.7

(2) a redundant ITAAC exists to provide for the NRC staff reviews and approval of the results of the HRA implementation

(3) much of the integration of HRA results should be reviewed under the work performed in other HFE elements. This is justified further as follows.

For example, Section 3 of WCAP-14651 specifies that the results of its Section 2 activities (specifically, the contents of WCAP-16555) will be incorporated by task analysis activities. Subsequently, Section 3 activities have been completed by a task analysis that incorporated the WCAP-16555 input, per the AP1000 OSA-1 activity described in DCD Section 18.5.2.2. The regulatory review of OSA-1 will consider whether the task analysis inputs, including the HRA input, were analyzed properly. If not, both the issue of proper analysis and the redress of any deficiencies will lie with task analysis. The alternative, to perform multiple reviews of OSA-1 inputs and processing, seems unnecessary and less efficient.

Similarly, Section 5 specifies that to validate HRA assumptions, certain scenarios will be incorporated in the AP1000 Integrated System Validation plans as identified under DCD Section 18.11 in WCAP-15860, "Programmatic Level Description of the AP1000 Human Factors Verification and Validation Plan." These Section 5 activities are therefore part of validation planning and execution, and the review of their collective performance should generally fall under validation review.

Also under Section 5 of WCAP-14651 is the commitment to write a final report "documenting the results of the exercises intended to validate the HRA performance assumptions, and the impact on HRA/PRA quantification, if any." This product is suggested to be addressed as a validation result and a PRA input (i.e., to Chapter 19) since there is no independent quantification of HRA results. Additional feedback and process iterations that may result must be addressed, but these extend beyond the Chapter 18 ITAAC, and should transition towards long-term (lifecycle) processing, such as required by maintenance of the PRA itself.

The results of the Integrated System Validation have potential impact on various other elements in the AP1000 human factors program, such as training, procedures, staffing, design, and HRA/PRA. Each of these impacts must be addressed in terms of the applicable process requirements, independent of the "closure" status of any applicable COL information items or ITAAC. At the other end of the spectrum, the view that no element can be closed until the related elements are themselves closed forms an unstable feedback model whose iterations will ripple throughout the entire program. This will delay the convergence of the results and undermine timely closure of the reviews.

Section 4 of WCAP-14651, in hindsight, is not well-stated, since critical and/or risk-important tasks are by definition determined by HRA/PRA rather than by the task analysis of Section 3. However, the consideration of such tasks is an ITAAC requirement (Table 3.2-1 Item 1) and is therefore clearly covered by current licensing commitments and reviews. In addition, the commitment to incorporate HRA results iteratively in various elements of the design process is a redundant commitment for the elements of task analysis, design, and validation, all interconnected as well by iterative process loops.

Finally and in general, COL information items identify objects for which the COL applicant is responsible. They are "front end" commitments, requirements for acknowledgment of a responsibility rather than for their ultimate completion. COL information items thus should be closed as a matter of COL application, independent of whether or not the responsibility is yet fulfilled. Item completion, in this and most if not all other cases in Chapter 18, is confirmed by ITAAC at the "back end" of design process and review. This explains why corresponding COL information items and ITAAC are actually not redundant, as well as why a COL information item can be closed prior to the corresponding ITAAC. From this perspective, as well as due to the interrelations, additional commitments, and completed progress described above, COL item 18.7-1 may be closed based on the existing submittals, pending closure of the remaining RAIs.

References:

None

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR59-002
Revision: 0

Question:

WCAP-16555, Sec. 3.1, under PRA criteria, states that: Tables 3-1 and 3-2 show risk achievement worth / risk reduction worth (RAW / RRW) values; Table 3-1 shows the top 10 sequences for core damage frequency (CDF); and Table 3-2 shows the top 10 sequences for large release frequency (LRF). However, the tables do not present this information. Please provide the top 10 sequences for CDF and LERF as noted in Section 3.2, as they provide the context for the risk important operation actions.

Westinghouse Response:

Table 3-1 is intended to show the important human actions to the baseline AP1000 at-power, internal events core damage frequency. Table 3-2 is intended to show the important human actions to the baseline AP1000 at-power, internal events large release frequency. The purpose of these two tables is to illustrate that none of the AP1000 operator actions meet the criteria from Section 2.1 of WCAP-16555 (CDF > 1E-4/yr or LRF > 1E-5/yr) (Reference 1) for determining critical actions. Table 3.2-2 was created to document RAW/RRW values for the AP1000 PRA operator actions.

The Tables of Section 3-1 were not intended to document top PRA sequences. However, at the staff's request, the following tables are provided to present the top sequences for at-power, internal events CDF and LRF.

Table 1

INTERNAL INITIATING EVENTS AT POWER DOMINANT CORE DAMAGE SEQUENCES

	Sequence Frequency	Percent Contrib	Cumulative % Contrib	Sequence Identifier	Sequence Description
1	6.88E-08	28.52	28.52	2esil-07	SAFETY INJECTION LINE BREAK INITIATING EVENT OCCURS RCPS TRIP AND CMT INJECTION IS SUCCESSFUL – 1 OF 2 CMT TRAINS SUCCESS OF FULL ADS DEPRESSURIZATION FAILURE OF ONE OF ONE IRWST INJECTION LINE
2	4.26E-08	17.66	46.18	2rllo-09	LARGE LOCA INITIATING EVENT OCCURS ANY ONE OF TWO ACCUMULATOR TRAINS FAIL
3	2.13E-08	8.82	55.00	3dsad-08	SPURIOUS ADS INITIATING EVENT OCCURS SUCCESS OF 1/2 OR 2/2 ACCUMULATORS FAILURE OF ADS OR CMT
4	1.98E-08	8.23	63.23	3dsil-08	SAFETY INJECTION LINE BREAK INITIATING EVENT OCCURS RCPS TRIP AND CMT INJECTION IS SUCCESSFUL – 1 OF 2 CMT TRAINS FAILURE OF FULL ADS DEPRESSURIZATION
5	1.00E-08	4.15	67.38	3crvr-02	REACTOR VESSEL RUPTURE INITIATING EVENT OCCURS

Table 1

INTERNAL INITIATING EVENTS AT POWER DOMINANT CORE DAMAGE SEQUENCES

	Sequence Frequency	Percent Contrib	Cumulative % Contrib	Sequence Identifier	Sequence Description
6	8.44E-09	3.5	70.88	2lslo-05	SMALL LOCA INITIATING EVENT OCCURS SUCCESS OF CMT & RCP TRIP SUCCESS OF PASSIVE RHR SYSTEM SUCCESS OF FULL ADS DEPRESSURIZATION FAILURE OF NORMAL RHR IN INJECTION MODE SUCCESS OF TWO OF TWO IRWST INJECTION LINES SUCCESS OF CIS & PRE-EXISTING CONTAINMENT OPENING FAILURE OF RECIRCULATION
7	7.35E-09	3.05	73.93	2lmlo-05	MEDIUM LOCA INITIATING EVENT OCCURS SUCCESS OF CMT & RCP TRIP SUCCESS OF FULL ADS DEPRESSURIZATION FAILURE OF NORMAL RHR IN INJECTION MODE SUCCESS OF TWO OF TWO IRWST INJECTION LINES SUCCESS OF CIS & PRE-EXISTING CONTAINMENT OPENING FAILURE OF RECIRCULATION
8	5.11E-09	2.12	76.05	3dslo-12	SMALL LOCA INITIATING EVENT OCCURS SUCCESS OF CMT & RCP TRIP SUCCESS OF PASSIVE RHR SYSTEM FAILURE OF FULL ADS DEPRESSURIZATION SUCCESS OF PARTIAL ADS DEPRESSURIZATION FAILURE OF NORMAL RHR IN INJECTION MODE

Table 1

INTERNAL INITIATING EVENTS AT POWER DOMINANT CORE DAMAGE SEQUENCES

	Sequence Frequency	Percent Contrib	Cumulative % Contrib	Sequence Identifier	Sequence Description
9	4.46E-09	1.85	77.90	3dmlo-12	MEDIUM LOCA INITIATING EVENT OCCURS SUCCESS OF CMT & RCP TRIP FAILURE OF FULL ADS DEPRESSURIZATION SUCCESS OF PARTIAL ADS DEPRESSURIZATION FAILURE OF NORMAL RHR IN INJECTION MODE
10	3.72E-09	1.54	79.44	2rsad-09	SPURIOUS ADS INITIATING EVENT OCCURS FAILURE OF 2/2 ACCUMULATORS

Table 2

INTERNAL INITIATING EVENTS AT POWER DOMINANT LARGE RELEASE SEQUENCES

	Sequence Frequency	Percent Contrib	Cumulative % Contrib	Sequence Identifier	Sequence Description
1	4.08E-09	20.9%	20.9%	23BP3A	PLANT DAMAGE STATE 3A OCCURS RCS DEPRESSURIZATION FAILS RESULTING IN A BYPASS
2	3.78E-09	19.4%	40.3%	23BP6	PLANT DAMAGE STATE 6 OCCURS RCS DEPRESSURIZATION FAILS RESULTING IN A BYPASSS
3	2.67E-09	13.7%	54.0%	21CFE2E	PLANT DAMAGE STATE 2E OCCURS RCS DEPRESSURIZATION SUCCESS CONTIAINMENT ISOLATION SUCCESS REACTOR CAVITY FLOODING FAILS RESULTING IN EARLY CONTAINMENT FAILURE
4	2.05E-09	10.5%	64.5%	21CFE3D	PLANT DAMAGE STATE 3D OCCURS RCS DEPRESSURIZATION SUCCESS CONTIAINMENT ISOLATION SUCCESS REACTOR CAVITY FLOODING FAILS RESULTING IN EARLY CONTAINMENT FAILURE
5	2.04E-09	10.5%	75.0%	23BP1A	PLANT DAMAGE STATE 1A OCCURS RCS DEPRESSURIZATION FAILS RESULTING IN A BYPASS

Table 2

INTERNAL INITIATING EVENTS AT POWER DOMINANT LARGE RELEASE SEQUENCES

	Sequence Frequency	Percent Contrib	Cumulative % Contrib	Sequence Identifier	Sequence Description
6	9.97E-10	5.1%	80.1%	10CFE3C	PLANT DAMAGE STATE 3D OCCURS RCS DEPRESSURIZATION SUCCESS CONTIAINMENT ISOLATION SUCCESS REACTOR CAVITY FLOODING SUCCESS REFLOODING OF A DEGRADED CORE SUCCESS VESSEL FAILURE OCCURS RESULTING IN EARLY CONTAINMENT FAILURE
7	9.71E-10	5.0%	85.1%	12CFE3D	PLANT DAMAGE STATE 3D OCCURS RCS DEPRESSURIZATION SUCCESS CONTIAINMENT ISOLATION SUCCESS REACTOR CAVITY FLOODING SUCCESS REFLOODING OF A DEGRADED CORE FAILS NO VESSEL FAILURE OCCURS PASIVE CONTAINMENT COOLING SUCCESS HYDROGEN CONTROL SYSTEM SUCCESS DIFFUSION FLAME OCCURS RESULTING IN EARLY CONTAINMENT FAILURE

Table 2

INTERNAL INITIATING EVENTS AT POWER DOMINANT LARGE RELEASE SEQUENCES

	Sequence Frequency	Percent Contrib	Cumulative % Contrib	Sequence Identifier	Sequence Description
8	6.05E-10	3.1%	88.2%	23BP1P	PLANT DAMAGE STATE 1P OCCURS RCS DEPRESSURIZATION FAILS RESULTING IN A BYPASS
9	5.83E-10	3.0%	91.1%	22CI2L	PLANT DAMAGE STATE 1P OCCURS RCS DEPRESSURIZATION SUCCESS CONTAINMENT ISOLATION FAILS
10	4.75E-10	2.4%	93.6%	6CFE2E	PLANT DAMAGE STATE 3D OCCURS RCS DEPRESSURIZATION SUCCESS CONTIAINMENT ISOLATION SUCCESS REACTOR CAVITY FLOODING SUCCESS REFLOODING OF A DEGRADED CORE FAILS NO VESSEL FAILURE OCCURS PASIVE CONTAINMENT COOLING SUCCESS HYDROGEN CONTROL SYSTEM FAILS EARLY HYDROGEN DETONATION OCCURS RESULTING IN EARLY CONTAINMENT FAILURE

Reference:

1. Westinghouse WCAP-16555, "AP1000 Identification of Critical Human Actions and Risk Important Tasks", Revision 0, 4/5/06.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:

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~~ operator actions with the highest CDF contribution. Table 3-2 shows the top 10 ~~sequences~~ operator actions with the highest LRF contribution. 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.

RAI Response Number: RAI-TR59-003
Revision: 0

Question:

WCAP-16555, Section 3.2, provides a two column cross-reference between the various CDF and LRF criteria and the tables in Attachment A of the WCAP. Information is not provided to address certain of the noted criteria, and the reasons are explained in footnotes. Footnote (1) states that fire CDFs were calculated for human actions (HAs) unique to the fire event, but not for other HAs. How were the other HAs included in the fire PRA? Also, footnote (1) justifies this approach by noting that the other HAs are in the baseline internal PRA and that fire PRA has a lower CDF, which will make the other HAs less important in the fire PRA. This is not always the case, as the human error probabilities may very well be different in the fire PRA and the sequences and cutsets, in which the HA appears, will likely be different in the fire PRA, leading to possibly-higher RAW values and also possibly-higher, resulting, CDF values. Please supplement Tables A-5 and A-6 to address this issue.

Westinghouse Response:

The AP1000 Fire Risk Assessment documented in APP-GW-GL-022 (Reference 1), Chapter 57 was performed based on the simplified process outlined in the EPRI Utility Requirements Document Volume III, Chapter 1, Appendix A (Reference 2) and adopted from the PRA Procedures Guide, NUREG/CR-2300 (Reference 3). In fact, the URD states that improvements in fire protections for existing plants show the fire protection design improvements of passive plants is "an improvement over the level of safety that has been reflected in some prior PRAs for existing plants, where the potential for total system failures due to less separation or more limited use of fire barriers has been observed." The process described below was used to perform the Fire Risk Analysis. Details of each step are provided in Chapter 57 of APP-GW-GL-022.

1. Define AP1000 fire areas;
2. Qualitative screening of the fire areas;
3. Quantitative analysis of fire initiation frequencies for remaining fire areas;
4. Development of fire scenarios, including fire suppression (automatic and manual) and fire propagation;

   For each fire area, there is a probability of fire initiation, and an accident sequence approach is used to develop fire scenarios based on probability of fire propagation and probability of fire suppression. Figure 1 illustrates this concept. The fire event begins in column 1, and various sequences are developed to determine the impact of the fire on the fire area. Additionally, the probabilities of each fire scenario top event are multiplied together within the fire scenario to calculate the fire scenario frequency.

In the AP1000 PRA internal fire analysis for events at power scenarios, operator actions are credited or affected for a few cases.

OPA-01 = Operator deactivates the protection and safety monitoring system (PMS) division involved in the fire.
OPA-02 = Operator opens the manual valve to sprinklers in containment.

The AP1000 PRA internal fire analysis also discusses remote shutdown panel actions and credit for manual actuation of ADS by DAS (REC-MANDAS).

5. Quantification of Conditional Core Damage Probabilities (CCDP) from AP1000 at-power, internal events PRA and Fire CDF Calculation;

   The fire scenario consequences are evaluated to select the representative internal initiating event and subsequent impact on equipment. Using the AP1000 at-power, internal events model, CCDPs are developed based on the fire scenario consequence evaluation. Operator human error probabilities are not adjusted from their previous values. Thus, at-power, internal events human actions are implicitly modeled in the fire risk assessment because they are explicitly modeled in the at-power, internal events PRA.

   The CCDP for a given fire scenario is multiplied by the fire scenario frequency to calculate the fire scenario CDF. This multiplication is repeated for each fire scenario. The fire scenario CDF values are summed in a spreadsheet to determine AP1000 fire CDF. Human error probabilities were not modified during this process.

In the above process, no single quantification of AP1000 internal fire CDF is performed, leaving no single cutset file for which to determine basic event (and operation action) importances. Basic event and operator action importances for Fire Risk were not presented in APP-GW-GL-022 for this very reason.

The greatest fire scenario contributor to internal fire CDF is fire scenario CT500-3 from fire area 1100 AF 11500 (Operation Deck). This sequence contributes 16% to the internal fire CDF. The cutsets resulting from the CCDP calculation can be used to determine operator action importances. Table 1 (Risk Achievement) and Table 2 (Risk Reduction) were created to document these results. These tables also present the capture criterion for the operator actions. The capture criterion means that any operator actions that meet the capture criterion (i.e. an operator action having a risk achievement worth greater than 3.0, or a risk reduction worth greater than 1.1) will be captured for further evaluation. The capture criterion provides a quantitative cutoff for differentiating the risk-important operator actions from the non-risk-important operator actions.

Table 1 and Table 2 were not created to be representative of the AP1000 internal fire risk analysis. However, the tables do illustrate that operator actions are not important to a high frequency fire risk sequence. None of the operator actions credited in this

sequence are shown to be risk important. It can therefore be concluded that the evaluation documented in WCAP-16555 (Reference 4) is conservative since WCAP-16555 assumes that the at-power, internal events operator action importances are applicable to the fire risk assessment. Tables 1 and 2 indicate that no operator actions may be important to fire risk, with the exception of the operator actions presented in Tables A-5 and A-6 of WCAP-16555.

1201 AF 03	Division D DC Equipment I&C												
Fire Occurs In 1201AF03	Fire Suppression Successful	Fire Is Contained	Detection and Deactivation Before Spurious Actuation	No Spurious ADS Room 1	Deactivation of ADS Room 2 Before Spurious Actuation	No Spurious ADS Room 2	Spurious Actuation of One Stage 4/Spurious Actuation of One Stage 1, 2 or 3	Fire Scenario Number	Scenario IE Frequency	Conditional CDP	Scenario CDF	Initiating Event Type	CCDP Scenario number	Failed Components
1	2	3	4	5	6	7	8							
	Yes							TB-1	0.00E+00	7.47E-08	0.00E+00	EV-TRANS	SCEN14A	
	0.03													
								TB-2	2.92E-03	7.47E-08	2.18E-10	EV-TRANS	SCEN14A	Loss of Div. D (ADS V002B/V012B Inoperable By 1E Division)
			0.97											
EV-1201AF03		Yes						TB-2	8.93E-05	7.47E-08	6.67E-12	EV-TRANS	SCEN14A	Loss of Div. D (ADS V002B/V012B Inoperable By 1E Division)
3.04E-03		0.99		9.88E-01				TB-3	3.22E-07	8.07E-04	2.60E-10	EV-MLOCA	SCEN20A	Loss of Div. D Spurious Opening of 1 ADS Stages 1 and/or 2 and/or 3 (MLOCA)
	No		0.03	Hot Short			0.33							
	1.00			1.98E-02				TB-4	6.50E-07	1.25E-03	3.17E-10	EV-SPADS	SCEN3A	Loss of Div. D Spurious Opening of 1 ADS Stages 4 V004E (Large LOCA or SPADS)
							0.67	TB-5	2.86E-05	2.70E-06	7.72E-1[illegible]	EV-TRANS	SCEN11A	Loss of Division E SD (V0023/V0023/V0018/V011B/V003E/V0153 V004B and V004D Inoperable By 1E Division)

Figure 1: Fire Initiation Sequences for Fire Area 1201 AF 03 (extracted from APP-GW-GL-022, Figure 57C-6)

Table 1: Internal Fire Risk Important Operation Actions, Risk Achievement Worth Capture Criterion is RAW ≥ 3.0					
BASIC EVENT ID	**BASIC EVENT DESCRIPTION**	**PSF**	**BASIC EVENT PROBABILITY**	**RAW**	**RESULT. CDF**
REN-MAN04	Operator fails to actuate sump recirc. Given IRWST level signal failure.	Procedure - LONG Tw = 60 min Ta > 1 min Stress level - HIGH	1.00E-02	1.02E+00	5.73E-08
LPM-MAN02	Operator Fails to recognize the need for RCS depressurization during MLOCA.	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	8.30E-02	1.00E+00	5.63E-08
ADN-MAN01	Operator fails to fulfill manual actuation of ADS.	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	4.93E-04	1.00E+00	5.63E-08
RHN-MAN01	Operation fails to align and actuate the RNS.	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	2.90E-03	1.00E+00	5.61E-08
LPM-MAN02C	Conditional probability of LPM-MAN02.	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	5.00E-01	1.00E+00	5.61E-08

Table 2: Internal Fire Risk Important Operation Actions, Risk Achievement Worth Capture Criteria is RRW ≥ 1.1					
BASIC EVENT ID	BASICE EVENT DESCRIPTION	PSF	BASIC EVENT PROBABILITY	RRW	RESULT. CDF
LPM-MAN02	Operator Fails to recognize the need for RCS depressurization during MLOCA.	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	8.30E-02	1.00E+00	5.61E-08
REN-MAN04	Operator fails to actuate sump recirc. Given IRWST level signal failure.	Procedure - LONG Tw = 60 min Ta > 1 min Stress level - HIGH	1.00E-02	1.00E+00	5.61E-08
ADN-MAN01	Operator fails to fulfill manual actuation of ADS.	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	4.93E-04	1.00E+00	5.61E-08
RHN-MAN01	Operation fails to align and actuate the RNS.	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	2.90E-03	1.00E+00	5.61E-08
LPM-MAN02C	Conditional probability of LPM-MAN02.	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	5.00E-01	1.00E+00	5.61E-08

Reference:

1. AP1000 Document APP-GW-GL-022, "AP1000 Probabilistic Risk Assessment" Revision 8, 7/30/04.
2. Advanced Light Water Reactor Utility Requirements Document, Volume III, Chapter 1, Appendix A, "PRA Key Assumptions and Groundrules", Revisions 5 & 6, 12/1993.
3. NUREG/CR-2300, "PRA Procedures Guide", 1983
4. Westinghouse WCAP-16555, "AP1000 Identification of Critical Human Actions and Risk Important Tasks", Revision 0, 4/5/06.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
The following text is added to WCAP-16555, Attachment A:

"The greatest fire scenario contributor to internal fire CDF is fire scenario CT500-3 from fire area 1100 AF 11500 (Operation Deck). This sequence contributes 16% to the internal fire CDF. The cutsets resulting from the CCDP calculation can be used to determine operator action importances. Table 1 (Risk Achievement) and Table 2 (Risk Reduction) were created to document these results. These tables also present the capture criterion for the operator actions. The capture criterion means that any operator actions that meet the capture criterion (i.e. an operator action having a risk achievement worth greater than 3.0, or a risk reduction worth greater than 1.1) will be captured for further evaluation. The capture criterion provides a quantitative cutoff for differentiating the risk-important operator actions from the non-risk-important operator actions.

Table A-5A and Table A-6A were not created to be representative of the AP1000 internal fire risk analysis. However, the tables do illustrate that operator actions are not important to a high frequency fire risk sequence. None of the operator actions credited in this sequence are shown to be risk important. It can therefore be concluded that the evaluation documented in Table A-5 and Table A-6 is conservative since WCAP-16555 assumes that the at-power, internal events operator action importances are applicable to the fire risk assessment. Tables A-5A and A-6A indicate that no operator actions may be important to fire risk, with the exception of the operator actions presented in Tables A-5 and A-6."

Also, in the header of Table A-6, the typographical error will be corrected as follows: Capture criteria is ~~RAW~~ RRW $\geq$ 1.1.

Table A-5A: Internal Fire Risk Important Operation Actions, Risk Achievement Worth Capture Criterion is RAW ≥ 3.0					
BASIC EVENT ID	**BASIC EVENT DESCRIPTION**	**PSF**	**BASIC EVENT PROBABILITY**	**RAW**	**RESULT. CDF**
REN-MAN04	Operator fails to actuate sump recirc. Given IRWST level signal failure.	Procedure - LONG Tw = 60 min Ta > 1 min Stress level - HIGH	1.00E-02	1.02E+00	5.73E-08
LPM-MAN02	Operator Fails to recognize the need for RCS depressurization during MLOCA.	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	8.30E-02	1.00E+00	5.63E-08
ADN-MAN01	Operator fails to fulfill manual actuation of ADS.	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	4.93E-04	1.00E+00	5.63E-08
RHN-MAN01	Operation fails to align and actuate the RNS.	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	2.90E-03	1.00E+00	5.61E-08
LPM-MAN02C	Conditional probability of LPM-MAN02.	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	5.00E-01	1.00E+00	5.61E-08

Table A-6A: Internal Fire Risk Important Operation Actions, Risk Achievement Worth Capture Criteria is RRW ≥ 1.1

BASIC EVENT ID	BASICE EVENT DESCRIPTION	PSF	BASIC EVENT PROBABILITY	RRW	RESULT. CDF
LPM-MAN02	Operator Fails to recognize the need for RCS depressurization during MLOCA.	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	8.30E-02	1.00E+00	5.61E-08
REN-MAN04	Operator fails to actuate sump recirc. Given IRWST level signal failure.	Procedure - LONG Tw = 60 min Ta > 1 min Stress level - HIGH	1.00E-02	1.00E+00	5.61E-08
ADN-MAN01	Operator fails to fulfill manual actuation of ADS.	Procedure - LONG Tw = 5 min Ta = 3 min Stress level - HIGH	4.93E-04	1.00E+00	5.61E-08
RHN-MAN01	Operation fails to align and actuate the RNS.	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	2.90E-03	1.00E+00	5.61E-08
LPM-MAN02C	Conditional probability of LPM-MAN02.	Procedure - LONG Tw = 20 min Ta = 15 min Stress level - HIGH	5.00E-01	1.00E+00	5.61E-08

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR59-004
Revision: 0

Question:

WCAP-16555, Section 3.2, Footnotes 2, 3, 4, 5, & 6 all state that RAW / RRW importance values could not be calculated for certain HAs in the flooding, shutdown, and focused PRAs, but they do not explain why they cannot be calculated. Please provide this explanation. Reasons are then given to justify why not calculating these importance values is acceptable, but these are not consistent with the implementation plan. Please explain why this is acceptable. Also, the HRA/HFE integration plan specifies that the risk-important HAs will be defined using the RAW / RRW values. Please provide the necessary RAW / RRW values and the resultant risk important HAs that result when an HA exceeds the threshold of he RAW/RRW.

Westinghouse Response:

The AP1000 PRA was based, in part, on the requirements of the EPRI Utility Requirements Document (Reference 1) and adopted from the guidance provided in NUREG/CR-2300 (Reference 2). Volume III, Chapter 1, Appendix A of the URD suggests that internal flooding be screened from the PRA "unless a preliminary screening identifies areas in which flooding could occur that would have the potential to affect core cooling". A preliminary screening was performed and several flooding initiating events were evaluated to potentially affect core cooling. Thus, a simplified approach was adopted to quantify flooding risk.

The AP1000 internal flooding CDF was quantified a similar manner as the internal fire CDF. An evaluation was performed to determine flooding initiating event frequencies. For each flooding event, a determination was made of the consequences of the flooding event. For each flooding event, and given consequences, the AP1000 at-power, internal events PRA model was used to develop conditional core damage probabilities (CCDP). The flooding initiating event frequencies were multiplied by the respective CCDP to determine CDF due to the flooding initiating event. All of the CDF values were summed to determine the plant internal flooding CDF.

In the above process, no single quantification of AP1000 internal flooding CDF is performed, leaving no single cutset file for which to determine basic event (and operation action) importances. Instead, multiple CCDP calculations were performed. The scope of the flooding PRA was intended to quantify the core damage risk contribution from internal flooding events and gain an understanding of the flood vulnerabilities that could jeopardize core integrity. Studies were performed to determine the sensitivity of the PRA model to flooding event frequencies; however, the methodology used was not conducive to gaining basic event importance results. Basic event and operator action importances were not presented in APP-GW-GL-022 (Reference 3) for this very reason. Basic event and operator action importance measures were quantified for the at-power, internal events PRA model. The

insights gained from those importance values are considered applicable to the AP1000 flooding risk assessment.

The greatest flooding scenario contributor to internal flooding CDF is a loss of component cooling water sequence. This sequence contributes 20% to the internal flooding CDF. The cutsets resulting from the CCDP calculation can be used to determine operator action importances. Table 1 (Risk Achievement) and Table 2 (Risk Reduction) were created to document these results. These tables also present the capture criterion for the operator actions. The capture criterion means that any operator actions that meet the capture criterion (i.e. an operator action having a risk achievement worth greater than 3.0, or a risk reduction worth greater than 1.1) will be captured for further evaluation. The capture criterion provides a quantitative cutoff for differentiating the risk-important operator actions from the non-risk-important operator actions.

Table 1 and Table 2 were not created to be representative of the AP1000 internal flooding risk analysis. However, the tables do illustrate that operator actions are not important to a high frequency flooding risk sequence. None of the operator actions credited in this sequence are shown to be risk important. The operator action REN-MAN04 does approach the RAW capture criterion. The AP1000 internal flooding risk (8.82E-10 /yr CDF) is extremely low relative to the other CDF contributors (less than 0.2% contribution to total plant CDF). Thus, any risk-important parameter to internal flooding risk is of minimal importance to total plant risk. Therefore, any operator action that has a high internal flooding risk importance could be screened from this evaluation. It can therefore be concluded that the evaluation documented in WCAP-16555 (Reference 4) is conservative since WCAP-16555 assumes that the at-power, internal events operator action importances are applicable to the flooding risk assessment. Tables 1 and 2 indicate that no operator actions may be important to flooding risk, with the exception of the operator actions presented in Tables A-5 and A-6 of WCAP-16555.

The AP1000 shutdown LRF was estimated using a ratio of AP600 results to AP1000 results. The analysis assumes that the AP600 shutdown level 2 model is applicable to the AP1000 design fore estimating plant LRF. The following equation was used and documented in Chapter 54 of APP-GW-GL-022.

LRF(AP1000, shutdown) = CCFP(AP600, shutdown) * CDF(AP1000, shutdown)

This equation assumes that the AP600 conditional containment failure probability (CCFP) is the same for AP1000. This is also based on the evaluation that the dominant sequences contributing to AP1000 shutdown risk as the same as those of AP600. It was concluded that no additional insights would be gained by performing a quantification of the LRF from events that could occur at shutdown for the AP1000. Since no AP1000 shutdown level 2 PRA model quantification was performed, no cutsets were generated and operator action importance measures were not quantified. The release frequency for events at shutdown is comparable to the release frequency for internal events at power. The shutdown risk assessment for AP1000

indicates that the risk profile and insights of the AP600 shutdown PRA are applicable to the AP1000 design. Since the shutdown large release risk profile is expected to be similar to that at-power large release risk profile, the at-power large release risk-important operator actions are considered representative of the shutdown large release risk-important operator actions.

The scope of the AP1000 PRA does not include Focused Fire CDF, Focused Flood CDF, or Focused Shutdown LRF. The definition of Regulatory Treatment of Non-Safety Systems does not require these analyses to be performed. Thus, operator action importances are not determined.

Table 1: Internal Flooding Risk, At Power CDF, RAW

Capture criteria is RAW ≥ **3.0**

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. CDF
27	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	2.60E+00	2.29E-09
38	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	1.18E+00	1.04E-09
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	1.04E+00	9.13E-10
61	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	8.84E-10
68	REC-MANDASC	Conditional probability of REC-MANDAS	N/A	5.06E-01	1.00E+00	8.82E-10

Table 2: Internal Flooding Risk, At Power CDF, RRW

Capture criteria is RRW ≥ 1.1

RANK	BASIC EVENT ID	BASIC EVENT DESCRIPTION	PSF	BASIC EVENT PROB.	RAW	RESULT. CDF
13	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	8.68E-10
23	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	8.80E-10
37	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	8.82E-10
38	REC-MANDASC	Conditional probability of REC-MANDAS	N/A	5.06E-01	1.00E+00	8.82E-10
71	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	8.82E-10

Reference:

1. Advanced Light Water Reactor Utility Requirements Document, Volume III, Chapter 1, Appendix A, "PRA Key Assumptions and Groundrules", Revisions 5 & 6, 12/1993.
2. NUREG/CR-2300, "PRA Procedures Guide", 1983.
3. AP1000 Document APP-GW-GL-022, "AP1000 Probabilistic Risk Assessment" Revision 8, 7/30/04.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR59-005
Revision: 0

Question:

WCAP-16555, Section 3.2.1, refers the reader to the AP600 PRA for HRA calculations for the HAs in question here in the AP1000 plant. Please explain why the AP1000 HRA is not used.

Westinghouse Response:

The AP1000 Human Reliability Assessment was used in the WCAP-16555 (Reference 1) evaluation. The AP600 HRA reference was reported erroneously as Reference 5.3 in WCAP-16555. This reference was discussed in Section 3.2.1 of WCAP-16555. The correct reference for documentation of the AP1000 HRA is Chapter 30 of the APP-GW-GL-022 (Reference 2). The Technical Report should be revised to correct this reference.

Reference:

1. Advanced Light Water Reactor Utility Requirements Document, Volume III, Chapter 1, Appendix A, "PRA Key Assumptions and Groundrules", Revisions 5 & 6, 12/1993.
2. AP1000 Document APP-GW-GL-022, "AP1000 Probabilistic Risk Assessment" Revision 8, 7/30/04.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:

From Section 3.1…

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~~3) and…

From Section 3.2.1…

- 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 Chapter 30 of reference 5.3 for additional details of these calculations including the cues available to the operators to diagnose the event.

From Section 5.0

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".

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

~~5.3Calc note PRA-GSC-231, Revision 2, "Human Reliability Analysis for Revision 7 of the AP600 PRA"~~

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

~~5.5AP1000 Probabilistic Risk Assessment, APP-GW-GL-022, Revision 8~~

~~None~~

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR59-008
Revision: 0

Question:

WCAP-16555, Table A-1, has basic event LPM-MAN02, Failure to recognize the need for depressurization during a medium loss of coolant accident, with a RAW value of 2.89, just below the acceptance criteria of 3.0. It also has a long procedure, high stress, and a 15 minute performance time with only 20 minutes available. These would seem to make this item fit the qualitative criteria for a risk-important item on page 2-4 of WCAP-14651. Please re-evaluate and elaborate on the rationale for your conclusion.

Westinghouse Response:

Operator action LPM-MAN02 is the failure of the operator to recognize the need for RCS depressurization during a medium LOCA. Upon recognizing the need for RCS depressurization, the operator is instructed to actuate the core makeup tanks and the automatic depressurization system.

Operator action LPM-MAN01 is the failure of the operator to recognize the need for RCS depressurization during a small LOCA or loss of high-pressure heat removal system. This operator action, like LPM-MAN02, has a long procedure with a high stress level. In fact, these two operator actions are identical, with the initiating event being the ultimate differentiating factor. In operator action LPM-MAN02, the process used by the operator, and the instrumentation available to the operator to recognize the need for RCS depressurization is identical to that of LPM-MAN01.

In Table A-3 of WCAP-16555 (Reference 1) for at-power, internal events Large Release Frequency, the operator action LPM-MAN01 is captured based on the Risk Achievement Worth (RAW) criterion. The LPM-MAN01 operator action is again captured in Table A-11 for the focused PRA, at-power internal events Large Release Frequency RAW criterion. As documented in Table 43.11 of the AP1000 PRA report (Chapter 43 of Reference 1), small LOCA events are a larger contributor to Large Release Frequency; thus, it is expected that the LPM-MAN01 operator action would be more important to risk than the LPM-MAN02 operator action.

Based on the criteria in WCAP-14651 (Reference 2), the LPM-MAN02 operator action was considered for addition to the list of risk-important operator actions. However, given that LPM-MAN01 is the identical action, and given that LPM-MAN01 has been captured as risk-important, the LPM-MAN02 evaluation concluded that no additional insight would be gained by adding LPM-MAN02 to the list of risk-important operator actions. This is further justified by considering the importance of small LOCA events versus medium LOCA events in the AP1000 PRA.

Reference:

1. Westinghouse WCAP-16555, "AP1000 Identification of Critical Human Actions and Risk Important Tasks", Revision 0, 4/5/06.
2. AP1000 Document APP-GW-GL-022, "AP1000 Probabilistic Risk Assessment" Revision 8, 7/30/04.
3. Westinghouse WCAP-14651, "Integration of Human Reliability Analysis with Human Factors Engineering Design Implementation Plan", Revision 2, May 1997.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

RAI Response Number: RAI-TR59-009
Revision: 0

Question:

A few of the risk important basic events in Table 3.2-2 are somewhat generic, such as item 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." Please explain how the required HFE activities could be performed for such a generic human action.

Westinghouse Response:

When an operator error is assessed for various accident scenarios in the AP1000 PRA, evaluations were performed for different conditions if major distinctions were believed to exist. Otherwise, they were grouped under one identifier and used in the different system fault trees. Although the limiting case is used, the results are not expected to be sensitive to this value. As such, several operator actions may be described in a more generic fashion because they were evaluated to be applicable across a range of accident sequences. The limiting operator action is used in performing the HFE activities.

The REC-MANDAS operator action is an example of the above concept. The following discussion is extracted from Chapter 30 of APP-GW-GL-022 (Reference 1) to discuss the REC-MANDAS operator action.

> The REC-MANDAS operator action evaluates the probability of failure to detect the need to perform an activity by using the cues provided by diverse actuation system following a common cause failure of the Protection and Safety Monitoring System (PMS), or the probability to perform an activity by using the controls that are DAS related.
>
> No detailed evaluation was conducted to deduce the HEPs for the DAS related activities. It is assumed that the independent HEPs for the PMS related activities in the various systems are similar to HEPs for the DAS related tasks.
>
> The formulation of REC-MANDAS is as follows:
>
> Table 30-2 summarizes the basis for REC-MANDAS, and identifies the systems in which the action is applied. For each system in which manual DAS activities are modeled, two actions are identified: SYS-MANDAS and SYS-RECDAS. SYS-MANDAS represents the activity if the manual DAS action is modeled as an independent failure. SYS-RECDAS represents the activity if the manual DAS action is modeled as a dependent failure.

The DAS HEPs are based on the existing human error probabilities that exist for PMS actuation of the respective systems.

The use of a different identification for actuating each system could result in cutsets with the product of several of these independent and/or dependent HEPs for situations where multiple systems have failed. The value reflected in such cutsets would be greatly underestimated.

Therefore, the "manual actuation of DAS" in the various system fault trees would be represented by the same identification REC-MANDAS.

The highest independent HEP of 1.16E-02 is chosen to represent REC-MANDAS; this is viewed as a conservative HEP for DAS actuation of all systems.

Thus, the REC-MANDAS operator action is a conservative representation of all potential manual DAS actions. It is described generically to encompass all possible DAS actions. The AP1000 standard control room has been designed such that recognizing the need for manual actions on the DAS panel will be fairly straight forward. The PMS is designed with comprehensive self diagnostics to provide indication of internal PMS health. Additionally, detailed Emergency Operating Procedures will be written to aide the operators in recognizing issues with internal PMS health. Operators will be well trained in recognizing failures of the PMS and will have adequate training in understanding the consequences of PMS failures and recoveries via the DAS. The process used by the operators to recognized failures of the PMS and to subsequently move to the DAS panel is expected to be similar among all possible manual DAS actions. Thus, the use of a generic operator action in the PRA is considered representative of the typical manual DAS action.

Table 30-2 (Sheet 1 of 2)

MANUAL DAS ACTUATION

System	SYS-MANDAS/HEP		SYS-RECDAS/HEP		Basis
ADS	ADS-MANDAS	6.99E-03	ADS-RECDAS	1.50E-01	Unconditional HEP ADS-MANDAS if same as (ADN-MAN01 + LPM-MAN02). By using the PSFs for ADN-MAN01, ADS-RECDAS is evaluated as having a moderate dependency on ADS-MANDAS
CIS	CIS-MANDAS	1.20E-03	CIS-RECDAS	5.00E-02	Unconditional HEP CIS-MANDAS is same as CIC-MAN01. By using the PSFs for CIC-MAN01, CIC-RECDAS is evaluated as having a low dependency on CIC-MANDAS
CMT	CMT-MANDAS	1.16E-02	CMT-RECDAS	5.06E-01	Unconditional HEP CMT-MANDAS is same as (CMN-MAN01 + LPM-MAN02). By using the PSFs for CMN-MAN01, CMT-RECDAS is evaluated as having a high dependency on CMT-MANDAS
PCS	PCS-MANDAS	1.48E-04	PCS-RECDAS	5.00E-02	Unconditional HEP PCS-MANDAS is same as PCN-MAN01. By using the PSFs for PCN-MAN01, PCS-RECDAS is evaluated as having a low dependency on PCS-MANDAS

Table 30-2 (Sheet 1 of 2)

MANUAL DAS ACTUATION

System	SYS-MANDAS/HEP		SYS-RECDAS/HEP		Basis
RHR	RHR-MANDAS	2.91E-03	RHR-RECDAS	1.50E-01	Unconditional HEP RHR-MANDAS is same as (PRN-MAN02 + HPM-MAN01). By using the PSFs for PRN-MAN02, RHR-RECDAS is evaluated as having a moderate dependency on RHR-MANDAS
RPT	RPT-MANDAS	6.33E-03	RPT-RECDAS	1.50E-01	Unconditional HEP RPT-MANDAS is same as (RCN-MAN01 + LPM-MAN01). By using the PSFs for RCN-MAN01, RPT-RECDAS is evaluated as having a moderate dependency on RPT-MANDAS
VLS	VLS-MANDAS	3.32E-04	VLS-RECDAS	5.00E-02	Unconditional HEP VLS-MANDAS is same as VLN-MAN01. By using the PSFs for VLN-MAN01, VLS-RECDAS is evaluated as having a low dependency on VLS-MANDAS

Reference:

1. AP1000 Document APP-GW-GL-022, "AP1000 Probabilistic Risk Assessment" Revision 8, 7/30/04

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None