Docket File

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 13, 1997

APPLICANT: Westinghouse Electric Corporation

FACILITY: AP600

SUBJECT: SUMMARY OF APRIL 15, 1997, MEETING WITH WESTINGHOUSE TO DISCUSS ISSUES ASSOCIATED WITH THE AP600 PROBABILISTIC RISK ASSESSMENT (PRA)

The subject meeting was held on April 15, 1997, in the Rockville, Maryland, offices of the Nuclear Regulatory Commission (NRC) between representatives of Westinghouse, and the NRC staff. Attachment 1 is a list of meeting attendees. Attachment 2 and 3 are the handouts provided during the meeting by the staff and Westinghouse respectively.

Prior to the meeting the staff sent Westinghouse a letter dated April 3, 1997, which detailed three areas of the PRA in which the staff had concerns. The areas were the focused PRA, steam generator tube rupture (SGTR) accident sequence modeling, and "safety insights" developed from the PRA.

Focused PRA

The focused PRA, which is a sensitivity study of the baseline PRA, was recognized as being important by both Westinghouse and the staff in resolving the issue of Regulatory Treatment of Non-Safety Systems (RTNSS). The staff was especially concerned with the impact that revisions to risk-important failure data had on the results of the focused PRA. In addition, the staff was concerned about the loss of AC power assumption that Westinghouse used in the focused PRA.

The risk-important failure data that were discussed during the meeting included the data for the following components: In-containment refueling water storage tank injection check valves, squib valves, and Reactor Coolant Pump (RCP) trip breakers. The staff believed additional justification is needed to support the failure data for the above components. (Westinghouse presented the data in attachment 4 during this discussion). The staff agreed to do a final review of the previously submitted failure data for the check valves, squib valves, and RCP trip breakers. Westinghouse agreed to assemble the pertinent data on the above components from their PRA into a single package and to resubmit this information to assist the staff in reviewing the material. Following the review, the staff committed to forward their findings to Westinghouse.

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The loss of AC power assumption used in the focused PRA was then discussed. In the focused PRA, Westinghouse assumed that, after the initiating event occurred, all non-safety systems (including AC power) failed. However, special consideration was given to the Anticipated Transient Without Scram events where main AC power was assumed available to the rod control system.

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The staff believed that the loss of AC power assumption eliminated the likelihood of some high risk-important failures such as the failure of one or more reactor coolant pumps to trip. Westinghouse believed that the modeling of the loss of AC power was consistent with the agreements reached and documented in the SECY papers concerning RTNSS. Westinghouse further stated that they believed the focused PRA was never intended to combine the conservatisms associated with the loss of certain non-safety systems with the conservatisms (e.g. adverse systems interactions) associated with other non-safety systems being available. The staff agreed to evaluate the loss of AC power assumption and how it could be treated in the "Adverse Systems Interactions" portion of the RTNSS review to capture events like the reactor coolant pumps failing to trip, within the context of the focused scope PRA.

SGTR accident sequence modeling

The staff was concerned with the lack of thermal-hydraulic analyses supporting the assumption that the AP600 design can use non-safety related systems only as the first line of defense to mitigate SGTR accidents. Westinghouse believes that the AP600 has unique features that make the AP600 SGTR response different from other pressurized water reactors. Additionally, Westinghouse stated that they were answering similar questions about SGTR events from the Reactor Systems Branch. The staff agreed to have the Reactor Systems Branch involved in the review of the thermal-hydraulic analyses that Westinghouse will be providing in response to concerns regarding the PRA SGTR modeling.

Safety Insights

The staff was concerned with a delay in Westinghouse's submission of the safety insights for external events. The staff was also concerned that during a review of the safety insights for the internal events, several important PRA assumptions may have been overlooked and not included in the submittal. Westinghouse responded that the safety insights for the external events had been transmitted April 11, 1997. Westinghouse believes that the safety insights list they developed for internal events was an inclusive list of insights. Westinghouse proposed that the staff's set of insights resulting from their review of the PRA be shared with Westinghouse. Unless Westinghouse determined that there was technically incorrect information in the staff's list there would be no new meetings or information transfer. The staff's insights would be added to the AP600 Design Control Document. The staff agreed to provide feedback to Westinghouse on its proposal.

A draft of this meeting summary was provided to Westinghouse to allow them the opportunity to ensure that the representations of their comments and discussions were correct.

original signed by:

Joseph M. Sebrosky, Project Manager
Standardization Project Directorate
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

Docket No. 52-003

Attachments: As stated

cc w/attachments:
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DOCUMENT NAME: A:FCSD PRA.SUM (6F AP600 DISK) *See previous concurrence

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OFFICE	PM:PDST:DRPM		SPSB:DSSA		D:PDST:DRPM					
NAME	JSebrosky:sg		JFlack*		TRQuay					
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cc: Mr. Nicholas J. Liparulo, Manager
Nuclear Safety and Regulatory Analysis
Nuclear and Advanced Technology Division
Westinghouse Electric Corporation
P.O. Box 355
Pittsburgh, PA 15230

Mr. B. A. McIntyre
Advanced Plant Safety & Licensing
Westinghouse Electric Corporation
Energy Systems Business Unit
Box 355
Pittsburgh, PA 15230

Ms. Cindy L. Haag
Advanced Plant Safety & Licensing
Westinghouse Electric Corporation
Energy Systems Business Unit
Box 355
Pittsburgh, PA 15230

Mr. M. D. Beaumont
Nuclear and Advanced Technology Division
Westinghouse Electric Corporation
One Montrose Metro
11921 Rockville Pike
Suite 350
Rockville, MD 20852

Mr. Sterling Franks
U.S. Department of Energy
NE-50
19901 Germantown Road
Germantown, MD 20874

Mr. S. M. Modro
Nuclear Systems Analysis Technologies
Lockheed Idaho Technologies Company
Post Office Box 1625
Idaho Falls, ID 83415

Mr. Charles Thompson, Nuclear Engineer
AP600 Certification
NE-50
19901 Germantown Road
Germantown, MD 20874

Mr. Frank A. Ross
U.S. Department of Energy, NE-42
Office of LWR Safety and Technology
19901 Germantown Road
Germantown, MD 20874

Mr. Ronald Simard, Director
Advanced Reactor Program
Nuclear Energy Institute
1776 Eye Street, N.W.
Suite 300
Washington, DC 20006-3706

Ms. Lynn Connor
Doc-Search Associates
Post Office Box 34
Cabin John, MD 20818

Mr. James E. Quinn, Projects Manager
LMR and SBWR Programs
GE Nuclear Energy
175 Curtner Avenue, M/C 165
San Jose, CA 95125

Mr. Robert H. Buchholz
GE Nuclear Energy
175 Curtner Avenue, MC-781
San Jose, CA 95125

Barton Z. Cowan, Esq.
Eckert Seamans Cherin & Mellott
600 Grant Street 42nd Floor
Pittsburgh, PA 15219

Mr. Ed Rodwell, Manager
PWR Design Certification
Electric Power Research Institute
3412 Hillview Avenue
Palo Alto, CA 94303

WESTINGHOUSE AP600 PRA
MEETING ATTENDEES
April 15, 1997

NAME	ORGANIZATION
CINDY HAAG	WESTINGHOUSE
BRIAN MCINTYTE	WESTINGHOUSE
JIM FREELAND	WESTINGHOUSE
BARRY SLOANE	WESTINGHOUSE
TERRY SCHULZ	WESTINGHOUSE
SELIM SANCAKTAR	WESTINGHOUSE
STEVE FOWLER	WESTINGHOUSE
TIM BUETER	WESTINGHOUSE
JIM FULFORD	LIS/NUS/SCIENTECH
JOE SEBROSKY	NRR/DRPM/PDST
BILL HUFFMAN	NRR/DRPM/PDST
JOHN FLACK	NRR/DSSA/SPSB
NICK SALTOS	NRR/DSSA/SPSB
MARK CUNNINGHAM	NRR/DSSA/SPSB
BOB PALLA	NRR/DSSA/SCSB
TED QUAY (PART TIME)	NRR/DRPM/PDST
GARY HOLAHAN (PART TIME)	NRR/DSSA

Attachment 1

AP600 DESIGN PRA REVIEW

MAJOR ISSUES

NRC/NRR/DSSA/SPSB

NRC/Westinghouse meeting

April 15, 1997

Attachment 2

MAJOR PRA REVIEW ISSUES

1. SAFETY INSIGHTS

2. SGTR MODELING ISSUES

3. FOCUSED PRA ISSUES

SAFETY INSIGHTS

Identification of design and operational requirements based on PRA insights and assumptions

- Partial submittal
  - Insights for external events, due 2-28-97, not received
- Incomplete submittal
  - Several important PRA assumptions were not included in the submittal
  - Uses wording from the SSAR rather than from the PRA
  - Does not include "integrated" insights
- Impact on FSER schedule

SAFETY INSIGHTS (continued)

Several important PRA assumptions were not included in Westinghouse's submittal

Examples:

- Separate hardware and application software modules for the Rx trip and ESF functions of the PMS, with the exception of a limited set of software modules which control fundamental computer operations.

- Operators will be trained to recognize the need for and take action to manually trip the reactor in time to avoid an ATWS when automatic trip fails following a LOCA or transient event (skill-based assumption in HRA).

- The reliability of the RCP trip breakers (to open on demand) is important [D-RAP].

SAFETY INSIGHTS (continued)

- Insights need to reflect that adequate net positive suction head (NPSH) exists for the NRHR pumps to prevent pump cavitation and failure even when the IRWST and sump inventory is saturated.

- Insights need to reflect that NRHR interlocks, administrative controls, operator actions, procedures, etc. are necessary.

- ADS is actuated automatically when AC power to 4160 V busses is unavailable for 15 continuous hours. In the PRA it is assumed that the operator will act to override automatic depressurization in certain cases. Insights need to identify cases and reflect the need for procedures and training.

SAFETY INSIGHTS (continued)

Several important insights are based on statements from the SSAR and do not reflect accurately the PRA assumptions

Examples:

- Software features, such as "fail safe" capability and "functional diversity," are assumed in the PRA. "Insights" submittal just mentions a V&V program in accordance with IEEE standards as stated in SSAR.

- No I&C failures are modeled in the PRA due to loss of HVAC. Submittal states that "PMS equipment is designed to accommodate a loss of HVAC." However, such statement should be tied to mission times and refer to features and analyses which prove that this statement is true.

SGTR MODELING ISSUES

- Lack of T-H analyses supporting the assumption that the AP600 design can use nonsafety-related systems only as the first line of defense to mitigate SGTR accidents

- Lack of T-H analyses supporting success criteria and modeling of sequences involving failure to trip one or more RCPs

- The staff asked W for such analyses over a year ago

- W responded w/o the analyses

- staff followed up

- Waiting for W's response

- impact on baseline and focused PRAs

FOCUSED PRA ISSUES

1. Revised risk-important failure data

Examples:

- IRWST injection check valve failure rate reduced from 1E-6/hr to 2E-7/hr
  - CCF is highly risk important
  - Unresolved DSER open item questioning the 1E-6/hr rate
  - Unresolved DSER open item questioning assumed CCF multiplier
- Explosive valve failure rate reduced from 3E-3/d to 5.8E-4/d without justification
- RCP failure to trip probability reduced from 1.2E-3/d to 4.2E-4/d without justification

FOCUSED PRA ISSUES (continued)

2. No bases for some important modeling assumptions

Example:

- Success criteria for systems and operator actions in SGTR sequences (important contributors to LRF)

3. Inappropriate use of software CCFs

- The CCF probability which includes failure of both PMS and PLS is used in several top cut sets instead of the higher CCF probability of just the PMS software

FOCUSED PRA ISSUES (continued)

4. **Issues with criteria for screening SSCs, contributing to initiating events, for RTNSS**

Examples:

- Only one criterion (% contribution)
- Criterion relaxed from 1% to 10%
- Reliability assurance not addressed

5. **Issue with assumption about AC power failure at the onset of an accident initiating event (IE)**

- Unrealistic and not consistent with the objectives of the focused PRA
- Impact on PRA results and insights
- Assess assumption's impact

AC POWER IN THE FOCUSED PRA

- Assumed that AC power is lost at the onset of an accident IE, except to the Rx trip breakers

- Focused PRA objectives

  - assess CDF and LRF using the "passive" safety systems only

  - use PRA results & insights to decide on RTNSS

- Assumption is not consistent with focused PRA objectives

  - An "unlikely" event is assumed to always occur and eliminate the likelihood of important failures (CDF and LRF are "artificially" decreased)

  - results are impacted and insights masked

AC POWER IN THE FOCUSED PRA (continued)

- assumption is unrealistic and not conservative
  - It is unlikely that AC power will be unavailable following a non-LOSP IE
- inconsistent use of assumption
  - AC power to the Rx trip breakers but not to every thing else
- assumption eliminates the likelihood of some high risk-important failures
  - failure of one or more RCPs to trip
  - failure of PRHR actuation and CMT injection due to I&C software and hardware CCFs

AC POWER IN THE FOCUSED PRA (continued)

- Assumption impacts PRA conclusions
  - A preliminary study by W indicates significant impact of this assumption on results and insights
  - CDF increases by over 1F-5/yr
  - LRF increases by over 1E-6/yr
  - issues with W's study (further CDF & LRF increases very likely)
- Assumption masks important insights
  - Importance of software reliability and DAS
  - mitigation of SGTR events when one or more RCPs fail to trip (T-H analyses pending)

NRC/WESTINGHOUSE MEETING

ON PRA TOPICS

APRIL 15, 1997

Attachment 3

SAFETY INSIGHTS

"Systematic search to identify **additional** design and operational requirements for the certified design, based on PRA insights and assumptions"

- How do we see the status
- A suggestion for closure

SAFETY INSIGHTS

How We See The Status

- The NRC SER authors have already developed an extensive "safety insights" list.

- Westinghouse concern is centered around the potential impact of this "insights" list on the future Design Certification Document - i.e. much of this list will end up in the DCD ?

- If the "safety insights" list is unduly detailed (e.g. compared to previous submittals), how does it potentially impact the DCD?

  Otherwise, an "insight" is in the eye of the beholder; the NRC SER authors could include what they see as "insights" in their document.

SAFETY INSIGHTS

History

- PRA insights were presented in chapters of the AP600 PRA submittal to the NRC
- NRC SER authors wrote their own version of "safety insights" containing more elements and formatted by system.
- Westinghouse wrote another set of insights similar to the System 80+ submittal scope and format, as suggested by the NRC reviewers. This was done systematically with an expert group.
- All Westinghouse insights material has been submitted to the NRC with the external events material transmitted April 11 completing the set.
- There is nothing more Westinghouse could add to the set already compiled between what the NRC SER authors wrote and what Westinghouse has submitted.
- NRC SER authors currently have enough information and have already written a considerable amount of "safety insights". This process can be wrapped up by the NRC SER authors soon without any additional "safety insights" input from Westinghouse.

SAFETY INSIGHTS

A Suggestion For Closure

- Closure can be accomplished by the following path:

1 NRC SER authors wrap up their "safety insights" writeup based on their already gathered input plus what Westinghouse submitted.

2 The SER writeup is shown to Westinghouse for final potential input.

3 Westinghouse will examine the writeup for suggestions that the SER authors may choose to incorporate. These suggestion could be of three types:

A Editorial comments.

B Westinghouse position that an item does not belong to the list.

C Westinghouse position that an item is technically incorrect.

SAFETY INSIGHTS

A Suggestion For Closure, Cont.

4 NRC SER authors would consider Westinghouse comments if time is available, and in accordance with the following:

Type A and B comments are optional for the NRC SER author to consider.

Type C comments are expected to be very few, if non-existent. If any exist, they must be addressed mutually.

- Unless type C comments arise, no new meetings or information transfer is expected.

Modeling of SGTR in the AP600 PRA

Brief History:

- Reviewer sent RAIs in March, 1996.

  General questions about the success criteria

  Westinghouse answered questions verbally in subsequent discussions

  Formal replies submitted in November, 1996.

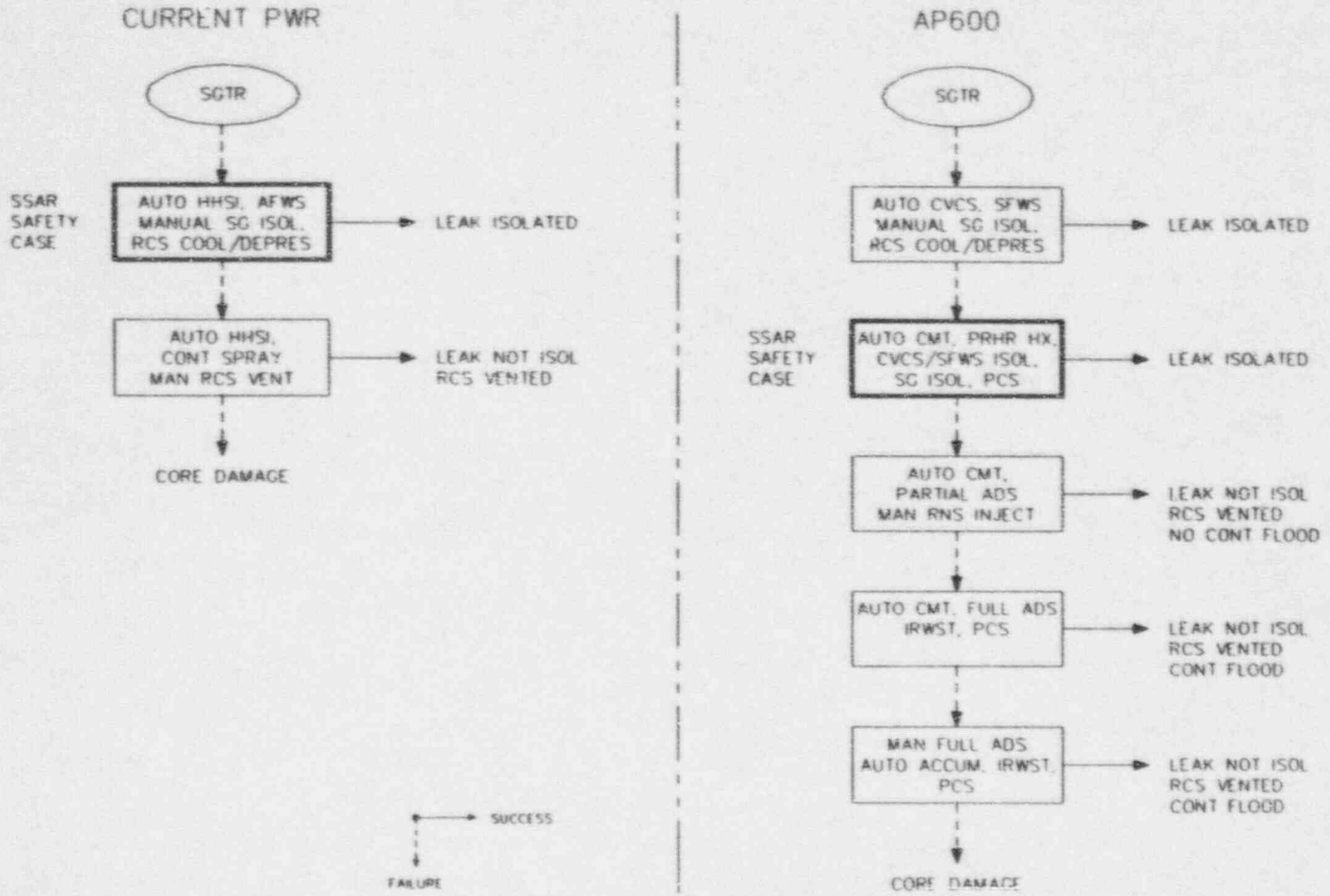
- In January 1997 meeting, received more detailed questions from the reviewer.

  Westinghouse provided verbal responses and presented T/H analyses at the meeting.

- Received more RAIs in March 1997 requiring additional T/H analyses.
  Mainly concern the use of CVS and operator actions.

  These questions can be answered verbally today.
  The written responses will be available soon.

Figure 1 - AP600 SG Tube Rupture Levels of Defense



SGTR in the AP600 PRA

- PRA model is based upon
  - Understanding the AP600 response to an SGTR
  - Integral tests
  - Safety analysis
  - T&H analysis
  - Computer simulations

- Uses conservative assumptions relative to the expected plant performance. (Operator action times, need for ADS, etc.)

- Multiple, diverse types of responses to a SGTR.
  1. active features and operator actions (similar to current plants)
  2. passive features
     a. automatic, and
     b. independent of AC power.

SGTR IN THE AP600 PRA

- **Active System Response**

(This plant response not applicable to the focused PRA.)

- Nonsafety-related, active features and operator actions equalize the RCS and SG pressure and terminate the leak.
- CVS and SFW are part of this response. Supported by testing and analysis
- The startup feedwater pumps provide RCS cooling through the intact SG.
- SG overfill is prevented through automatic control on feedwater.
- One CVS makeup pump provides sufficient RCS makeup to prevent RCS voiding.
- Operator actions:
  - Isolate the faulted SG
  - Cool the RCS using the intact SG
  - Reduce RCS pressure with
    - CVS auxiliary spray or
    - ADS stage 1 (backup)

Analyses show sufficient time to perform these actions

This response has been shown to be effective through analysis and computer simulations.

- **Active System Response**

This response is similar to current plants.

Most notable difference is the high head safety injection in current plants have greater capacity than the AP600 CVS pumps. This higher capacity maintains the RCS pressure higher during an SGTR relative to the SG pressure than the CVS does in the AP600. This makes the leak flow larger and reduces the time available for operator actions in current plants.

AP600 Focused PRA

Summary of Actions to Date:

- September, 1993: Completion of initial RTNSS evaluation documented in WCAP-13856
- June, 1995: Focused PRA updated to latest (Revision 2) baseline PRA model
- June, 1996: Meeting to discuss focused PRA held between NRC reviewers and Westinghouse; request for sensitivity study made by the reviewers
- September, 1996: Focused PRA updated to latest (Revision 7) baseline PRA model
- December, 1996: Sensitivity study transmitted to NRC reviewers
- February, 1997: Questions received from the NRC reviewers regarding sensitivity study, no further comment on the submitted focused PRA

The AP600 Focused PRA Method

- Consistent with SECY-94-084
- The scope and frequency of initiating events are maintained in the focused PRA as in the baseline PRA
- Following the initiating event, all nonsafety system credit is removed in Level 1 and Level 2 PRA calculations

Modeling and Assumptions

- Clarified the definition of the "initiating event" to be the point at which a demand for reactor trip should occur

- Assume failure of all nonsafety systems after initiating event occurs

- Special consideration given to the ATWS events:

  - Initiating event defined to be the point at which the safety-related trip function fails to trip in response to an ATWS precursor

  - After the initiating event occurs, it is assumed main AC power is available to rod control system (and thus, to the RCPs since they are on same bus) so as to not change the initiating event frequency

    - This approach adopted or else ATWS event would not occur (rods drop on loss of main ac power to rod control system)

    - Power to reactor coolant pumps is a penalty

AP600 IRWST injection check valves

- simple check valve design
- RCS grade water environment
- stainless steel construction

Previous AP600 PRA Revision

URD Value	Basis	Value used in PRA
1.0E-06/hr	extrapolation of 0 failures in data	1.0E-06/hr
=8.76E-03/demand		
(for adverse conditions)		

Current AP600 PRA (based upon current design)

URD Value	Basis	Value used in PRA
2.0E-07/hr	0 failures in data	2.0E-07/hr
=1.75E-03/demand		
(for plant design conditions)		

Value in NUREG/CR 2815 and used in IPEs on some current plants
2.0E-07/hr
=1.75E-03/demand

Conclusion:
The AP600 check valve value is based upon the current design and the URD value.

RCP Breaker Data

URD Value	Basis
5.0E-04/demand 1.4E-06/hour	1993 generic plant data calculation from URD data

Plant Specific NPRDS Value	Basis
4.8E-07/hour (1.7E-04/demand)	1986-1996 Westinghouse plant specific data

Conclusion:
The AP600 RCP breaker value is based upon significant Westinghouse plant specific data.

Squib Valve Data

URD Value	Basis
3E-03/demand	small data population with 0 failures & assumption

Sandia Data	Basis
2.0E-04/demand	large population of data with 0 failures & analysis
3.2E-04/demand	large population of data & analysis

Value used in the AP600 PRA is a geometric average of the above values, giving each of them an equal weight.

The squib valves in the Sandia data are the same or similar to the AP600 design.

Conclusion:
The AP600 squib valve value is based upon extensive experience with similar equipment.