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June 5 1996

MEMORANDUM FOR: Edward J. Butcher, Chief
Probabilistic Safety Assessment Branch
Division of Systems Safety and Analysis

FROM: Jin W. Chung
Reliability & Risk Application Section
Probabilistic Safety Assessment Branch
Division of Systems Safety and Analysis

SUBJECT: TRIP REPORT - BRUNSWICK UNIT 2 CONFIGURATION RISK PROFILE, APRIL 29 - MAY 2, 1996

During the week of April 29 - May 2, 1996, a PRA team of NRC staff members and contractors visited Brunswick 2 to develop a configuration risk profile using the plant operating records of six months from July 28, 1995 to January 28, 1996. The necessary plant documents and records were obtained during an advance trip on April 2, 1996. The visit was a part of pilot program under the PRA Implementation Plan (PIP), and the objective was to develop a risk-based methodology for regulatory applications employing plant specific PRA information and operating records. The site activities included development of the configuration risk profiles using plant-specific PRA model and associated utility and other computer codes, and evaluation of different options and limitations. The assumptions and recovery actions were evaluated jointly with the licensee's operations and PRA staff members. The Brunswick risk model and data were used to quantify their risk model using three different quantification computer codes. The Brunswick risk model was large linked fault trees/small event trees, and the computer codes used for the risk profiles were CAFTA/RELMCS, EOOS/R&R Workstation, and SAPHIRE. This report summarizes descriptions of different methodologies used and preliminary results of sensitivity studies, and risk insights. The preliminary results are enclosed in the Appendix, and the reports from participants are enclosed as attachments.

1. CONFIGURATION RISK PROFILES - CAFTA/RELMCS

Risk calculations were performed using the Brunswick 2 CAFTA/RELMCS computer code. A baseline CDF was created from the Brunswick 2 model by setting all maintenance and testing events as zero. The cutset for the new CDF were generated by truncating at a 1E-10 level after solving the fault tree for the new configuration. The risks for those configurations with only one component out-of-service for maintenance were calculated from risk achievement worth (RAW).

- o CAFTA/RELMCS with basic events: The configuration risk profile was developed by solving fault trees for each configuration in basic event level and then, truncating a pre-determined truncation level of 1.0E-10.

- The RELMCS, an algorithm to accelerate the quantification speed, was incorporated into the CAFTA code, improving the computation speed.

- A total of 213 configurations were identified from the plant records of 7/28/95 - 1/28/96, and the largest multiple outage configuration was the one with 14 out-of-service tags.

- Recovery Actions: Contrary to the Crystal River 3 model, the recovery actions were built into the CAFTA/RELMCS. However, the team discussed the recovery rules employed by the licensee with the plant experts (PRA staff, SRO, and system engineers). On the basis of this discussions, 6 records (11 configurations) were eliminated due to the modeling ambiguity and inadequate interpretation of the outage records. For example, the licensee records indicated that a certain piece of equipment was out of service due the painting work being performed on the casing.

- Sensitivity Study: (1) the effects of cutset manipulation for each configuration were evaluated and compared with fault tree solution, (2) the effects of truncation level were evaluated, (3) the sensitivity to the human error probability was evaluated, and (4) the sensitivity to the common cause failure was evaluated.

- Uncertainty Analyses: Density distributions of selected configurations were calculated using Monte Carlo method with a sample size of 1000. The software used was UNCERT with the Error Ranges (error factors) provided by the utility. The first through 4th moments were calculated and the 90 % confidence intervals were calculated as shown in the enclosed results.

2. CONFIGURATION RISK PROFILES WITH SAPHIRE AND EOOS/R&R WORKSTATION

Configuration profiles were developed for the same six month period with 213 configurations using SAPHIRE and EOOS software. Objective was to demonstrate the methodology using different Boolean reduction methods and computation tools, and compare the results with that of the CAFTA/RELMCS.

- IRRAS: The plant PRA model and data were exported to IRRAS successfully and the six month configuration risk profile was calculated using the recovery rule developed for the CAFTA/RELMCS. The preliminary results indicated that they were comparable with CAFTA/RELMCS and EOOS results. The Risk and Reliability (R & R) workstation was not used.

- EOOS with the Risk and Reliability Workstation: the risk profile was also successfully developed and the preliminary results from R & R workstation were reasonable and expected. The software was simple and user-friendly.

3. PRELIMINARY RESULTS

The selected variables and factors which may impact on risk and adequacy of the PRA results were evaluated on a sampling basis. They included some aspects of PRA modeling, quantification method and tools (computer software), and the assumptions used for configuration risk calculations. Uncertainty analyses of the PRA model or data were not performed during this visit. However, density distribution of the core damage frequency was evaluated for the pre-selected configurations using the error ranges (error factors: 95% divided by median).

The objective of this pilot visit was not to perform detail evaluations and to derive final conclusions, but to demonstrate methodology and approaches for applications, and to explore the options. For this pilot visit, the utility PRA model and initiators were assumed to be correct for the analysis purpose. Some of the observations are summarized in the following:

- Calculated average CDF values, utilizing actual plant records of equipment unavailabilities, for 7/28/95 through 1/28/96, are as follows:

Core Damage Frequency, CDF/reactor year				
IPE				
Original	Updated	CAFTA/RELMCS	EOOS/R&R	IRRAS
2.7E-5	0.96E-5	1.0E-5	0.98E-5	0.96E-5

- The baseline CDF value without maintenance and testings is 6.3E-5/reactor year and same for all three codes.

- No major advantages in computation time were observed by using CAFTA with RELMCS. The pentium PC provided ample speed of computation, minimizing the advantages of using RELMCS.

- The IRRAS and EOOS are basically the same codes, and both required a user to enter the common cause data manually. However, the IRRAS required additional efforts to convert the risk model and to filter the data in order to down-load the risk model.

- All three codes (CAFTA/RELMCS, EOOS, SAPHIRE) produced basically the same risk profiles. The preliminary results of the CDF configuration risk profiles and cumulative profiles are presented in the attached figures as well as the results of the sensitivity and uncertainty evaluation.

- For same truncation levels, fault tree solution for each configuration, as compared with the cutset manipulation, resulted in more accurate results. The truncation before the fault tree solution for a certain configuration can eliminate some of the important contributors.

- The cutset truncation levels smaller than 1E-8 did not influence the final CDF values significantly. However, the importance ranking appeared to be dependent on the truncation levels. For example, more than 80 % of total cutsets were eliminated when the truncation level was increase by one order of magnitude (eg. 1E-8 from 1E-9, or 1E-9 from 1E-10).

TRUNCATION	CDF(/RY)	NO. OF CUTSETS
1.0E-8	4.41E-6	95
1.0E-9	5.73E-6	558
1.0E-10	6.32E-6	2540
1.0E-11	6.53E-6	9491

- On the basis of the above truncation study, the risk importance ranking may require low level of cutset truncation, as low as 1.0E-13, and may have to consider the configuration risk. The preliminary results indicated that cutsets, containing relatively reliable component or basic event (e.g., probability of 1.0E-7 or 1.0E-05), were truncated at a relatively high truncation level (say, 1.0E-8 or even 1.0E-9), and that the reliable components did not make top 100 ranking in the RAW.

- Recovery rule implemented for the utility PRA/IPE model was included in the CAFTA/RELMCS, making computation for the configuration risk profile relatively easier. In general, CDF decreases by one order of magnitude after recovery action.

- The common cause failures of two components were modeled, and a limited sensitivity study was performed to demonstrate the methodology. Configurations containing common cause failures with high CDF configurations were selected for the study, and the beta factors were increased by factors of 2, 5, and 10. The resulting changes in CDF did not impact the risk appreciably, except in some configurations.

- For similar study for human reliability, the HEP values were doubled, five-folded, and ten-folded, and the impacts on CDFs were not significant. Some configurations were found sensitive to HEP but no major effects were identified. Again, these results are on the basis of a limited study, and represent a preliminary finding.

- Density distribution of the CDF with 1000 sample size and Monte Carlo calculation resulted in a density distribution similar to lognormal distribution. Selected calculations with first through 4th moments and 90 % confidence intervals were included.

- The normal tagging practice in the plant for the out-of-service components may not represent true status of component outages for for the purpose of configuration identifications.

4. TRIAL APPLICATIONS

The following observations were made from the risk insights of the preliminary results, pending additional study of the risk profiles. These observations were strictly on the basis of risk profile and within the scope and duration of data and records.

- On-line maintenance activities, both planned and implemented under the 12 weeks rolling schedule, were evaluated from the risk profile. Any high risk peaks due to the activities or large configuration outage durations were evaluated. Within the scope of the trial observation and risk perspective, the on-line maintenance activities did not increase the risk beyond level (CDP value of 1.0E-6) endorsed by NEI (the NEI risk level was not reviewed nor endorsed by NRC).

- Integrated Operational Performance: Cumulated core damage probability (CDP) during the evaluation period was better than the value submitted in the licensee's IPE submittal but was comparable to the value documented in the licensee's updated IPE CDF number.

- Surveillance: None of the surveillance activity drove the configuration peaks higher than the threshold level (temporary CDP increase of 1.0E-6) endorsed by the NEI. NRC has neither evaluated nor endorsed the NEI numbers at this time.

- Engineering: (1) no common-cause failures drove the plant risk beyond the NEI unacceptable level, (2) no human errors drove the risk profiles beyond the NEI levels in risk perspective.

- Maintenance: No maintenance activities resulted in high incremental changes in risk (core damage frequency peaks, large configuration time windows, and unnecessary configuration peak clustering).

- For the maintenance and surveillance planning purpose, the clustering of configuration risk peaks appear to be important. The height and outage time-window of the configuration risk peaks are important for the plant operational risk. Narrow CDF peaks may not be critical in risk perspective, compared with the peaks with extended outage time.

- Risk-informed Inspection Plan for Integrated Performance Assessment Process (IPAP): The following list of risk insights that can be derived from the risk profiles was developed for each of four areas of focus during an IPAP. Components associated with the most significant CDF/CDP peaks are identified on the attached configuration risk profile that, along with the risk insights, can be used to provide a risk focus for the inspection.

OPERATIONS:

- Evaluate initiating event spikes to assess cause/operator response.
- Assess risk peaks and identify operator errors for adequacy of operator training and its program.
- Assess configuration risk management: compare cumulative risk during the assessment period with IPE and other risk evaluation results during different time period.

ENGINEERING:

- Repeat failures due to design errors; root cause analyses
- Failures caused by design process, engineering, and operations
- Timeliness and quality of engineering response to risk significant events.

MAINTENANCE:

- Safety significant post maintenance test failures.
- Planning, scheduling, and implementing on-line rolling maintenance
- Actual out of service time versus planned time.

SAFETY ASSESSMENT/CORRECTIVE ACTIONS:

- Reliability/unavailability trend of safety significant components.
- Verify the quality of corrective actions on risk/safety significant components/systems.

5. VISITING TEAM

The visiting team included two candidates of Senior Reactor Analysts (SRA) from Regions assigned to NRR as a part of their training programs in PRA. The specific onsite tasks and activities of the participants were assigned prior to the site visit as following:

Jin W. Chung (NRR): Team Leader and methodology development

Seming Wong (BNL) / Wei He (BNL):
Development of Risk Profiles using the licensee's CAFTA/RELMCS and EOOS codes.

Curtis Smith (INEL) / Steven Eide (INEL):
Development of Risk Profile using IRRAS.

Jim Trapp (RI SRA) / Pete Wilson (HQ SRA):
Familiarize with the various methods of developing configuration risk profiles using CAFTA/EOOS/IRRAS: identification of configurations from plant records:

applications of risk profile and development of an risk-informed inspection plan on the basis of risk profiles and IPAP method.

The preliminary results and the listing of the licensee personnel interfaced during the visit are enclosed.

Attachments: As Stated

DISTRIBUTION	Central File	PDR	SPSB File	WRussell/FMiraglia
MCullingford	AThadani	GHolahan	MVirgilio	EButcher
MRubin	JChung	OGC	EJordan, AEOD	ACRS

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OFFICE	SPSB:DSSA		SPSB:DSSA							
NAME	JChung		MRubin							
DATE	5/23/96		6/5/96							

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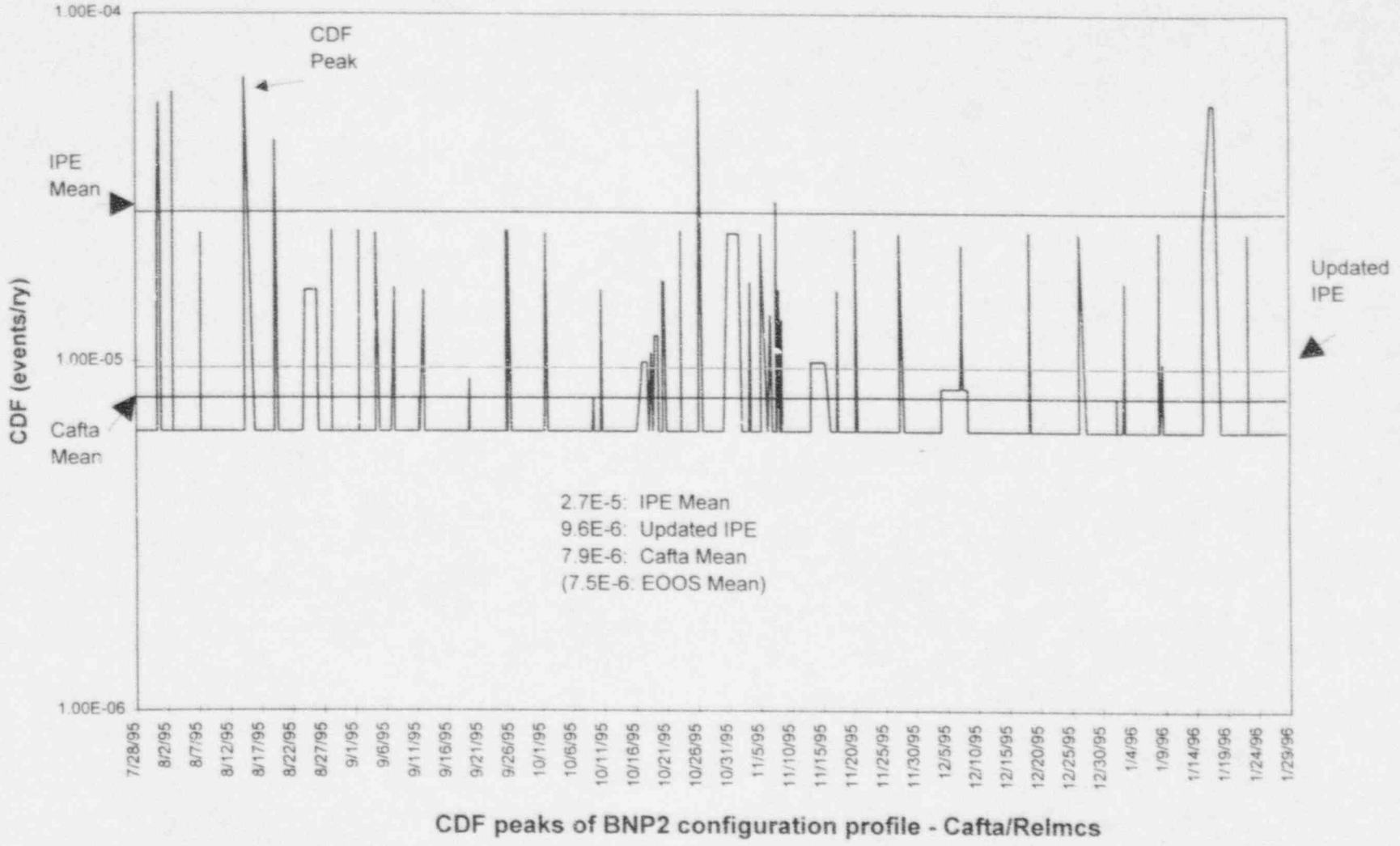
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CDF
Peak
IPE
Mean
Cafta
Mean
Updated
IPE
2.7E-5: IPE Mean
9.6E-6: Updated IPE
7.9E-6: Cafta Mean
(7.5E-6: EOOS Mean)
7/28/95
8/2/95
8/7/95
8/12/95
8/17/95
8/22/95
8/27/95
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12/30/95
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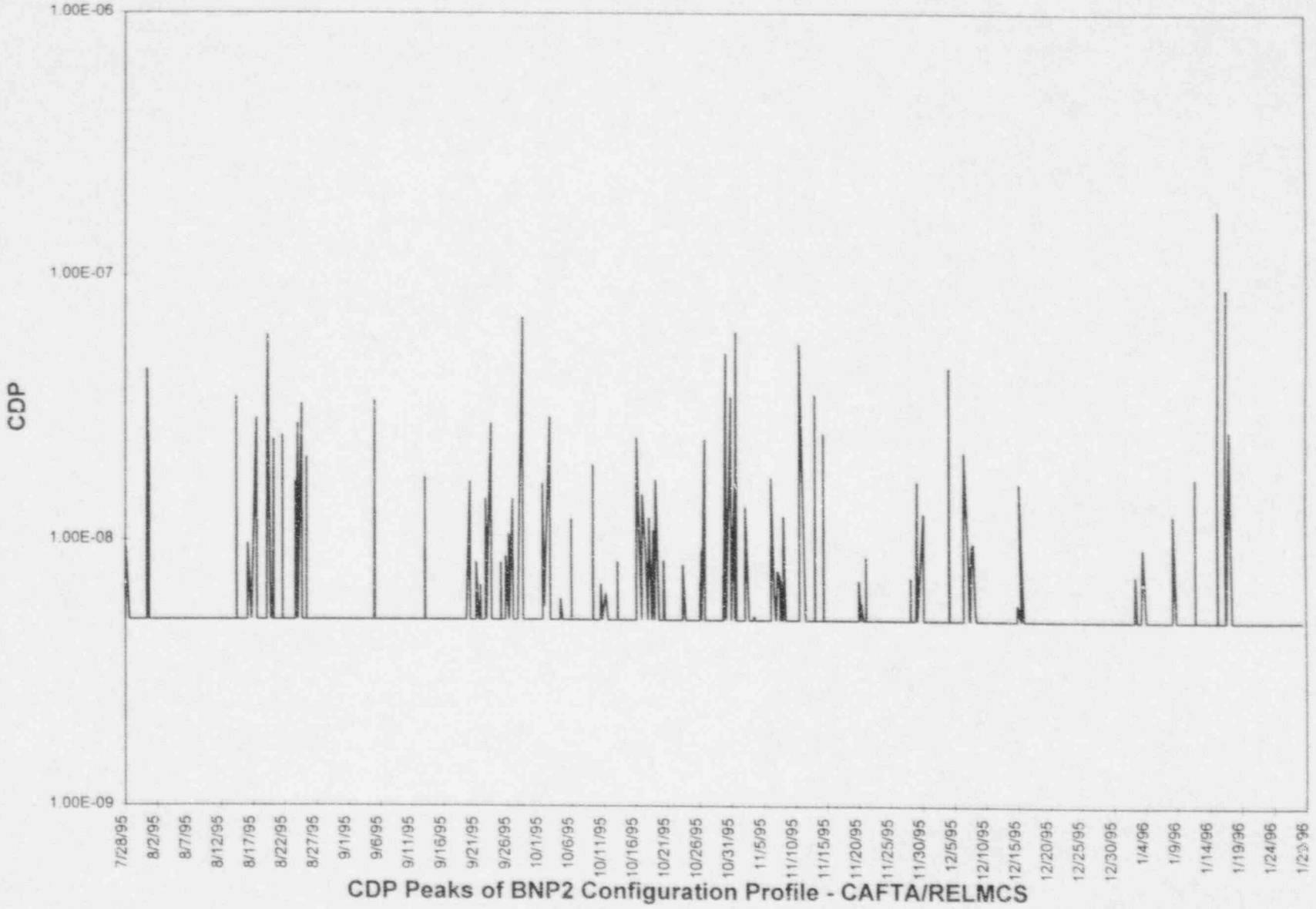
CDF peaks of BNP2 configuration profile - Cafta/Relmcs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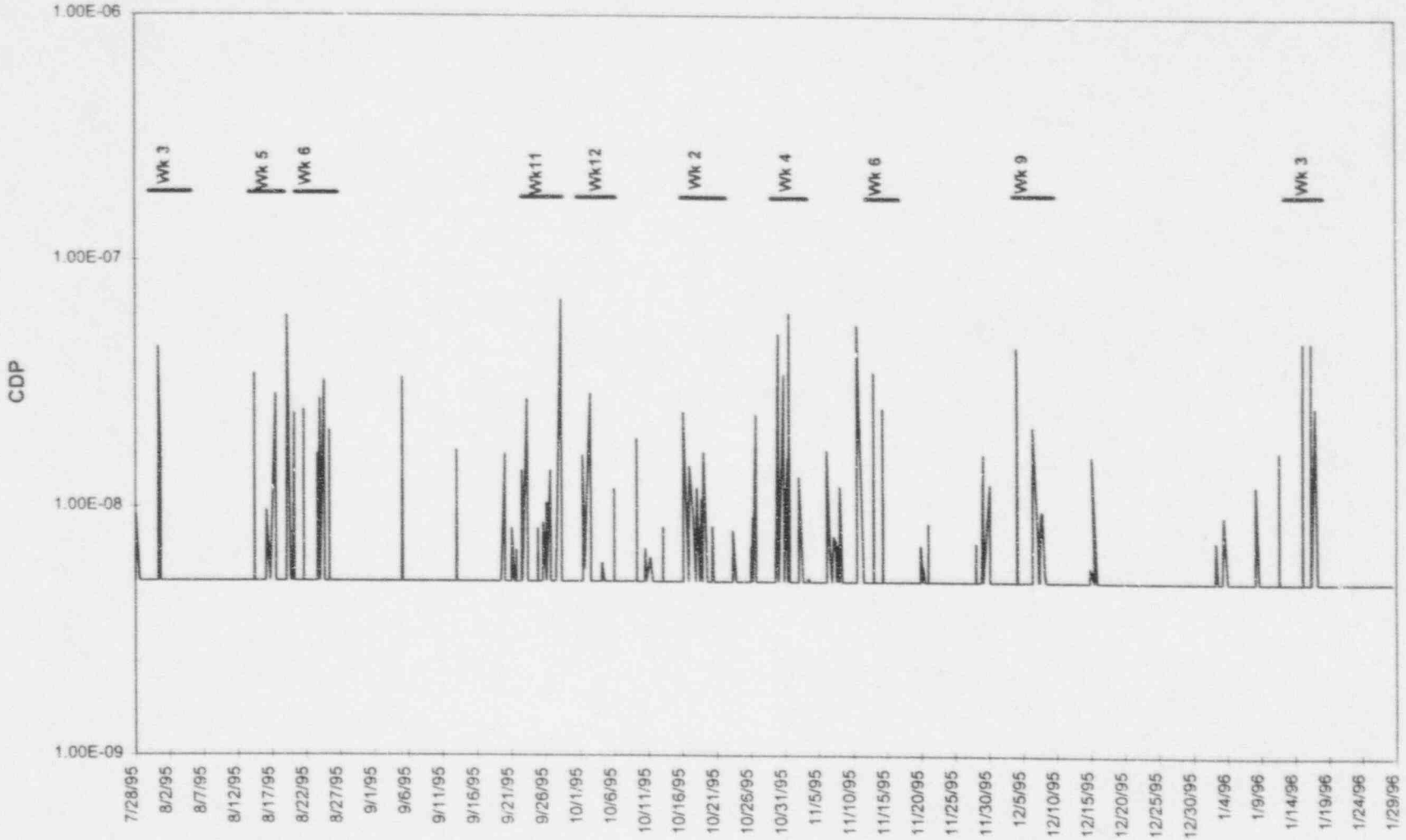

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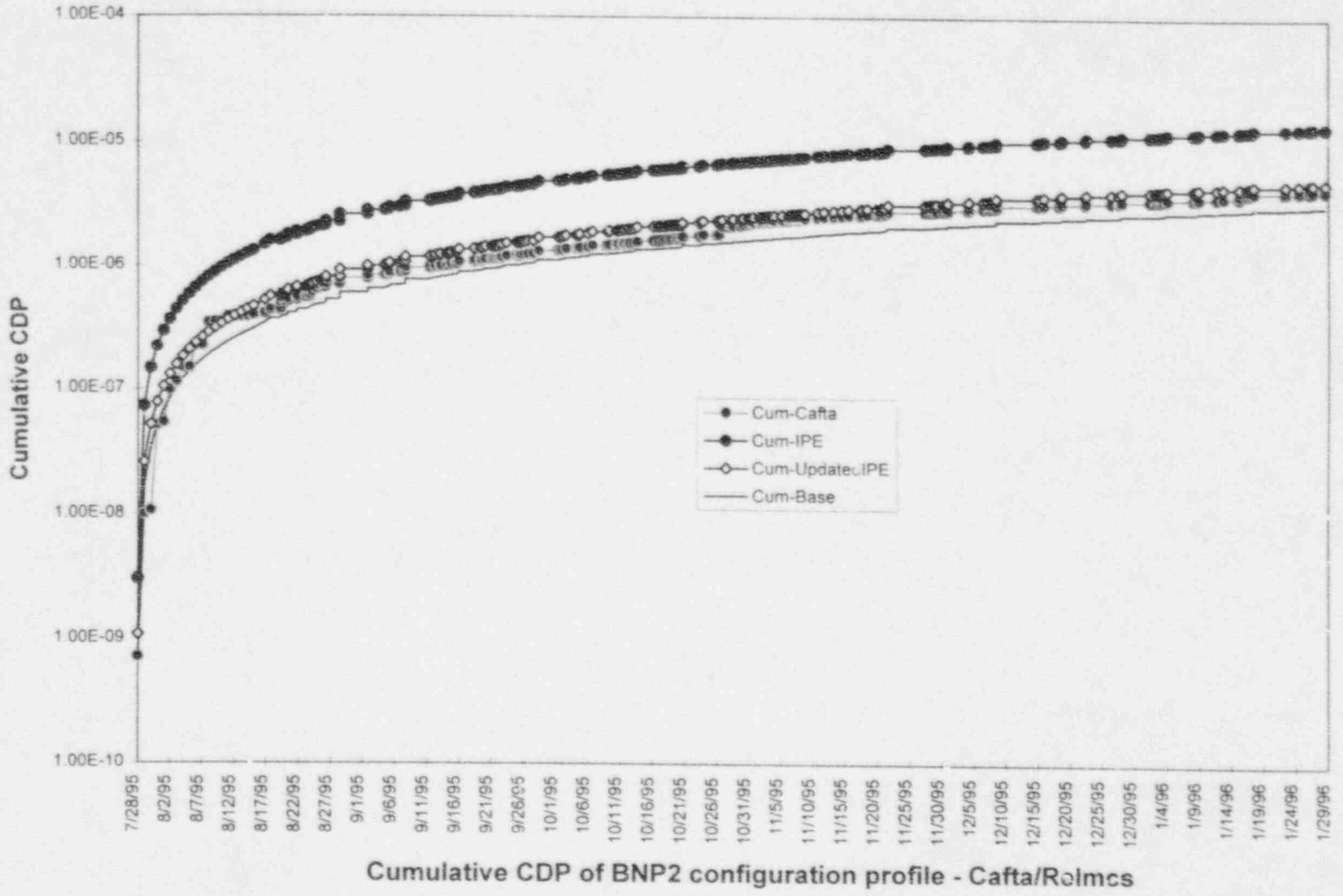
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Cum-Cafta
Cum-IPE
Cum-UpdatedIPE
Cum-Base
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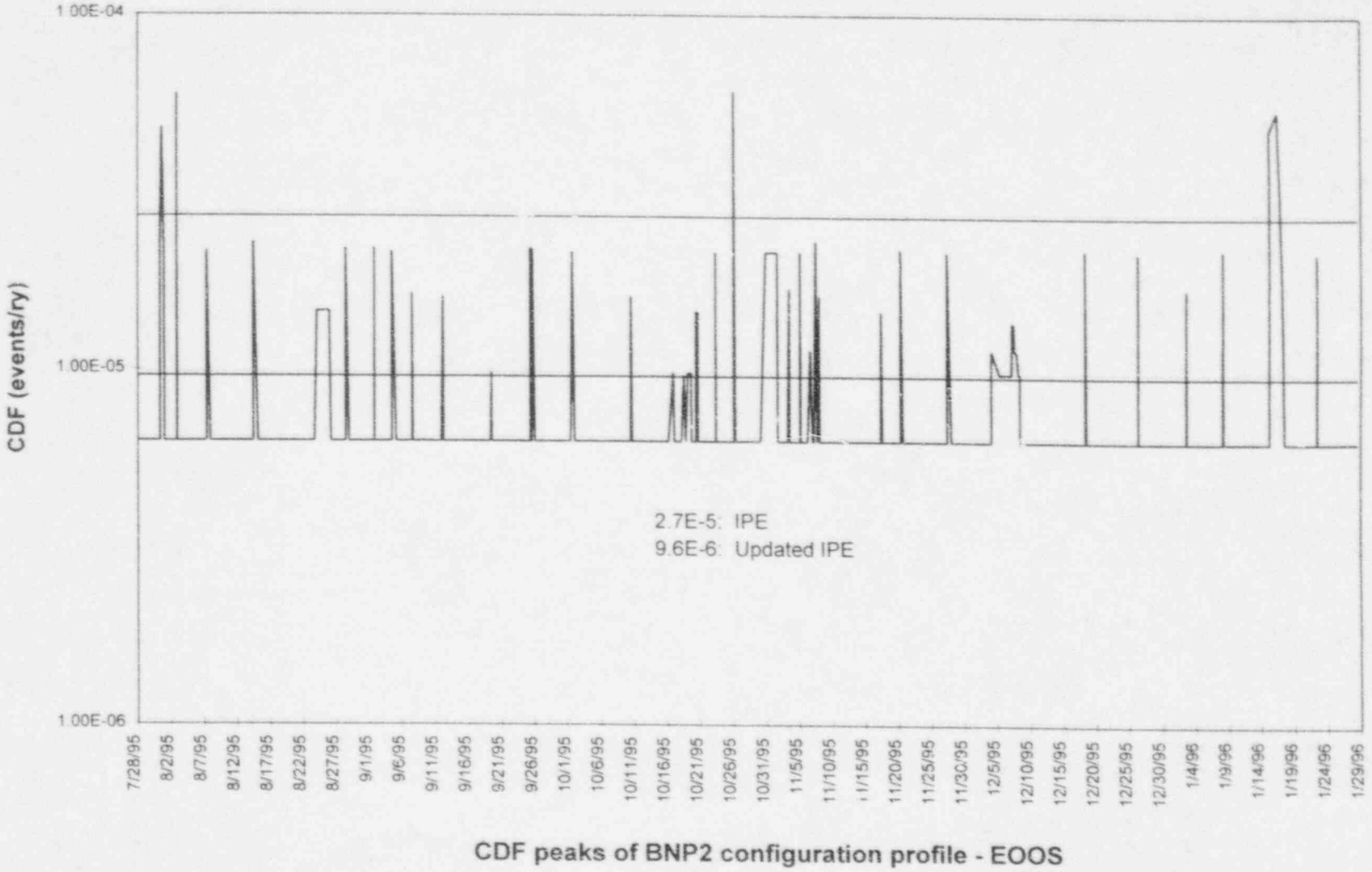
1/29/96
Cumulative CDP of BNP2 configuration profile - Cafta/Relmcs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CDF (events/ry)
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9.6E-6: Updated IPE
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8/2/95
8/7/95
8/12/95
8/17/95
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9/1/95
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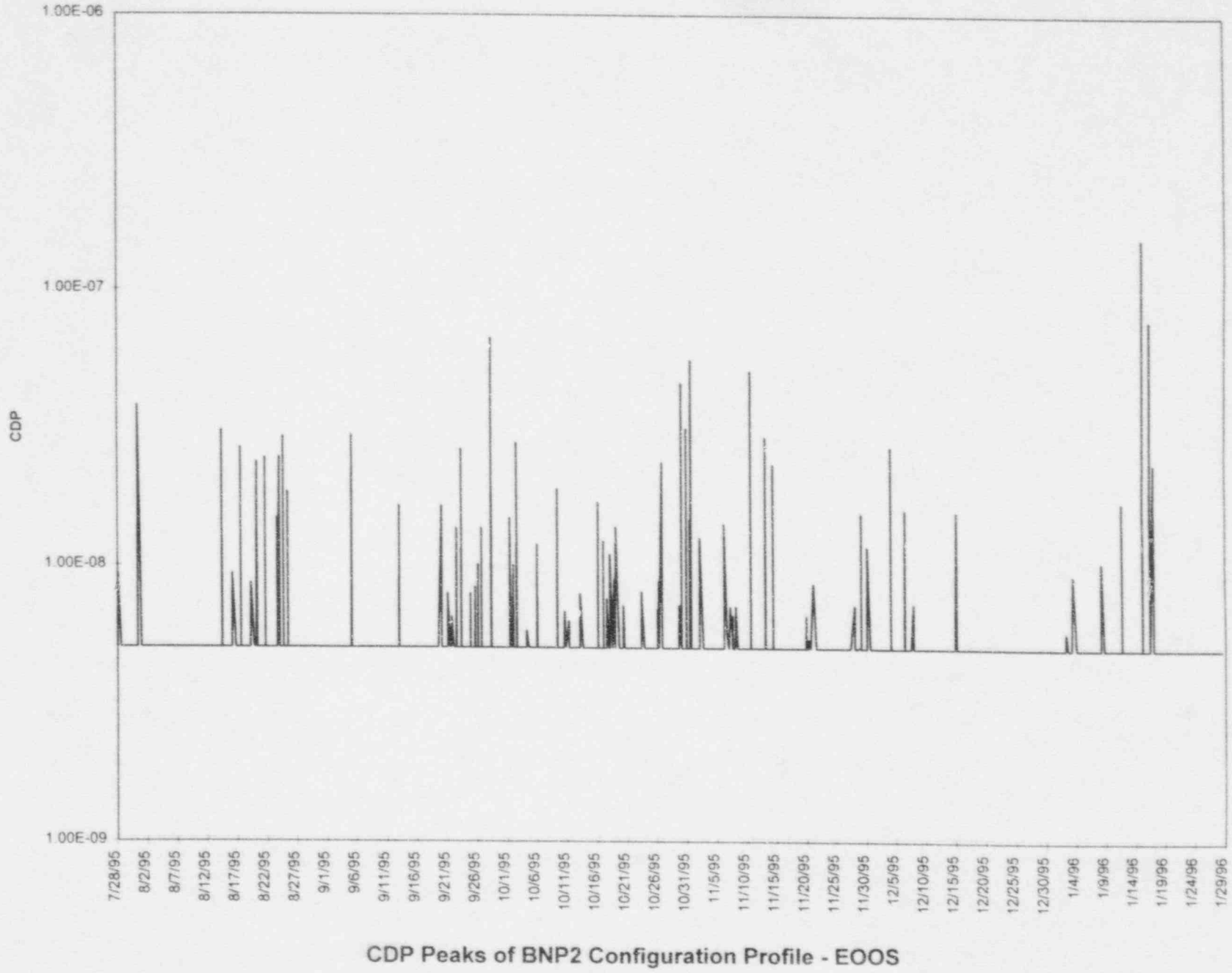
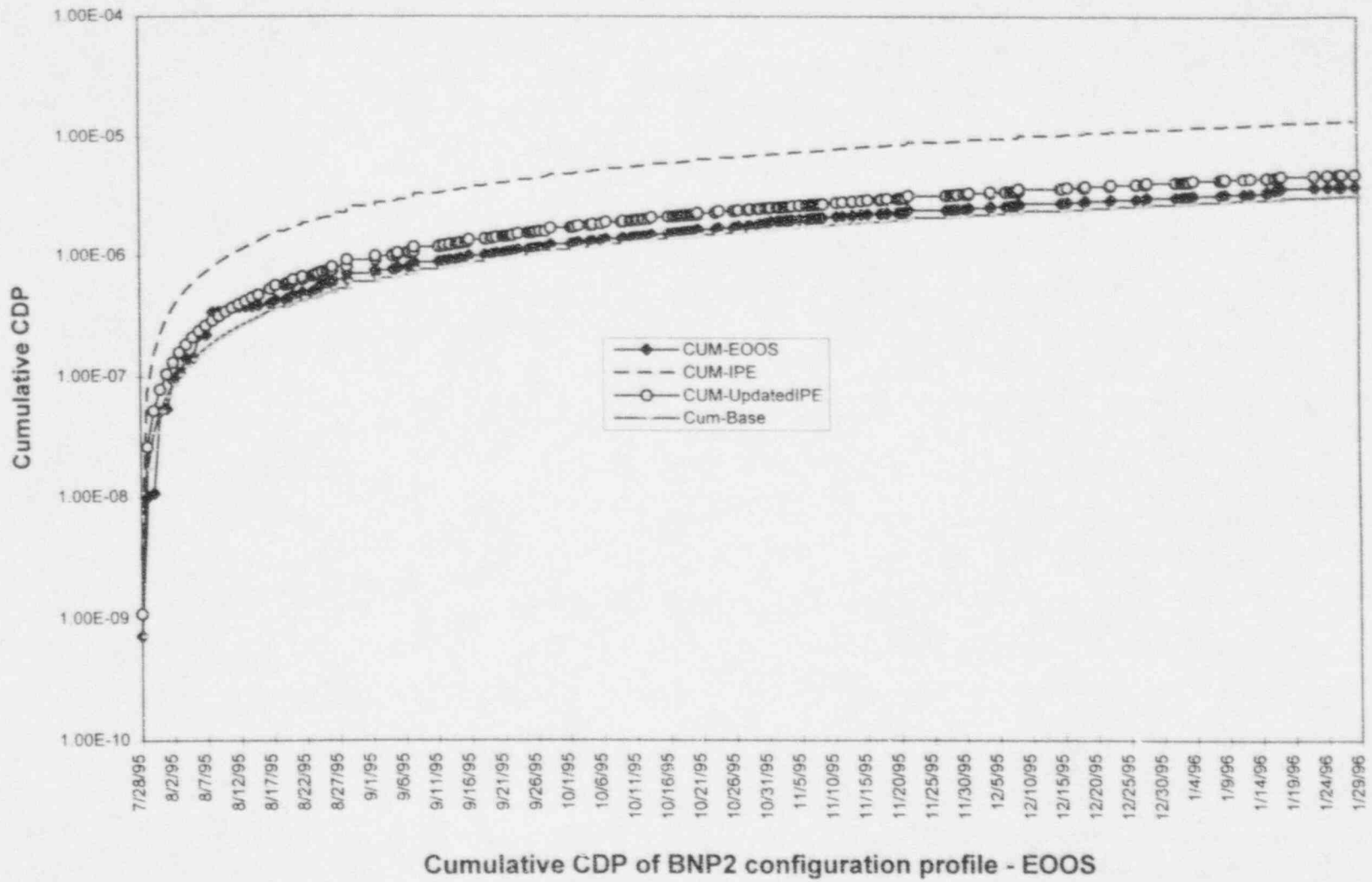
CDF peaks of BNP2 configuration profile - EOOS



CDP Peaks of BNP2 Configuration Profile - EOOS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CUM-IPE
CUM-UpdatedIPE
Cum-Base
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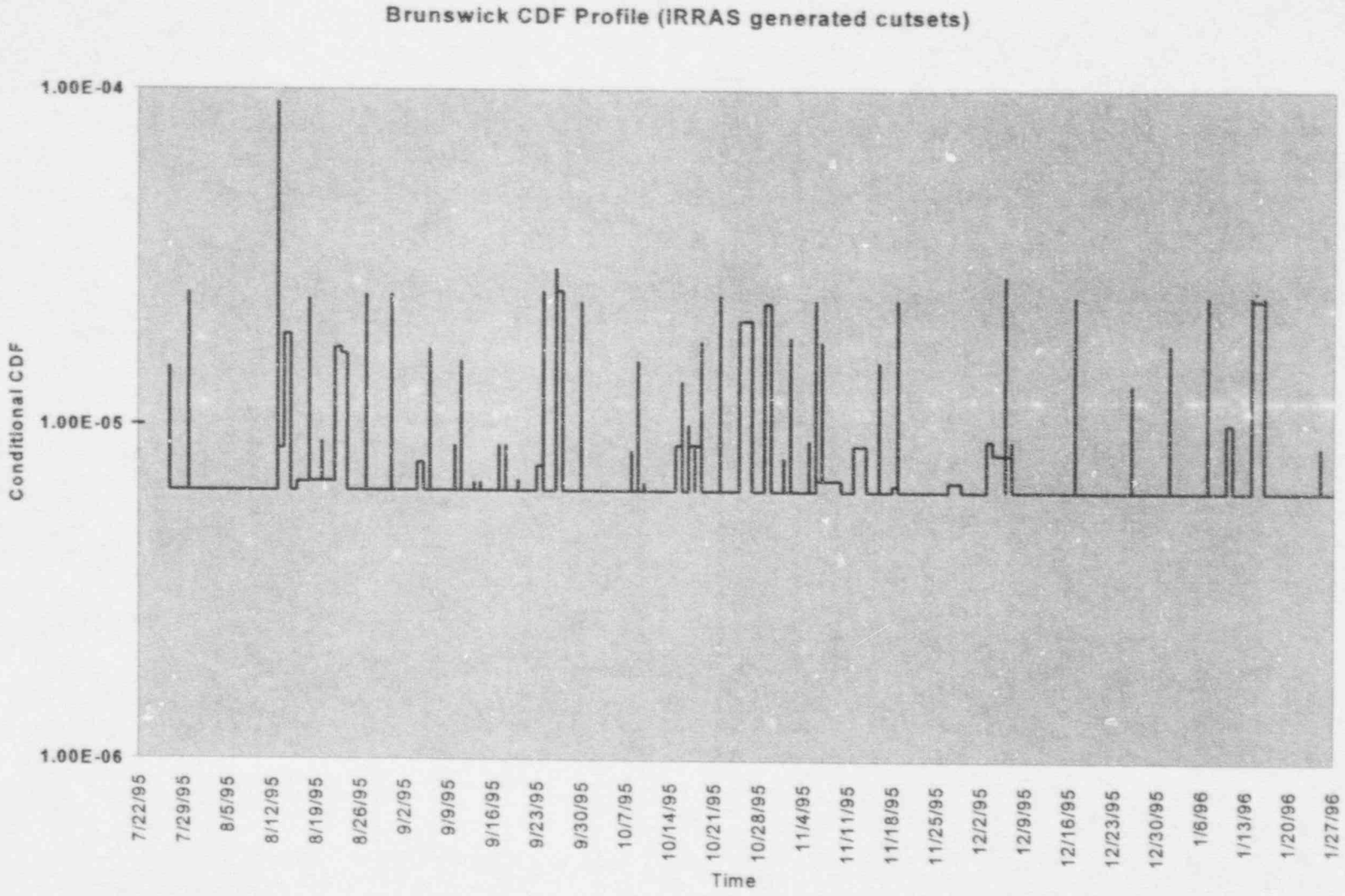
Cumulative CDP of BNP2 configuration profile - EOOS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Conditional CDF
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8/5/95
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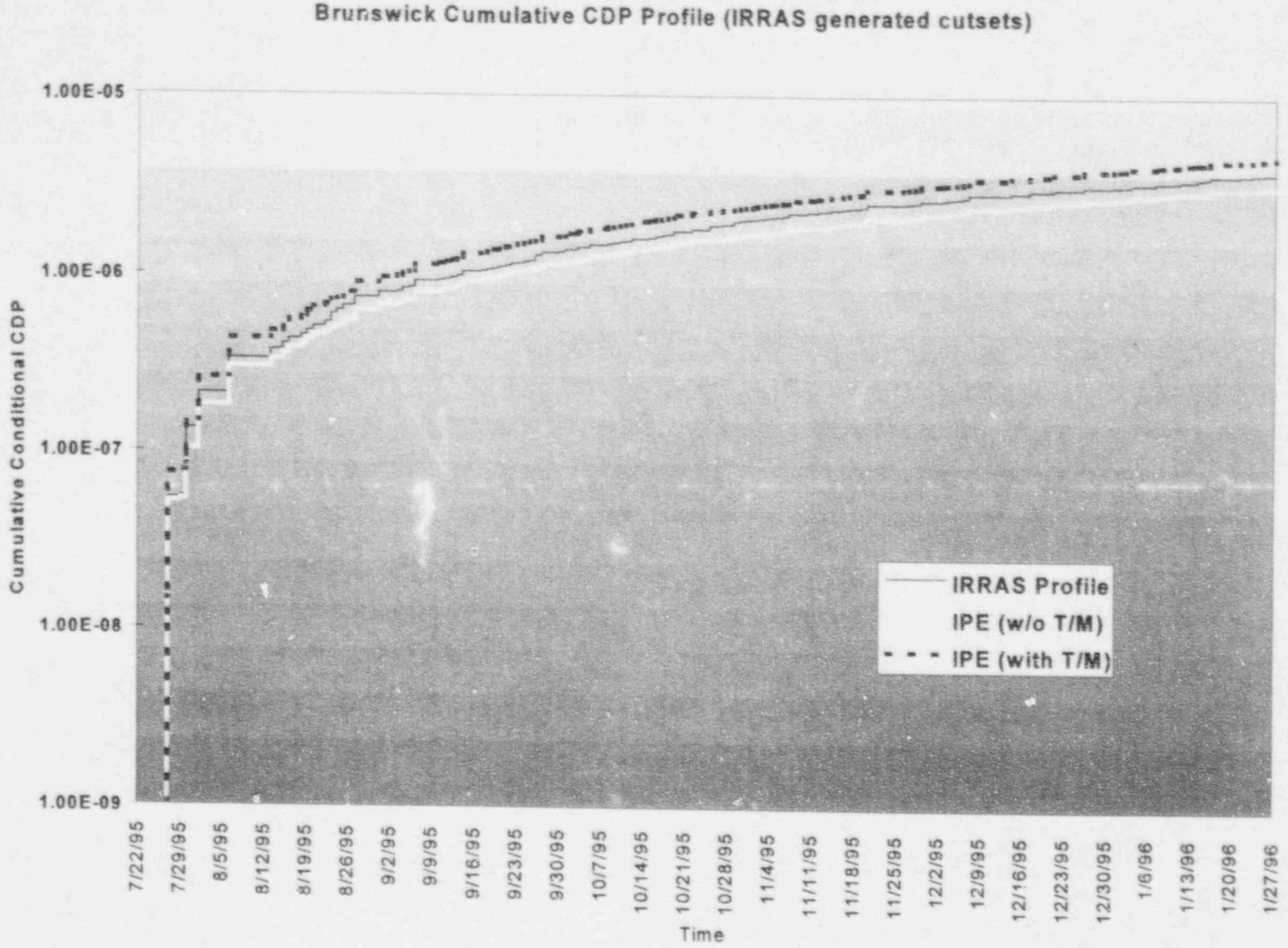
Time


Brunswick Cumulative CDP Profile (IRRAS generated cutsets)
Cumulative Conditional CDP
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1.00E-06
1.00E-07
1.00E-08
1.00E-09
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7/29/95
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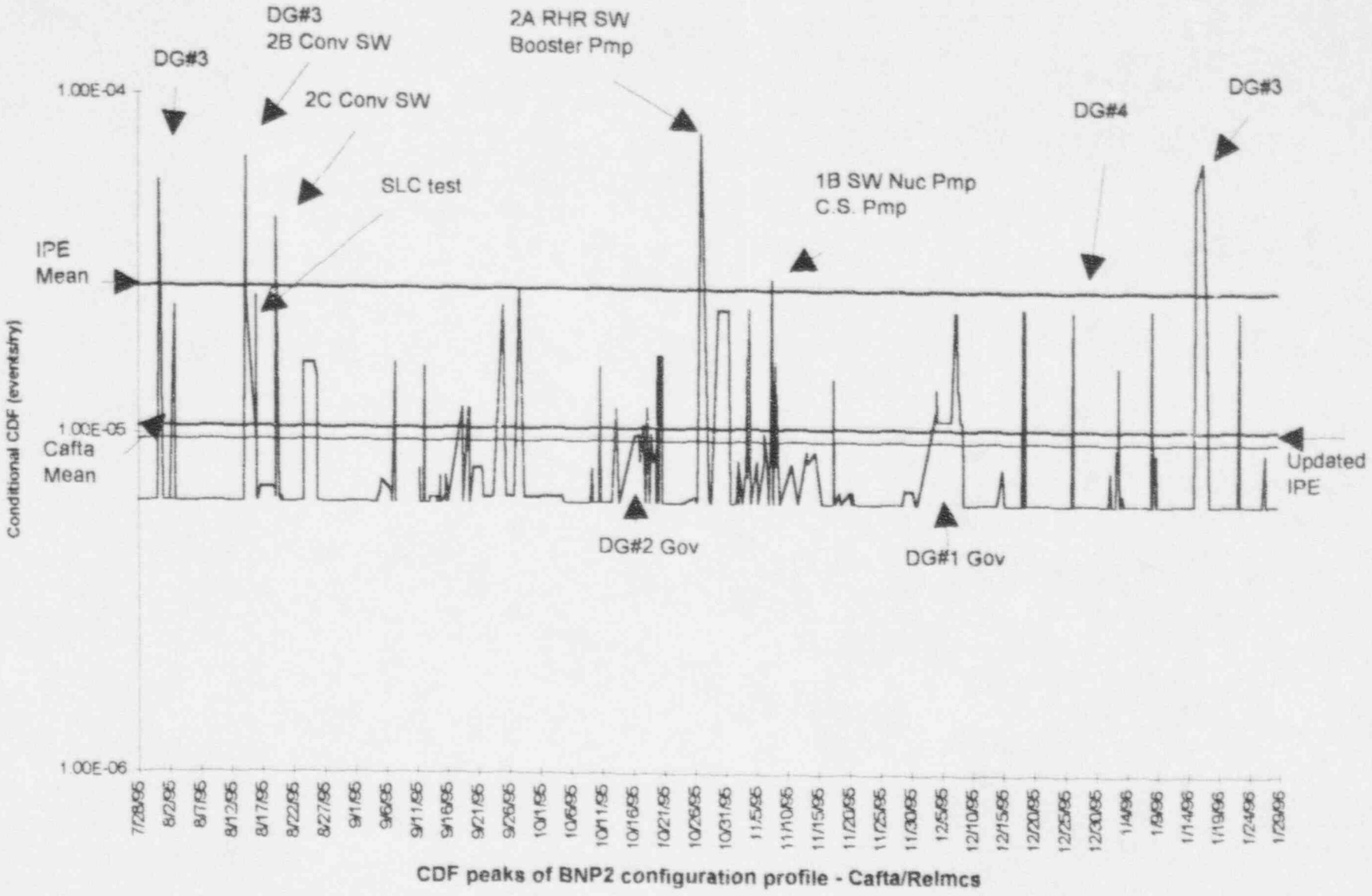
IRRAS Profile
IPE (w/o T/M)
IPE (with T/M)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Cafta
Mean
Updated
IPE
DG#2 Gov
DG#1 Gov
1.00E-04
1.00E-05
1.00E-06
Conditional CDF (events/ry)
CDF peaks of BNP2 configuration profile - Cafta/Relmcs

DRAFT

Development of Plant Configuration Risk Profiles at Brunswick Nuclear Plant.

See-Meng Wong
Wei He
Joseph F. Carbonaro

May 16, 1996

DRAFT

EXECUTIVE SUMMARY

During the week of April 29-May 2, 1996, an NRC team including BNL staff visited the Brunswick Nuclear Plant, Unit 2 (BNP2) as part of a program to develop Probabilistic Risk Assessment (PRA) methodology for evaluating the effectiveness of plant operational risk management at U.S. commercial nuclear power plants. This methodology is being developed to support NRC staff activities under the PRA Implementation Plan (see SECY-95-079) with specific emphasis on inspection planning and Maintenance Rule Implementation (MRI) assessments. The team leader was Dr. Jin W. Chung of NRC/NRR and the team included NRR and NRC Region I staff members, and NRC contractor staff from Brookhaven National Laboratory (BNL), and Idaho National Engineering Laboratory (INEL).

The focus of onsite visit activities was the development and trial applications of a risk-based methodology using plant configuration risk profiles to assess operational risk performance. Specific objectives of the plant site visit included the identification of limitations associated with the methodology, and documenting lessons learned. Potential applications for integrated performance assessment and for developing insights on online maintenance activities were evaluated. The summary results of this site visit will be combined with those obtained at other plant sites and will be issued for the benefit of licensees as part of a "lessons learned" NUREG report.

To accomplish the objectives, plant records and procedures were reviewed to identify the equipment outages occurring over a six month time period, and time-dependent configuration risk profiles were then developed using the plant PRA/IPE model. Results of development of BNP2 configuration risk profiles were presented to the licensee staff at the NRC Entrance Meeting on April 29, 1996. The BNP2 configuration risk profile was based on a review of plant operational records such as the equipment clearance/tag-out records, LCO logs, shift foreman logs, control room operator logs, and maintenance work database. The review period was from July 28, 1995 to January 28, 1996. The computer codes used for configuration risk calculations were CAFTA/RELMCS and EOOS Monitor (EPRI/SAIC's Risk and Reliability Workstation software).

A quality assurance (QA) review of the BNP2 risk profiles was performed to assure the accuracy, consistency, and adequacy of the plant configurations and risk calculations. Prior to the onsite plant visit, NRC staff members (J. Trapp and P. Wilson) and BNL staff had performed a QA review of the equipment outage events considered for input to the development of the plant risk profiles. Both NRC and BNL staff also had discussions with the plant PRA staff members to resolve questions and issues regarding the plant configurations and risk calculations. During the onsite visit, the review teams included licensee PRA staff members, licensee SRO and expert panel members, and the NRC team. The team also held several discussions with licensee staff members on the Maintenance Rule and rolling on-line maintenance activities, PRA and Individual Plant Evaluation (IPE) activities, engineering programs, and operations. The QA review of the BNP2 risk profile resulted in the elimination of 6 plant records and consequently, 11 configuration peaks from the risk profile.

A limited scope assessment of methodology limitations was performed by evaluating risk calculations of selected configurations by other computer codes such as EOOS. (INEL staff

used the IRRAS code to perform configuration risk calculations for methodology validation purposes). Results of EOOS calculations were generally consistent with risk estimates produced by the CAFTA/RELMCS code. However, the comparison between EOOS Monitor and CAFTA/RELMCS calculated results showed that several cases of CAFTA/RELMCS calculations produced higher CDF estimates. The main reasons are: (a) CAFTA/RELMCS results are obtained through full quantification of the BNP2 risk model while EOOS results are produced using pre-solved cutsets, and (b) common cause failure (CCF) probabilities are not adjusted in EOOS calculations to account for CCF impact. In a few cases, the EOOS-calculated CDF estimates were greater than CAFTA/RELMCS results. These results are due to no subsuming of cutsets by EOOS when the pre-solved cutset model was used. (If desired, the cutset subsuming operation can be enabled in the EOOS executable program file). In addition to evaluating calculations between the different computer codes, sensitivity analyses were performed to assess the impact of human error probability (HEP) estimates, common cause failures, and computer code efficiency on configuration risk calculations. A sample uncertainty analysis of important parameters which impact the configuration risk calculations was also performed.

The impact of rolling maintenance and surveillance schedules as reflected in the BNP2 risk profiles, and their impacts on risk and plant performance were evaluated. Repeat failures and duration of equipment outages from the identified configurations were evaluated to determine the bottom-line effectiveness of root cause analyses, maintenance, surveillance activities, and work coordination between plant operations and work control groups.

The detailed findings from the assessment team were discussed daily with members of the licensee staff. Insights from assessment findings were summarized by Dr. Chung and NRC team members at the Exit Meeting on May 2, 1996. Based on the pilot methodology used in this assessment and the plant configuration risk profiles as developed from the plant operating records, the NRC team concluded that the overall risk-informed performance at the Brunswick Nuclear Plant Unit 2 station during the 6-month evaluation period was consistent with the risk envelope of IPE study results.

The following specific observations are made:

1. The CAFTA/RELMCS calculated average Core Damage Frequency (CDF) for the BNP2 configuration risk profile of July 28, 1995 through January 28, 1996 is 7.9E-6 events/reactor year (ry), as compared with the published IPE mean value of 2.7E-5 events/ry. The cumulative Core Damage Probability (CDP) profile for the BNP2 configurations over the 6-month period is 4.3E-6, as compared to the cumulative CDP of 1.36E-5 defined by the yearly IPE mean value.

2. Rolling maintenance schedules for July 28, 1995 - January 28, 1996 for BNP2 station were reviewed, and the dates for the implemented schedules were superimposed onto the plant configuration risk profile. The CDP profile for all "configuration peaks" contributed by work activities in the rolling schedules were **less than** the value of 1.0E-6. This value of 1.0E-6 for the CDP is a proposed decision criterion by NEI (utility industry group) for risk significance determination of temporary plant conditions. (The proposed values for risk significance determination have not been reviewed or approved by NRC staff).

3. The plant documentation to identify the equipment outage configurations was easily accessible and various plant records reflect a consistent picture of plant operational status. Equipment outages due to surveillance and other testing activities as documented in the shift foreman logs were clear and traceable.

4. There were no repeat component failures identified due to corrective maintenance activities. This bottom-line analysis identified no significant problems associated with the root cause analysis program or the post maintenance testing program.

5. No major risk contributors due to prolonged component outages were identified from the BNP2 plant configuration risk profile. Plant configurations that have noticeable risk impacts (i.e., temporary CDF increases above 1.9E-5 events/ry which is 3 x baseline CDF) were driven by simultaneous outages of the diesel generators and service water pumps, or HPCI turbine steam supply isolation valves. It was noted that these configuration peaks were due to surveillance tests performed in one system (e.g., diesel generator DG3) concurrently with planned corrective maintenance activities in another system (e.g., conventional SW pump 2B). However, the durations of most of these configurations were of short time intervals (typically, less than 1 hour durations).

6. Some clusters of configuration peaks were noted in a few specific weeks of the BNP2 configuration risk profile. There is a density of clusters of CDP peaks under the consecutive work weeks of Wk-5 and Wk-6, and Wk-11 and Wk-12. Equipment outages in work weeks Wk-5 and Wk-6 were mostly due to planned corrective maintenance and clearance tags for maintenance activities. In the work weeks of Wk-11 and Wk-12, the equipment outages were due to surveillance testing and corrective maintenance activities. This indicates that preplanning and scheduling work activities of the rolling on-line maintenance program could be more effectively coordinated to address the management of plant risk, and thus minimizing the risk impact of on-line maintenance activities.

7. Several plant configurations have multiple combinations of 6 or more equipment outages. In one particular configuration on August 14, 1995 with relatively high CDF peak, planned corrective maintenance activities were performed on the 2B service water pump and other components in the NSW system while surveillance testing on diesel generator DG3 was conducted simultaneously. However, the time duration of this particular configuration was about 0.3 hour. A few of the other large equipment outage configurations are caused by planned maintenance activities on components on one system (e.g., diesel generators). The time durations of these configurations range from 12 to 29 hours. This indicates that proper coordination between work control and administrative control groups could be improved to avoid multiple outage configurations of components that have risk impact on plant operations.

8. In sensitivity evaluations of human error impact on selected configurations, the BNP2 baseline configuration CDF estimate was sensitive to increased human error probability (HEP) values. In other selected configurations, a factor of 10 change in HEPs resulted in CDF increases by more than a factor of 10. Review of minimal cutsets generated from the calculations showed the presence of multiple human errors in the same cutsets. No remodeling of human errors was performed, and we note that the actual HEP for recovery actions associated with out-of-service equipment may either decrease

or increase from PRA base case values, depending on the specific conditions of each case.

9. In the evaluations of impact of common cause failures (CCFs) on a selected sample of configurations, the CDF estimates were slightly sensitive to changes in the *beta* factors. This is because there were no CCF events associated with the top 10 risk important components based on the Fussell-Vesely importance measure.

10. In the computation uncertainty analysis, the point estimate calculations of CDF for selected sample of configurations provided results very similar to Monte Carlo calculations. The uncertainty distributions for selected basic events were based on the BNP2 database of error (or range) factors provided by the plant PRA staff. (Due to time constraints, uncertainty distributions for HEPs and CCFs were not developed for the analyses performed here). The uncertainty importance of basic events to the CDF distribution were also determined. The uncertainty importance measure provides a figure of merit of the basic event contribution to overall CDF uncertainty. Point estimates of CDF were used in the development of the configuration risk profiles.

11. The configuration risk profile methodology appears workable and provides useful insights on BNP2 operational risk performance.

12. It is recognized that, at present, no quantitative criteria have been established relative to the configuration risk profiles.

1.0 INTRODUCTION

This report documents the results of a plant site visit for development of a PRA assessment methodology to evaluate operational risk performance and configuration control at the Brunswick Nuclear Plant Unit 2 (BNP2) electric station. This methodology is being developed to support NRC staff activities under the PRA Implementation Plan (described in SECY-95-079) for applications to enhance inspection planning and Maintenance Rule Implementation (MRI) assessments. The proposed methodology requires identification of time-dependent plant configurations and development of configuration risk profiles which reflect the risk variations during normal plant operations.

The focus of onsite visit activities was the **development and quality assurance (QA) review** of BNP2 plant configuration risk profiles and trial application of the risk-based methodology to assess operational risk performance. Specific objectives of this plant site visit included the identification of limitations associated with the methodology, and documenting the lessons learned. Potential applications for integrated performance assessment and for developing risk insights on online maintenance activities were evaluated. The summary results of this site visit will be combined with those obtained at other plant sites and will be issued for the benefit of licensees as part of a "lessons learned" NUREG report.

To accomplish the objectives, plant operating records were reviewed to identify equipment outages, and time-dependent configuration risk profiles were then developed using the plant-specific PRA/IPE model. The computer codes used for configuration risk calculations were CAFTA/RELMCS and EOOS. (Risk calculations were also performed using the IRRAS code by INEL staff for methodology validation purposes). Insights from the BNP2 configuration risk profiles are used to identify the strengths and weaknesses of plant performance areas, and to assess the effectiveness of operational risk management processes. In addition, risk insights from the evaluation of integrated performance of plant maintenance activities especially online maintenance activities with 12 week rolling schedules are also included in this report for completeness.

2.0 PLANT CONFIGURATION RISK PROFILES

2.1 Identification of Configurations

Plant operating records for the Brunswick Nuclear Plant, Unit 2 electric station were reviewed to identify configurations of out-of-service equipment for subsequent risk calculations. The review period was from July 28, 1995 through January 28, 1996. The types of plant operating records reviewed include:

- Equipment clearance/tag-out records
- LCO log
- Shift foreman log
- Control room operators log
- Maintenance work database
- Maintenance and surveillance test schedules
- Online maintenance procedures
- Twelve week rolling maintenance schedules
- Plant piping and instrumentation diagrams (P&IDs)

The review of equipment clearance records, LCO logs, maintenance work database and shift foreman logs identified a final list of 249 equipment out-of-service events for the risk profile. A computer software program, called "Configuration Identification System (CIS)", was used to identify the time-dependent configurations based on the input database of the 249 outage events. This software program systematically determines the combinations of equipment outages occurring within same time intervals (i.e., time windows). In each configuration, the operational activities that caused the individual equipment outages were also identified to allow the assessment of performance trends. These operational activities were mostly related to preventive and corrective maintenance, and surveillance test activities.

Prior to the onsite plant visit, NRC staff members (J. Trapp and P. Wilson) and Brookhaven National Laboratory (BNL) staff had performed a QA review of the equipment outage events considered for input to the development of the plant risk profiles. Both NRC and BNL staff also had discussions with the plant PRA staff members to resolve questions and issues regarding the plant configurations to assure that configuration components were accurately modeled in the PRA database. During the onsite visit, plant records were further cross-reviewed to assure accuracy and consistency of the individual equipment outages. The plant configurations for risk evaluation were further reviewed by the NRC/BNL team and licensee personnel using plant procedures and P&IDs. The total number of configurations during the selected review period was 213 configurations. Out of these 213 configurations, 73 configurations were duplicate configurations (i.e., with similar component outages). The list of all configurations with CAFTA/RELMCS calculated risk estimates for the BNP2 risk profile is provided in Table A1 in Appendix A. A similar list of all configurations with EOOS calculated risk estimates is provided in Table A2.

OBSERVATIONS

1. Most of the posted times of component outages recorded in the equipment clearance/tag-out records and LCO logs were consistent with that documented in the shift foreman logs. In a few cases of discrepancies, the posted times documented in the shift foreman logs were used as the actual outage times for the configuration profile.

2. Equipment outages due to surveillance tests were primarily identified from the shift foreman logs. Documentation of operational activities in these logs were clear and traceable.

On the basis of the above observations, it is concluded that plant record keeping between different logs are consistent and appear to reflect an accurate picture of plant operational status. However, the documentation of equipment tag-outs and clearances for corrective and preventive activities could be improved to allow work risk assessment studies to be more conveniently performed.

2.2 Calculation of Configuration Risks

The risk calculations for each identified equipment outage configuration were performed using the updated version of BNP2 PRA model developed for the IPE submittal to the NRC. This BNP2 PRA model is used as the risk model for the plant PRA applications to Maintenance Rule implementation activities. In this PRA model, a very large fault tree was developed to represent the Level 1 core damage model. All configuration risk calculations were performed using the CAFTA/RELMCS code to solve the PRA model. The EOOS Monitor (EPRI/SAIC's Risk & Reliability Workstation program) was also used to generate risk profiles based on a pre-solved cutset model generated from one full quantification of the BNP2 PRA model.

The reference BNP2 PRA model for risk calculations was created by setting all maintenance and test contributions to zero in the input database for the fault tree logic model. Minimal cutsets were then generated to estimate the core damage frequency (CDF) for the baseline configuration. The baseline CDF of 6.3E-6 events/reactor year (ry) was obtained at the cutset probability truncation level of 1.0E-10. The number of minimal cutsets generated at this truncation level was approximately **2540** cutsets, and the time taken for risk quantification is about **6** minutes. Sensitivity evaluations were performed to determine the impact of cutset probability truncation on the fidelity of the PRA model for configuration risk calculations. It was found that the probability truncation levels of 1.0E-8, 1.0E-9, and 1.0E-11 resulted in about 95, 558, and 9491 cutsets, respectively. The baseline CDFs obtained at the truncation levels of 1.0E-8, 1.0E-9, and 1.0E-11 were respectively, 4.4E-6, 5.7E-6, and 6.5 events/ry. The time taken for requantification of the reference risk model at cutset probability truncation levels of 1.0E-8, 1.0E-9, and 1.0E-11 were respectively, about 4 minutes, 5 minutes and 25 minutes. Due to time constraints for requantification of the complete risk model, no sensitivity evaluation of truncation below the probability value of 1.0E-11 was performed at this time.

For each configuration risk calculation, the unavailability values of PRA basic events corresponding to each out-of-service component were modified by setting the relevant event probability values to 1.0, or 0.0. Typically, a plant component unavailability is modeled in a PRA using two or more basic events to account for different failure modes. The total probability from all failure modes of a component cannot exceed the value of 1.0. Thus, when one of the failure modes is assigned a failure probability of 1.0, all other failure mode probabilities are modified accordingly to zero values[1]. No remodeling of human recovery actions associated with the downed components in each configuration were performed. However, sensitivity evaluations of human error impact on selected configurations were performed. In each configuration risk calculation, the common cause failure (CCF) probabilities were adjusted to account for the CCF impact when the status of one or more members of the common cause group (CCG) is known. Thus, the likelihood of failures among the remaining members of the CCG is also considered in the risk calculations. A modified Multiple Greek

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[1] When a basic event unavailability is set to "TRUE", most PRA computer codes implement the requirement for total probability of all failure modes of not exceeding 1.0 by removing "OR" gates associated with the basic events. Thus, if all failure modes for the "TRUE" basic event are not modeled exclusively under the same "OR" gate, the end result estimates are higher than expected.

Letter method was used for quantification of CCF impact. For a group of two components, the CCF probability was set to *beta* or zero when one of the CCG component was taken out-of-service. The CCF probability was set to *beta* if the out-of-service component was a random failure (since the *beta* factor represents the conditional failure probability of one CCG component given the other component was a random failure), and the CCF probability was set to zero if the out-of-service component was under preventive maintenance and can be functionally operable upon demand. In addition, "credit" was also considered to account for the availability of standby component trains, specific components being maintained in the "fail safe" position, and the effects of component outages on initiating event frequencies. The new CDF estimates for individual configurations were then plotted against the time scale to provide a time-dependent configuration risk profile.

When a component is taken out of service, the component outage affects not only unavailability of the system containing the component but it may also affect the frequency of an initiating event (IE). Therefore, it is desirable to have plant-specific fault tree models to evaluate the impact of system train unavailability on the IE frequencies. In the case of the BNP2 PRA model, a fault tree model was developed to calculate the frequency of an accident initiator due to a loss of nuclear service water (NSW) system. If a component outage was determined to have a potential impact on the NSW system, the fault tree was evaluated to obtain a new IE frequency value. In the configuration risk calculations, the modified IE frequencies were used in the quantification process whenever a component outage event has an impact on the NSW system IE frequency.

A limited scope assessment of methodology limitations was performed by evaluating risk calculations of selected configurations by other computer codes such as EOOS. (INEL staff used the IRRAS code to perform configuration risk calculations for methodology validation purposes). Results of EOOS calculations were generally consistent with risk estimates produced by the CAFTA/RELMCS code. However, the comparison between EOOS Monitor and CAFTA/RELMCS calculated results showed that several cases of CAFTA/RELMCS calculations produced higher CDF estimates. The main reasons are: (a) CAFTA/RELMCS calculations are obtained through full quantification of the BNP2 risk model while the EOOS results are produced using pre-solved cutsets, and (b) CCF probabilities are not adjusted in EOOS calculations to account for CCF impact. In a few cases, the EOOS-calculated CDF estimates were greater than CAFTA/RELMCS results. These results are due to no subsuming of cutsets by EOOS when the pre-solved cutset model was used. (If desired, the "cutset subsuming" operation can be enabled in the EOOS executable program file). In addition to evaluating calculations between the different computer codes, sensitivity analyses were performed to assess the impact of HEP estimates, common cause failures (CCFs), and computer code efficiency on configuration risk calculations. A sample uncertainty analysis of important parameters which impact the configuration risk calculations was also performed.

In sensitivity evaluations of human error impact on selected configurations, the HEPs associated with the restoration of out-of-service equipment were changed by factors of 2, 5 or 10 to assess the impact on the CDF estimates of the configurations. It was observed that the BNP2 baseline configuration CDF estimate was sensitive to increased human error probability (HEP) values. In other selected configurations, a factor of 10 change in HEPs resulted in CDF increases by more than a factor of 10. Review of minimal cutsets generated from the calculations showed the presence of multiple human errors in the same cutsets. We

note that the actual HEP for recovery actions associated with out-of-service equipment may either decrease or increase from base case PRA values, depending on the specific conditions of each particular configuration being evaluated.

An important issue in evaluating the risk impact of changing plant configurations is the treatment of common cause failures. Sensitivity evaluations of the impact of CCFs on a selected sample of configurations were performed by adjusting the beta factors of all CCF events affecting the configurations. It was observed that the CDF estimates were slightly sensitive to changes in the beta factors. This indicates that there were no CCF events associated with the top 10 risk important components based on the Fussell-Vesely (FV) importance measure. The CCF events associated with diesel generator failure events are found among the top 400 risk important events based on the F-V importance measure.

The impact of uncertainty in input probabilities was evaluated by performing Monte Carlo calculations of CDF for the base case and selected configurations. Uncertainty distributions were developed for selected basic events based on the BNP2 database of error (or range) factors. This database was provided to BNL staff by the plant PRA staff. (Due to time constraints, the uncertainty distributions for HEPs and CCFs were not developed for the analyses performed here). The database with uncertainty distributions and cutsets generated from each risk calculation of selected configurations were then provided as input to a SAIC uncertainty analysis code called "UNCERT" to perform Monte Carlo simulations. The sampling size for each uncertainty calculation was 1000. The CDF distributions produced from the Monte Carlo simulations showed long "tails" which are typical PRA results. The mean values from the Monte Carlo calculations were very close to the point estimates of CDF which were used in the development of the configuration risk profiles. In addition, the median, skewness, and kurtosis for each CDF distribution are provided. The uncertainty importance of basic events to the CDF distribution were also determined. (However, the importance calculations require long computational times when this feature of the UNCERT code is enabled). The uncertainty importance measure provides a figure of merit of the basic event contribution to overall CDF uncertainty.

Out of 213 configurations identified for the BNP2 risk profile, the CAFTA/RELMCS calculations showed 166 configurations with CDF "peaks" while the EOOS calculations showed 125 configurations with CDF peaks. The new average CDF value obtained by CAFTA/RELMCS calculations was 7.9E-6 events/ry, while the average CDF estimate obtained by EOOS calculations was 7.5E-6 events/ry.

Summary

	CAFTA/RELMCS	EOOS
Review period	7/28/95 - 1/28/96	7/28/95 - 1/28/96
Number of configurations	213	213
CDF peaks above baseline	166	125

2.3 Review of Configuration Risk Profiles

The CDF and Core Damage Probability (CDP) profiles for 213 equipment out-of-service configurations were plotted from results of CAFTA/RELMCS and EOOS calculations. (It should be noted that each CDF peak represents the value of CDF if the plant was to operate continuously under the same configuration for a full 12 month period). A quality assurance (QA) review of the BNP2 risk profiles were performed during the plant site visit. This QA review was conducted to assure accuracy, consistency, and adequacy of the plant configurations and risk calculations. The QA review team included licensee PRA staff members, licensee Senior Reactor Operators (SROs) and Expert Panel members, and the NRC team. The QA review resulted in the elimination of 6 plant records as input to the database for determining the configurations. These 6 plant records documented outage events which were interpreted to have no risk impact because the components were in "fail safe" positions (i.e., functionally operable upon demand), or the components were modeled ambiguously in the BNP2 risk model. This revision resulted in the elimination of 11 configuration peaks, and some of these peaks have erroneously high CDF estimates. Plant procedures and P&ID drawings for the out-of service equipment were reviewed to support the revision of the input database for developing the risk profiles. The final cumulative CDP profiles (CAFTA/RELMCS & EOOS) for BNP2 configurations are observed to be consistent with the CDP profile defined by the yearly IPE mean value.

The implemented 12-week rolling maintenance schedule was superimposed on the BNP2 profile of CDP peaks. This superimposition provided the risk perspective of work control and scheduling of planned maintenance activities and their impact on BNP2 plant operational performance.

As shown in the BNP2 risk profiles, the new average CDF values (CAFTA mean of 7.9E-6 events/ry and EOOS mean of 7.5E-6 events/ry) for all configurations during the review period are below the updated IPE mean value of 9.6E-6 events/ry, and the previously published IPE mean value of 2.7E-5 events/ry. The CAFTA/RELMCS generated profile shows 33 CDF peaks with CDF values above 1.9E-5 events/ry (3 x baseline CDF), and the highest CDF peak has a value of 6.5E-5 events/ry. For comparison, the EOOS generated profile shows 31 CDF peaks with CDF values above 1.9E-5 events/ry, and the highest CDF peak has a value of 6.1E-5 events/ry. The highest CDF peaks shown in the CAFTA/RELMCS and EOOS generated profiles were due to configurations with simultaneous outages of the diesel generators and service water pumps, or HPCI turbine steam supply isolation valves. It was noted that these configuration peaks were due to surveillance tests performed in one system (e.g., diesel generator DG3) concurrently with planned corrective maintenance activities in another system (e.g., conventional SW pump 2B). However, the durations of these configurations were of short time intervals (typically, less than 1 hour durations). The CDP peaks of these configurations were less than the value of 1.0E-8. (The NEI threshold value is 1.0E-6 which has not been reviewed by NRC staff).

OBSERVATIONS

		CAFTA/RELMCS	EOOS
1.	Highest CDP peak value	1.8E-7	1.6E-7
2.	Highest CDF peak value	6.5E-5 /ry	6.1E-5 /ry
3.	CDF Peaks > 1.9E-5 /ry(3 x baseline)	33	31
4.	New Average CDF value	7.9E-6 /ry	7.5E-6 /ry
5.	Baseline CDF* value	6.3E-6 /ry	6.3E-6 /ry
6.	Updated IPE Mean CDF value	9.6E-6 /ry	9.6E-6 /ry
7.	Published IPE Mean CDF value	2.7E-5 /ry	2.7E-5 /ry

(*) : Test and maintenance contributions set to zero probability

3.0 RISK INSIGHTS FROM THE RISK PROFILE

3.1 Integrated Operational Performance

The primary objectives of the operational risk management methodology are to extract risk insights from time-dependent risk profiles, and to identify risk contributors associated with each configuration and peaks from the risk profiles. To accomplish these objectives, observable elements of the risk profiles are identified to determine the risk contributors due to plant operational activities. As an example, configuration peaks due to repetitive failures in the risk profile may indicate weaknesses in root-cause analysis programs, and the repetitive peaks are an observable element of the configuration risk profiles.

Overall operational performance was evaluated by review of integral effects of plant risk profiles for the management and control of risk during plant operations. The time-dependent configuration risk profiles were reviewed against the time-averaged risks presented in the IPE submittal, and the cumulative risks due to equipment outage configurations occurring over the period of review were compared with the yearly average cumulative risks presented in the IPE study.

OBSERVATIONS

Based on results presented on the summary table in Section 2.3, it is concluded that the operational risk performance for BNP2 station during the review period was managed to a value better than the published IPE mean value. The overall operational performance during the review period was consistent with the risk envelope defined in the IPE study as far as equipment unavailability was concerned.

3.2 Risk-based Assessment of Operations

The area of plant operations was evaluated by review of several observable elements from the risk insights and the configuration risk profiles. The observable elements include (i) the cumulative CDP value from the plant configuration risk profile for comparison with the time-averaged IPE estimate, (ii) equipment failures as potential accident initiators or initiating events, (iii) development of an operational risk improvement program and operational interfaces with Maintenance Rule Implementation, (iv) "time window" of configuration risk peaks, and (v) magnitude of risk increase or number of instances of CDP or CDF peaks within a short time period.

OBSERVATIONS

1. Based on the new average CDF values obtained for all configurations in the BNP2 risk profiles (CAFTA/RELMCS & EOOS calculated values), the operational risk performance during the assessment period was better than the risk estimate presented in the IPE submittal. Most of the peaks and integrated data presented are within the expected variation of data.

2. Within the assessment period, it was observed that a few equipment outages in the configurations were random equipment failures. These equipment failures occurred in the RHR service water, nuclear service water, diesel generator, and RHR systems. However, none of these random equipment failures had resulted in accident initiating events or that could be traced to event initiators.

3. Some clusters of configuration peaks were noted in a few specific weeks of the BNP2 configuration risk profiles. However, the heights of the clustered peaks are not relatively high and the time windows have very short durations. As shown by the calculated CDP values (which are less than 2.0E-7), these configuration peaks do not indicate any significant risk concerns. The clustering of the peaks shows that preplanning and scheduling work activities of the rolling online maintenance program could be more effectively coordinated to address the management of plant risk, and thus minimizing the risk impact of online preventive maintenance activities.

4. Among the 33 configurations with noticeable risk impact above the baseline of CAFTA/RELMCS generated profile, 19 configurations have component outages due to surveillance activities. These 19 configurations were mostly due to surveillance testing activities on the diesel generators, HPCI turbine driven pump, and HPCI turbine steam supply isolation valves. However, these surveillance activities were mostly less than one hour durations and the associated CDP peaks were less than 2.0E-8.

Based on the above observations, it is concluded that the operational risk management process at BNP2 station is effectively implemented during plant operations. There is also effective coordination between the PRA staff and work control group to managing plant operational risks to even lower levels.

3.3 Risk-Based Assessment of Engineering

The area of engineering support to plant operations and maintenance was assessed by review of several observable elements found from the risk insights and the configuration risk profile. The observable elements include (i) management of planned and unplanned operational activities as shown by the insights gained from the risk profiles, (ii) number of repeat failures of plant components and system trains, (iii) common cause failures, (4) the occurrence rate of failures in risk important plant components and system trains, and (v) failures in plant systems and equipment subject to Technical Specifications (TSs) requirements.

OBSERVATIONS

1. No repeat failures of plant components were identified in the peaks of the configuration risk profiles. Therefore, there were no problems associated with the root cause analysis program or the post maintenance testing program, as identified from this review.

2. Among the component outages in the configurations, no common cause failures were identified. Thus, no problems were identified in the engineering support to plant operations.

3. There were a few equipment outages in the configuration peaks that were random failures. These random failures occurred in configurations in which the other outage events were due to either preventive maintenance, surveillance test, or clearance tagging activities. There were no coincident random failures in any particular configuration, and none of these random failures resulted in accident initiators.

Based on the above observations, no weaknesses were identified in the integrated performance of engineering support to plant operations and maintenance.

3.4 Risk-based Assessment of Maintenance

The area of maintenance was assessed by review of several observable elements from the configuration risk profiles. The observable elements include: (i) the maintenance program uses an acceptable risk-based methodology to consider risk significance of maintenance unavailabilities, (ii) effective applications of risk-based methods to lower the mean CDF value as enveloped in the IPE submittal, (iii) magnitude of configuration peaks driven by equipment outages due to corrective or preventive maintenance activities and length of the "time windows", (iv) size or number of instances of CDP peaks due to surveillance testing activities or random equipment failures, and (v) risk management of online rolling maintenance activities.

OBSERVATIONS

1. No repeat maintenances were observed on the same components identified in the peaks of the configuration risk profiles. Review of previous monthly plant performance reports found no repeat maintenances on the components in the identified

configurations. These observations imply that the quality of corrective maintenance work and maintenance planning were well managed.

2. Most of the high CDP or CDF peaks in the plant configuration risk profile for BNP2 station were observed to have short "time windows". However, some clusters of CDP peaks were noted under a few specific work weeks of the rolling maintenance schedule. This observation implies that maintenance work preplanning and work control processes for maintenance of risk important plant components could be improved to better coordinate the management of plant operational risk.

Based on the above observations, it was concluded that the preplanning and scheduling of maintenance work activities could be improved to better coordinate the management of plant operational risk.

4.0 ONLINE MAINTENANCE RISK ASSESSMENT

As part of trial applications of the configuration risk profile methodology (to provide PRA insights for use in Online Maintenance Risk assessments), the 12 week rolling maintenance schedules for maintenance activities at BNP2 station were reviewed. The objective of this review was to determine the effectiveness of the licensee's applications of risk-based methodologies for the implementation of maintenance programs.

The area of maintenance was evaluated on the basis of several observable elements from the configuration risk profiles. The observable elements include (i) the use of appropriate risk-based methods for evaluating risk impact of the rolling online maintenance program and activities, (ii) risk assessment of non-PRA and BOP systems and component trains, (iii) size of configuration risk peaks and length of "time windows" driven by the online maintenance activities, and (iv) risk management of online rolling maintenance activities.

Work schedules for planned maintenance activities in the 12 week rolling maintenance program at BNP2 station were reviewed to identify the risk impact of the rolling maintenance schedule. Weekly periods of the rolling schedule, identified as Wk-5, Wk-4, Wk-1, etc., for planned maintenance activities on a particular system division, or equipment train (e.g., Unit II Div 1 DG3, Train A; or Unit II Div2 DG4, Train B), were superimposed on the BNP2 risk profile. The superimposition of the rolling schedule on the BNP2 risk profile provides insights on the potential risk impacts of a particular planned maintenance work week of the 12-week rolling schedule.

OBSERVATIONS

1. The long term (12 week window) rolling schedule for online maintenance activities are continuously monitored against allowed outage times defined in Technical Specifications. On-line maintenance which requires entry into a voluntary LCO are scheduled not to exceed one half of LCO time unless prior plant management approval is obtained. Rolling schedules for maintenance activities are established for

divisional/train-wise implementation (e.g., DG3/HPCI/SBGT in Week 3 "C" versus DG4/RCIC in Week 4 "D").

2. Risk changes due to the performance of the planned maintenance work (both CM and PM), surveillances and other operational activities are evaluated prior to initiation of work activity. System outages of more than one risk significant system at the same time are minimized by using the BNP System Matrix to identify unacceptable system outage combinations. Suggestions for schedule revision of planned maintenance activities are transmitted to the PRA personnel and maintenance scheduling planners when potential undesirable equipment outage configurations are anticipated.

3. Within the assessment period, the superimposition of the rolling maintenance schedule on the BNP2 risk profile indicates that none of the CDP peaks for planned maintenance work weeks of the rolling schedule exceeded the value of 1.0E-6. However, some clusters of CDP peaks were noted under a few specific work weeks of the rolling schedule. For example, there is a density of clusters in the consecutive work weeks of Wk-5 and Wk-6, and Wk-11 and Wk-12. Equipment outages in work weeks Wk-5 and Wk-6 were mostly due to planned corrective maintenance and clearance tags for maintenance activities. In the work weeks of Wk-11 and Wk-12, the equipment outages were due to surveillance testing and corrective maintenance activities. This indicates that the use of PRA insights for preplanning and scheduling work activities of the rolling online maintenance program could be more effectively coordinated to address the management of plant risk.

4. Several plant configurations have multiple combinations of 6 or more equipment outages. In one particular configuration on August 14, 1995 with relatively high CDF peak, planned corrective maintenance activities were performed on the 2B service water pump and other components in the NSW system while surveillance testing on diesel generator DG3 was conducted simultaneously. However, the time duration of this particular configuration was about 0.3 hour. A few of the other large equipment outage configurations are caused by planned maintenance activities on components in one system (e.g., diesel generators). The time durations of these configurations range from 12 to 29 hours. This indicates that proper coordination between work control and administrative control groups could be improved to avoid multiple outage configurations of components that have risk impact on plant operations.

Based on the above observations, it was concluded that the licensee staff is using PRA insights to manage plant operational risk. This approach has helped to improve the integrated performance of online maintenance activities at the BNP2 nuclear station.

In summary, the configuration risk profile methodology appears workable and provides useful insights on BNP2 operational risk performance. It is recognized that, at present, no quantitative criteria have been established relative to the configuration risk profiles.

ATTACHMENT 1

Nuclear Regulatory Commission	Organization
Brown, E.	Intern Inspector
Chung, Jin W.	PSPB, NRR
Eide, S.	INEL
He, W.	BNL
Janus, M.	Resident Inspector
Lanahan, J.	Resident Inspector
Patterson, C.	Sr. Resident Inspector
Smith, C.	INEL
Trapp, J.	Region I
Wilson, P.	NRR
Wong, S.M.	BNL

Carolina Power & Light Company

Altman, B.	Manager, Outage & Scheduling
Barnes, G.	Manager, Training
Blinson, M.	Engineer, Maintenance Rule Implementation
Bryant, R.	Staff, Document Services
Creech, R.	Lead Engineer, Regulatory Affairs
Franke, J.	Supervisor, BNP Engineering Support Services
Gannon, C.	Manager, Maintenance
Gawron, J.	Manager, Nuclear Assessment Department
Gibbs, R.	PRA Engineer
Hardin, D.	Operations Supt., Work Coordination
Hicks, D.	Manager, Regulatory Affairs
Honma, G.	Manager (Lic & Reg Prog), Regulatory Affairs
Laur, S.	PRA Engineer
Levis, W.	Director, BNP Site Operations
Leviner, J.	Supt (Mech NSSS), BNP Engineering Support Services
Lindgren, B.	Manager, Site Support Services
Lopriore, R.	Plant Manager
Lyash, J.	Manager, Operations
Martin, J.	Supervisor, On-Line Scheduling
McKenzie, S.	Staff, Communications
Miller, G.	Manager, PRA Group
Morris, M.	Work Week Manager, Operations
Mullis, R.	Assistant to Vice-President, BNP Site
Noland, W.	Engineer, Operations
Pardee, C.	Manager, Operations Support
Pierce, T.	Project Analyst, Outage & Scheduling
Pitts, H.	Supervisor (Elec/I&C), BNP Engineering Support Services
Poteralski, D.	Manager, Nuclear Fuels Management & Safety Analysis

Schlichter, R.	Manager, Environmental & Radiation Control
Thompson, J.	Supervisor, Plant Operations Assessment

Appendix A

Table A1. Equipment Outage Configurations for BNP Unit 2 Configuration Risk Profile - CAFTA/RELMCS Calculations

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
1	2-E11-F016A-MO	7/28/95	1.0	6.32E-06	7.21E-10	3.6.3	DM	
2	2-E11-F016A 2-E11-F016A-MO 2-E11-F021A	7/28/95	13.0	6.32E-06	9.38E-09	 3.6.3	DM DM CL	
3	2-E11-F016A-MO	7/28/95	1.0	6.32E-06	7.21E-10	3.6.3	DM	
4	2-DG3-GEN	7/31/95	1.0	2.39E-05	2.73E-09	3.8.1.1	CMp	
5	2-DG3-CS-209SS 2-DG3-CS-211SS 2-DG3-GEN 2-DGC-DJ0-52 2-E3-AI5-52 2-EB-CS-962-2	7/31/95	7.0	5.54E-05	4.43E-08	 3.8.1.1	CMp CMp CMp CMp CMp CMp	
6	2-DG3-GEN	7/31/95	6.0	2.39E-05	1.64E-08	3.8.1.1	CMp	
7	2-E41-C001	8/2/95	0.4	5.96E-05	2.72E-09		ST	
8	2-DG4-GEN	8/7/95	0.8	2.35E-05	2.15E-09		ST	
9	2-2PB-E37-52 2-E4-AL2 2-SW-2B-CONV-PMP 2-SW-CS-319 2-SW-V16	8/14/95	3.3	7.94E-06	2.99E-09	 3.7.1.2	CMp CMp CMp CMp CMp	
10	2-2PB-E37-52 2-DG3-GEN 2-E4-AL2 2-SW-2B-CONV-PMP 2-SW-CS-319 2-SW-V16	8/14/95	0.3	6.53E-05	2.24E-09	 3.8.1.1 3.7.1.2	CMp ST CMp CMp CMp CMp	
11	2-2PB-E37-52 2-E4-AL2 2-SW-2B-CONV-PMP 2-SW-CS-319 2-SW-V16	8/14/95	38.3	7.94E-06	3.47E-08	 3.7.1.2	CMp CMp CMp CMp CMp	
12	2-2PB-E37-52 2-C41-F001 2-E4-AL2 2-SW-2B-CONV-PMP 2-SW-CS-319 2-SW-V16	8/15/95	0.7	7.94E-06	6.34E-10	 3.1.5 3.7.1.2	CMp ST CMp CMp CMp CMp	
13	2-2PB-E37-52 2-E4-AL2 2-SW-2B-CONV-PMP 2-SW-CS-319 2-SW-V16	8/16/95	1.4	7.94E-06	1.27E-09	 3.7.1.2	CMp CMp CMp CMp CMp	
14	1-1PA-BU9 1-1PA-BV0 1-E1-AF6 2-SW-CS-320 2-SW-V17 2-SW-V18	8/16/95	13.0	6.54E-06	9.71E-09		CL CL CL CL CL CL	
15	2-2PB-E38 2-SW-V20	8/17/95	36.4	6.93E-06	2.88E-08		CL CL	

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (event/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
16	1-E1 2-2PB-E38 2-SW-V20	8/19/95	1.0	6.93E-06	7.91E-10	3.8.2.1	ST CL CL	
17	2-2PB-E38 2-SW-2C-CONV-PMP 2-SW-V20	8/19/95	0.6	6.93E-06	4.75E-10	3.7.1.2	CL ST CL	
18	2-SW-2C-CONV-PMP	8/19/95	3.0	6.32E-06	2.16E-09	3.7.1.2	ST	
19	1-1PA-BU9 1-1PA-BV0 1-E1-AF6 2-SW-2C-CONV-PMP 2-SW-CS-320 2-SW-V17 2-SW-V18	8/19/95	12.0	4.33E-05	5.93E-08	3.7.1.2	CL CL CL ST CL CL CL	
20	2-SW-2C-CONV-PMP	8/19/95	7.0	6.32E-06	5.05E-09	3.7.1.2	ST	
21	1-E1-AF6-52 2-SW-2C-CONV-PMP	8/20/95	1.0	6.32E-06	7.21E-10	3.8.2.1 3.7.1.2	CL ST	
22	2-SW-2C-CONV-PMP	8/20/95	4.0	6.32E-06	2.89E-09	3.7.1.2	ST	
23	1-E1-AF6 2-SW-2C-CONV-PMP 2-SW-CS-320	8/20/95	33.3	6.32E-06	2.40E-08	3.7.1.2	CL ST CL	
24	1-E1-AF6 2-DG2-ENG 2-SW-2C-CONV-PMP 2-SW-CS-320	8/21/95	0.2	8.96E-06	2.05E-10	3.7.1.2	CL ST ST CL	
25	1-E1-AF6 2-SW-2C-CONV-PMP 2-SW-CS-320	8/21/95	34.5	6.32E-06	2.49E-08	3.7.1.2	CL ST CL	
26	1-E1-AF6 2-E11-F016B-MO 2-SW-2C-CONV-PMP 2-SW-CS-320	8/23/95	2.0	6.32E-06	1.44E-09	3.6.3 3.7.1.2	CL PM ST CL	
27	1-E1-AF6 2-E11-F016B-MO 2-E11-F021B 2-SW-2C-CONV-PMP 2-SW-CS-320	8/23/95	5.2	6.32E-06	3.75E-09	3.6.3 3.7.1.2	CL PM PM ST CL	
28	1-E1-AF6 2-E11-F016B-MO 2-E11-F021B 2-SW-2C-CONV-PMP 2-SW-CS-320 2-SW-PS-1176B	8/23/95	1.7	6.32E-06	1.23E-09	3.6.3 3.7.1.2	CL PM PM ST CL ST	
29	1-E1-AF6 2-E11-F016B-MO 2-E11-F021B 2-SW-2C-CONV-PMP 2-SW-CS-320	8/23/95	4.1	6.32E-06	2.96E-09	3.6.3 3.7.1.2	CL PM PM ST CL	
30	2-E11-F016B-MO 2-E11-F021B 2-SW-2C-CONV-PMP	8/23/95	0.7	6.32E-06	5.05E-10	3.6.3 3.7.1.2	PM PM ST	
31	2-E11-F016B-MO 2-E11-F021B	8/23/95	0.3	6.32E-06	2.16E-10	3.6.3	PM PM	

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
32	2-E11-F016B-MO 2-E11-F021B 2-E11-PDV-F068B	8/23/95	9.0	1.61E-05	1.65E-08	3.6.3 3.6.5.1	PM PM CM	 RandomF
33	2-2XB-DN1 2-2XB-HL4-21 2-E11-CS-5572B 2-E11-PDV-F068B	8/24/95	15.0	1.61E-05	2.76E-08	 3.6.5.1	CL CL CL CM	 RandomF
34	1-E2-AG8-52 2-2XB-DN1 2-2XB-HL4-21 2-E11-CS-5572B 2-E11-PDV-F068B	8/24/95	17.8	1.61E-05	3.27E-08	 3.6.5.1	CL CL CL CL CM	 RandomF
35	1-E2-AG8-52 2-2XB-DN1 2-2XB-HL4-21 2-E11-CS-5572B	8/25/95	11.2	1.61E-05	2.06E-08		CL CL CL CL	
36	1-E2-AG8-52 2-2XB-DN1 2-E11-CS-5572B	8/25/95	1.0	1.61E-05	1.84E-09		CL CL CL	
37	2-E11-F015B	8/26/95	0.2	6.32E-06	1.44E-10		ST	
38	2-DG3-ENG	8/28/95	0.5	2.39E-05	1.36E-09	3.8.1.1	ST	
39	2-DG3-GEN	9/1/95	0.3	2.39E-05	8.18E-10	3.8.1.1	ST	
40	2-DG4-GEN	9/4/95	0.4	2.35E-05	1.07E-09	3.8.1.1	ST	
41	2-SW-V16	9/5/95	2.8	7.33E-06	2.34E-09	3.7.1.2	CL	
42	2-2PB-E37-52 2-E4-AL2 2-SW-CS-319 2-SW-V16	9/5/95	37.0	7.94E-06	3.35E-08	 3.7.1.2	CL CL CL CL	
43	2-SW-V16	9/6/95	3.9	7.33E-06	3.26E-09	3.7.1.2	CL	
44	2-E51-V8	9/7/95	0.5	1.64E-05	9.36E-10		CMp	
45	2-E4-AL2	9/7/95	0.3	6.75E-06	2.31E-10		CL	
46	2-DG1-GEN	9/11/95	0.4	8.37E-06	3.82E-10		ST	
47	2-C41-F001	9/12/95	1.7	1.61E-05	3.12E-09	3.1.5	ST	
48	2-SW-V123	9/13/95	0.7	6.54E-06	5.23E-10	3.5.3.1	CL	
49	2-RNA-IV-230 2-SW-V123	9/13/95	23.0	6.54E-06	1.72E-08	 3.5.3.1	CL CL	
50	2-RNA-IV-230 2-SW-V123 2-SW-V123-AO	9/14/95	2.0	6.54E-06	1.49E-09	 3.5.3.1	CL CL CMp	
51	2-SW-V123 2-SW-V123-AO	9/14/95	1.0	6.54E-06	7.47E-10	3.5.3.1	CL CMp	
52	2-SW-V123	9/14/95	0.9	6.54E-06	6.72E-10	3.5.3.1	CL	
53	2-2PB-E38-52 2-SW-V20	9/14/95	3.0	6.93E-06	2.37E-09		CMp CL	
54	2-SW-2B-CONV-PMP	9/14/95	0.7	6.39E-06	5.11E-10	3.7.1.2	ST	
55	2-2PB-E38-52 2-SW-V20	9/15/95	4.0	6.93E-06	3.16E-09		CL CL	
56	2-SW-2B-CONV-PMP	9/15/95	6.4	6.39E-06	4.67E-09	3.7.1.2	ST	
57	2-DG2-ENG	9/18/95	0.3	8.96E-06	3.07E-10	3.8.1.1	ST	
58	2-DG2-ENG	9/19/95	0.3	8.96E-06	3.07E-10	3.8.1.1	CM	RandomF

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
59	1-E2-AG7-52 2-DG2-ENG 2-DGB-DY3 2-EB-CS-957-2	9/19/95	3.0	8.96E-06	3.07E-09	3.8.1.1	CL CM CL CL	RandomF
60	2-DG2-ENG	9/19/95	1.7	8.96E-06	1.74E-09	3.8.1.1	CM	RandomF
61	2-C12-F013B	9/20/95	23.0	6.32E-06	1.66E-08		CMp	
62	2-2XB-DM6-52 2-C12-F013B 2-SW-CS-V102	9/21/95	9.0	8.00E-06	8.22E-09		DM CMp CL	
63	2-2XB-DM6-52 2-C12-F013B 2-E11-F015B 2-SW-CS-V102	9/21/95	0.2	8.00E-06	1.83E-10	3.5.3.2	DM CMp ST CL	
64	2-2XB-DM6-52 2-C12-F013B 2-E11-C002B 2-E11-F015B 2-SW-CS-V102	9/21/95	2.0	8.01E-06	2.56E-09	3.5.3.2	DM CMp ST ST CL	
65	2-2XB-DM6-52 2-C12-F013B 2-E11-C002B 2-SW-CS-V102	9/21/95	3.0	8.01E-06	2.74E-09		DM CMp ST CL	
66	2-C12-F013B 2-E11-C002B	9/21/95	1.0	6.55E-06	7.48E-10		CMp ST	
67	2-E11-C002B	9/21/95	9.0	6.55E-06	6.73E-09	3.7.1.1	ST	
68	2-E11-C002B 2-RCC-V32 2-RCC-V38	9/22/95	6.0	6.55E-06	4.49E-09		ST PM PM	
69	2-E11-C002B 2-E11-F015A 2-E3-AJ1-52 2-RCC-V32 2-RCC-V38	9/22/95	3.0	6.55E-06	2.24E-09	3.5.3.2 3.5.3.2	ST PM PM PM PM	
70	2-E11-C002B 2-E11-F015A 2-RCC-V32 2-RCC-V38	9/22/95	2.0	6.55E-06	1.50E-09	3.5.3.2	ST PM PM PM	
71	2-E11-C002B 2-RCC-V32 2-RCC-V38	9/22/95	19.0	6.55E-06	1.42E-08		ST PM PM	
72	2-E11-C002B	9/23/95	37.0	6.55E-06	2.77E-08		ST	
73	2-C12-F046A 2-C12-F047A 2-E11-C002B	9/24/95	11.0	6.55E-06	8.22E-09		CL CL ST	
74	2-C12-F046A 2-C12-F047A 2-DG3-GEN 2-E11-C002B	9/25/95	0.5	2.39E-05	1.36E-09	3.8.1.1	CL CL ST ST	
75	2-C12-F046A 2-C12-F047A 2-E11-C002B	9/25/95	3.5	6.55E-06	2.62E-09		CL CL ST	
76	2-E11-C002B	9/25/95	1.8	6.55E-06	1.35E-09	3.5.3.2	ST	

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
77	2-DG3-GEN 2-E11-C002B	9/25/95	1.6	2.39E-05	4.37E-09	 3.5.3.2	ST ST	
78	2-E11-C002B	9/25/95	11.6	6.55E-06	8.67E-09	3.5.3.2	ST	
79	2-2PA-E08 2-E11-C002B 2-SW-2A-CONV-PMP	9/26/95	14.0	6.55E-06	1.05E-08	3.7.1.2 3.5.3.2 3.7.1.2	DM ST DM	
80	2-E11-C002B	9/26/95	19.0	6.55E-06	1.42E-08		ST	
81	2-C12-C001A-M 2-E11-C002B	9/27/95	1.0	6.55E-06	7.48E-10		ST ST	
82	2-E11-C002B	9/28/95	93.4	6.55E-06	6.98E-08		ST	
83	2-DG4-GEN 2-E11-C002B	10/1/95	6.1	2.35E-05	1.64E-08		ST ST	
84	2-E11-C002B	10/1/95	7.5	6.55E-06	5.61E-09		ST	
85	2-E11-C002B 2-X33-L44-52	10/2/95	14.0	6.55E-06	1.05E-08		ST CMp	
86	2-E11-C002B	10/2/95	39.0	6.55E-06	2.92E-08		ST	
87	2-E11-C002B 2-X33-L43-52	10/4/95	8.0	6.55E-06	5.98E-09		ST CMp	
88	2-E11-C002B	10/4/95	2.0	6.55E-06	1.50E-09	3.5.3.2	ST	
89	2-E11-C002B 2-E11-F015B	10/4/95	1.4	6.55E-06	1.05E-09	3.5.3.2	ST ST	
90	2-E11-F015B	10/4/95	0.6	6.32E-06	4.33E-10		ST	
91	2-DGA-DR6-52	10/6/95	16.6	6.32E-06	1.20E-08		CL	
92	1-1CA-C06-52	10/9/95	6.1	6.32E-06	4.40E-09	3.8.2.4.1	PM	
93	1-1CA-C06-52 2-DG1-GEN	10/9/95	0.4	8.37E-06	3.82E-10		PM ST	
94	1-1CA-C06-52	10/9/95	26.6	6.32E-06	1.92E-08		PM	
95	2-C41-F001	10/10/95	3.7	1.61E-05	6.80E-09	3.1.5	ST	
96	1-1PA-BU9 1-1PA-BV0 2-SW-V17-MO	10/11/95	8.7	6.32E-06	6.28E-09	3.7.1.2 3.7.1.2 3.7.1.2	CMp CMp CMp	
97	1-1PA-BU9	10/12/95	5.8	6.32E-06	4.18E-09	3.7.1.2	CMp	
98	2-2XF-ED7 2-RCC-V36	10/13/95	11.0	6.63E-06	8.33E-09		CMp CMp	
99	1-E2-AG7-52 2-DGB-DY3 2-EB-CS-957-2	10/16/95	18.0	8.96E-06	1.84E-08		DM DM DM	
100	1-E2-AG7-52 2-EB-CS-957-2	10/16/95	3.1	9.97E-06	3.53E-09		DM DM	
101	1-E2-AG7-52 2-2XE-EA7 2-EB-CS-957-2	10/17/95	13.0	9.99E-06	1.48E-08		DM CMp DM	
102	1-E2-AG7-52 2-EB-CS-957-2	10/17/95	8.0	9.97E-06	9.11E-09		DM DM	
103	2-2XA-DH5-52 2-SW-CS-V101 2-SW-V101	10/18/95	10.0	1.06E-05	1.21E-08		PM PM PM	
104	1-E2-AG7-52 2-DGB-DY3 2-EB-CS-957-2	10/18/95	8.0	1.19E-05	1.09E-08		DM DM DM	

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
105	1-E2-AG7-52 2-DGB-DY3 2-EB-CS-957-2 2-SW-V107 2-SW-V133	10/19/95	12.4	1.19E-05	1.68E-08		DM DM DM CL CL	
106	2-SW-V107 2-SW-V133	10/19/95	0.6	6.32E-06	4.33E-10		CL CL	
107	2-DG2-ENG	10/19/95	4.0	8.96E-06	4.09E-09	3.8.1.1	ST	
108	2-E11-F002A	10/20/95	1.0	1.71E-05	1.95E-09	3.7.1.1	PM	
109	1-E1-AF4 2-E11-F002A 2-E3-AI7	10/20/95	4.3	1.71E-05	8.39E-09	3.7.1.1	PM PM PM	
110	1-E1-AF4 2-E11-F002A 2-E11-F015A 2-E3-AI7	10/20/95	0.4	1.71E-05	7.81E-10	3.7.1.1	PM PM ST PM	
111	1-E1-AF4 2-E11-F002A 2-E3-AI7	10/20/95	1.4	1.71E-05	2.73E-09	3.7.1.1	PM PM PM	
112	2-E11-F002A	10/20/95	0.3	1.71E-05	5.86E-10	3.7.1.1	PM	
113	2-DG3-GEN	10/23/95	0.5	2.39E-05	1.36E-09	3.8.1.1	ST	
114	2-SW-2A-CONV-PMP	10/23/95	11.2	6.32E-06	8.08E-09		CMp	
115	2-E41-F002 2-E41-F003	10/26/95	1.0	6.09E-05	6.95E-09	3.3.2 3.3.2	ST ST	
116	2-E11-C001A	10/26/95	12.3	6.54E-06	9.18E-09	3.6.2.2	CM	RandomF
117	1-E1-AF4 2-2A-120V-22 2-2XA-DH5 2-2XB-DM6 2-E11-C001A 2-E3-AI7 2-RNA-IV-241 2-RNA-IV-242 2-SW-CS-V101 2-SW-CS-V102 2-SW-V101 2-SW-V102 2-SW-V136 2-SW-V137	10/26/95	33.0	6.39E-06	2.41E-08		CL CL CL CL CM CL CL CL CL CL CL CL CL CL	 RandomF
118	2-E11-C001A	10/28/95	4.3	6.54E-06	3.21E-09	3.6.2.2	CM	RandomF
119	2-E11-C001A 2-SW-2C-CONV-PMP	10/28/95	0.7	6.54E-06	5.23E-10	3.6.2.2	CM ST	RandomF
120	2-E11-C001A	10/28/95	3.1	6.54E-06	2.31E-09	3.6.2.2	CM	RandomF
121	2-SA-CS-453	10/29/95	10.0	6.54E-06	7.47E-09		CMp	
122	2-DG4-ENG 2-SA-CS-453	10/30/95	19.0	2.35E-05	5.10E-08	3.8.1.1	CMp CMp	
123	2-DG4-ENG 2-DGD-D53 2-SA-CS-453	10/30/95	13.0	2.35E-05	3.49E-08	3.8.1.1	CMp CMp CMp	
124	2-DG4-ENG 2-SA-CS-453	10/31/95	6.0	2.35E-05	1.61E-08	3.8.1.1	CMp CMp	
125	2-DG4-ENG	10/31/95	23.0	2.35E-05	6.17E-08	3.8.1.1	CMp	

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
126	2-E51-F029	11/2/95	1.3	6.32E-06	9.38E-10	3.6.3	ST	
127	2-2XA-DI0	11/2/95	14.0	8.36E-06	1.34E-08		PM	
128	2-SW-2B-CONV-PMP	11/3/95	3.5	6.32E-06	2.53E-09	3.7.1.2	CMp	
129	2-2PB-E37 2-E4-AL2 2-SW-2B-CONV-PMP 2-SW-CS-319 2-SW-V16	11/3/95	5.8	7.55E-06	5.00E-09	 3.7.1.2 	PM CL CMp CL CMp	
130	2-2PB-E37 2-E4-AL2 2-E51-V8 2-SW-2B-CONV-PMP 2-SW-CS-319 2-SW-V16	11/3/95	0.2	1.70E-05	3.88E-10	 3.7.1.2 	PM CL ST CMp CL CMp	
131	2-2PB-E37 2-E4-AL2 2-SW-2B-CONV-PMP 2-SW-CS-319 2-SW-V16	11/3/95	6.0	7.55E-06	5.17E-09	 3.7.1.2 	PM CL CMp CL CMp	
132	2-SW-2B-CONV-PMP	11/3/95	6.8	6.32E-06	4.91E-09	3.7.1.2	CMp	
133	2-DG4-GEN	11/5/95	0.6	2.35E-05	1.61E-09	3.8.1.1	ST	
134	2-DG1-ENG	11/6/95	0.6	8.37E-06	5.73E-10	3.8.1.1	ST	
135	1-1A-DG-12 1-E1-AE9 2-DG1-CS-209SS 2-DG1-CS-211SS 2-DG1-ENG 2-EB-CS-950-2	11/6/95	11.0	1.37E-05	1.72E-08	 3.8.1.1 	CL CL CL CL ST CL	
136	2-DG1-ENG	11/6/95	6.6	8.37E-06	6.31E-09	3.8.1.1	ST	
137	2-E21-F031A-MO	11/7/95	4.5	6.32E-06	3.25E-09		PM	
138	2-2XC-DT4 2-E21-F001A 2-E21-F004A 2-E21-F005A 2-E21-F031A-MO	11/7/95	8.2	8.20E-06	7.68E-09	3.5.3.1 3.5.3.1 3.5.3.1	PM PM PM PM PM	
139	2-2XC-DT4 2-DSA-DG3-CMP-2-M 2-E21-F001A 2-E21-F004A 2-E21-F005A 2-E21-F031A-MO	11/7/95	2.2	2.90E-05	7.28E-09	3.5.3.1 3.6.3 3.6.3 3.6.3 3.6.3	PM CMp PM PM PM PM	
140	2-2XC-DT4 2-E21-F001A 2-E21-F004A 2-E21-F005A 2-E21-F031A-MO	11/7/95	0.5	8.20E-06	4.68E-10	3.5.3.1 3.6.3 3.6.3 3.6.3 3.6.3	PM PM PM PM PM	
141	1-SW-1B-NUC-PMP	11/7/95	9.0	6.92E-06	7.11E-09	3.7.1.2	CM	RandomF
142	1-SW-1B-NUC-PMP 2-C41-F001	11/8/95	0.6	1.62E-05	1.11E-09	3.7.1.2 3.1.5	CM ST	RandomF
143	1-SW-1B-NUC-PMP	11/8/95	2.4	6.92E-06	1.90E-09	3.7.1.2	CM	RandomF

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
144	1-SW-1B-NUC-PMP 2-2XC-DS9 2-2XC-DT0 2-2XC-DT1 2-2XC-DT3 2-E21-F001A 2-E21-F004A 2-E21-F005A	11/8/95	8.1	1.33E-05	1.23E-08	3.7.1.2 3.6.3 3.5.3.1 3.5.3.1 3.5.3.1 3.5.3.1	CM ST ST ST ST ST ST ST	RandomF
145	1-SW-1B-NUC-PMP 2-2XC-DS9 2-2XC-DT0 2-2XC-DT1 2-2XC-DT3 2-E21-F004A 2-E21-F005A	11/8/95	1.7	8.59E-06	1.67E-09	3.7.1.2 3.6.3 3.5.3.1 3.5.3.1	CM ST ST ST ST ST ST	RandomF
146	1-SW-1B-NUC-PMP 2-2XC-DS9 2-2XC-DT0 2-2XC-DT1 2-2XC-DT3 2-E21-F004A	11/8/95	2.9	8.59E-06	2.84E-09	3.7.1.2 3.6.3 3.5.3.1 3.6.3 3.5.3.1	CM ST ST ST ST ST	RandomF
147	1-SW-1B-NUC-PMP 2-E21-F004A	11/8/95	0.3	6.92E-06	2.37E-10	3.7.1.2 3.5.3.1	CM ST	RandomF
148	1-SW-1B-NUC-PMP	11/10/95	70.2	6.92E-06	3.55E-08	3.7.1.2	CM	RandomF
149	1-E2-AG7-81D	11/13/95	0.9	8.96E-06	9.21E-10	3.8.1.1	CMp	
150	1-E2-AG7-52 1-E2-AG7-81D 2-DG2-CS-209SS 2-DG2-CS-211SS 2-EB-CS-957-2	11/13/95	31.2	9.97E-06	3.55E-08		CMp CMp CMp CMp CMp	
151	1-E2-AG7-81D	11/14/95	24.9	8.96E-06	2.55E-08		CMp	
152	2-SW-2A-CONV-PMP	11/17/95	0.2	6.32E-06	1.44E-10		DM	
153	2-E11-F048B 2-SW-2A-CONV-PMP	11/17/95	2.1	1.61E-05	3.86E-09		PM DM	
154	2-SW-2A-CONV-PMP	11/17/95	2.8	6.32E-06	2.02E-09		DM	
155	2-E11-F015B	11/18/95	1.2	6.32E-06	8.66E-10	3.5.3.2	ST	
156	2-2XF-ED5	11/20/95	9.1	6.79E-06	7.05E-09		PM	
157	2-2XF-ED5 2-DG3-GEN	11/20/95	0.4	2.42E-05	1.11E-09		PM ST	
158	2-2XF-ED5	11/20/95	7.5	6.79E-06	5.81E-09		PM	
159	2-SW-2A-CONV-PMP	11/21/95	12.0	6.32E-06	8.66E-09		PM	
160	2-DG4-GEN	11/27/95	0.2	2.35E-05	5.37E-10		ST	
161	2-2XB-DP2 2-SW-V117	11/28/95	10.0	6.32E-06	7.21E-09		CL CL	
162	2-SW-2C-CONV-PMP	11/28/95	7.0	6.32E-06	5.05E-09	3.7.1.2	CM	
163	1-1PA-BU9 1-1PA-BV0 1-E1-AF6 2-SW-2C-CONV-PMP 2-SW-CS-320 2-SW-V17 2-SW-V18	11/29/95	21.1	6.93E-06	1.67E-08	 3.7.1.2 	CL CL CL CM CL CL CL	

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
164	1-1PA-BU9 1-1PA-BV0 1-E1-AF6 2-2PB-E38 2-SW-2C-CONV-PMP 2-SW-CS-320 2-SW-V17 2-SW-V18	11/30/95	15.9	6.93E-06	1.26E-08	 3.7.1.2 	CL CL CL CL CM CL CL CL	
165	2-2PB-E38 2-SW-2C-CONV-PMP	11/30/95	0.3	6.32E-06	2.16E-10	 3.7.1.2	CL CM	
166	2-SW-2C-CONV-PMP	11/30/95	3.7	6.32E-06	2.67E-09	3.7.1.2	CM	
167	1-E1-AE9-52 2-DG1-EGA-CTRL-BOX 2-EB-CS-950-2	12/4/95	0.1	8.37E-06	9.55E-11	 3.8.1.1	DM DM DM	
168	1-E1-AE9-52 2-DG1-EGA-CTRL-BOX 2-DG1-ENG 2-EB-CS-950-2	12/4/95	28.9	8.37E-06	2.76E-08	 3.8.1.1 3.8.1.1 	DM DM DM DM	
169	2-DG1-EGA-CTRL-BOX 2-DG1-ENG	12/4/95	26.0	8.37E-06	2.48E-08	3.8.1.1 3.8.1.1	DM DM	
170	2-DG1-EGA-CTRL-BOX 2-DG1-ENG 2-EB-CS-950-2	12/6/95	2.0	8.37E-06	1.91E-09	3.8.1.1 3.8.1.1 	DM DM DM	
171	2-DG1-EGA-CTRL-BOX 2-DG1-ENG	12/6/95	17.0	8.37E-06	1.62E-08	3.8.1.1 3.8.1.1	DM DM	
172	1-E1-AE9-52 2-DG1-EGA-CTRL-BOX 2-DG1-ENG 2-EB-CS-950-2 2-SW-CS-V105	12/7/95	3.0	1.17E-05	4.01E-09	 3.8.1.1 3.8.1.1 	DM DM DM DM PM	
173	1-E1-AE9-52 2-DG1-EGA-CTRL-BOX 2-DG1-ENG 2-DGD-D68 2-EB-CS-950-2 2-SW-CS-V105	12/7/95	1.1	1.17E-05	1.47E-09	 3.8.1.1 3.8.1.1 	DM DM DM ST PM PM	
174	1-E1-AE9-52 2-C41-F001 2-DG1-EGA-CTRL-BOX 2-DG1-ENG 2-DGD-D68 2-EB-CS-950-2 2-SW-CS-V105	12/7/95	2.4	2.18E-05	5.97E-09	 3.8.1.1 3.8.1.1 	DM ST DM DM ST PM PM	
175	1-E1-AE9-52 2-DG1-EGA-CTRL-BOX 2-DG1-ENG 2-DGD-D68 2-EB-CS-950-2 2-SW-CS-V105	12/7/95	0.5	1.17E-05	6.68E-10	 3.8.1.1 3.8.1.1 	DM DM DM ST PM PM	
176	1-E1-AE9-52 2-DG1-EGA-CTRL-BOX 2-DG1-ENG 2-DGD-D68 2-EB-CS-950-2	12/7/95	4.0	8.37E-06	3.82E-09	 3.8.1.1 3.8.1.1 	DM DM DM ST PM	

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
177	1-E1-AE9-52	12/7/95	6.0	8.37E-06	5.73E-09		DM	
	2-DG1-EGA-CTRL-BOX					3.8.1.1	DM	
	2-DG1-ENG					3.8.1.1	DM	
	2-EB-CS-950-2						DM	
178	2-DG1-EGA-CTRL-BOX	12/7/95	7.7	8.37E-06	7.36E-09	3.8.1.1	DM	
	2-DG1-ENG					3.8.1.1	DM	
179	2-DG1-EGA-CTRL-BOX	12/8/95	4.3	8.37E-06	4.11E-09	3.8.1.1	DM	
	2-DG1-ENG					3.8.1.1	DM	
	2-DG1-GEN					3.8.1.1	ST	
180	2-DG1-ENG	12/8/95	0.4	8.37E-06	3.82E-10	3.8.1.1	DM	
	2-DG1-GEN					3.8.1.1	ST	
181	2-SW-V102-MO	12/14/95	6.3	8.00E-06	5.75E-09	3.7.1.1	CMp	
182	2-2XB-DM6-52	12/15/95	18.0	8.00E-06	1.64E-08		CMp	
	2-SW-CS-V102						CMp	
	2-SW-V102-MO					3.7.1.1	CMp	
183	2-DG3-GEN	12/18/95	0.3	2.39E-05	8.18E-10	3.8.1.1	ST	
184	2-DG3-PS-6525-3	12/18/95	2.3	6.32E-06	1.66E-09		ST	
185	2-DGD-D68	12/22/95	4.0	6.32E-06	2.89E-09		PM	
186	2-DG4-GEN	12/26/95	0.4	2.35E-05	1.07E-09	3.8.1.1	ST	
187	1-E2-AG9-52	12/27/95	4.0	6.32E-06	2.89E-09	3.6.2.2	CM	RandomF
188	2-E51-F008	12/27/95	2.5	6.32E-06	1.80E-09	3.7.4	ST	
189	2-DG1-GEN	1/1/96	0.5	8.37E-06	4.78E-10	3.8.1.1	ST	
190	2-DGB-D99	1/2/96	1.0	6.32E-06	7.21E-10		CL	
191	2-DGB-D99	1/2/96	2.0	7.70E-06	1.76E-09		CL	
	2-E21-F031A					3.6.3	CL	
	2-E21-FS-N006A					3.5.3.1	DM	
192	2-2XC-DT4-52	1/2/96	7.0	9.26E-06	7.40E-09		CL	
	2-DGB-D99						CL	
	2-E21-CS-S3A						CL	
	2-E21-F031A					3.6.3	CL	
	2-E21-FS-N006A					3.5.3.1	DM	
	2-E3-AI6						CL	
193	2-2XC-DT4-52	1/2/96	1.1	8.09E-06	1.02E-09		CL	
	2-E21-CS-S3A						CL	
	2-E3-AI6						CL	
194	2-2XC-DT4-52	1/2/96	0.9	1.70E-05	1.75E-09		CL	
	2-C41-F001						ST	
	2-E21-CS-S3A						CL	
	2-E3-AI6						CL	
195	2-2XC-DT4-52	1/2/96	3.0	8.09E-06	2.77E-09		CL	
	2-E21-CS-S3A						CL	
	2-E3-AI6						CL	
196	2-E21-C001B-M	1/3/96	2.0	6.74E-06	1.54E-09	3.5.3.1	CL	
	2-E21-F031B					3.6.3	CL	
	2-E21-FS-N006B					3.5.3.1	DM	
197	2-2XD-DW9-52	1/3/96	0.3	6.74E-06	2.31E-10		CL	
	2-E21-C001B-M					3.5.3.1	CL	
	2-E21-CS-S3B						CL	
	2-E21-CS-S5B						CL	
	2-E21-F031B					3.6.3	CL	
	2-E21-FS-N006B					3.5.3.1	DM	
	2-E4-AK5						CL	

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
198	2-2XD-DW9-52 2-DGA-DR6-52 2-E21-C001B-M 2-E21-CS-S3B 2-E21-CS-S5B 2-E21-F031B 2-E21-FS-N006B 2-E4-AK5	1/3/96	5.7	6.74E-06	4.39E-09		CL PM CL CL CL CL DM CL	
199	2-DGA-DR6-52	1/3/96	13.0	6.32E-06	9.38E-09		PM	
200	2-DG3-GEN	1/8/96	0.7	2.39E-05	1.91E-09		ST	
201	2-DG4-GEN	1/8/96	0.3	2.35E-05	8.05E-10		ST	
202	1-E2-AG7-52 2-DG2-CS-209SS 2-DG2-CS-211SS 2-EB-CS-957-2	1/8/96	11.0	9.97E-06	1.25E-08		CL CL CL CMp	
203	2-DG2-ENG	1/8/96	2.1	8.96E-06	2.15E-09		ST	
204	2-SW-V137 2-SW-V137-AO	1/11/96	24.0	6.32E-06	1.73E-08	3.7.1.1 3.7.1.1	CL CM	
205	2-DG3-ENG	1/15/96	0.8	2.39E-05	2.18E-09	3.8.1.1	CMp	
206	2-DG3-CS-209SS 2-DG3-CS-211SS 2-DG3-ENG 2-DGC-DJ0-52 2-E3-AI5-52 2-EB-CS-962-2	1/15/96	28.6	5.54E-05	1.81E-07	3.8.1.1	CL CL CMp CL CL CL	
207	2-DG3-CS-209SS 2-DG3-CS-211SS 2-DG3-ENG 2-E3-AI5-52 2-EB-CS-962-2	1/16/96	14.4	5.54E-05	9.11E-08	3.8.1.1	CL CL CMp CL CL	
208	2-DG3-ENG	1/17/96	9.6	2.39E-05	2.62E-08	3.8.1.1	CMp	
209	2-DG4-GEN	1/22/96	0.3	2.35E-05	8.05E-10	3.8.1.1	ST	
210	2-E51-F062	1/24/96	0.6	6.32E-06	4.33E-10		ST	
211	2-E51-F008	1/26/96	0.3	6.32E-06	2.16E-10		ST	
212	2-DG2-ENG	1/26/96	2.3	8.96E-06	2.35E-09	3.8.1.1	CMp	
213	2-E21-C001B	1/28/96	0.3	6.32E-06	2.16E-10		ST	

Table A2. Equipment Outage Configurations for BNP Unit 2 Configuration Risk Profile - EOOS Monitor Calculations

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
1	2-E11-F016A-MO	7/28/95	1.0	6.32E-06	7.21E-10	3.6.3	DM	
2	2-E11-F016A 2-E11-F016A-MO 2-E11-F021A	7/28/95	13.0	6.32E-06	9.38E-09	 3.6.3	DM DM CL	
3	2-E11-F016A-MO	7/28/95	1.0	6.32E-06	7.21E-10	3.6.3	DM	
4	2-DG3-GEN	7/31/95	1.0	2.19E-05	2.50E-09	3.8.1.1	CMp	
5	2-DG3-CS-209SS 2-DG3-CS-211SS 2-DG3-GEN 2-DGC-DJ0-52 2-E3-AI5-52 2-EB-CS-962-2	7/31/95	7.0	4.79E-05	3.83E-08	 3.8.1.1	CMp CMp CMp CMp CMp CMp	
6	2-DG3-GEN	7/31/95	6.0	2.19E-05	1.50E-08	3.8.1.1	CMp	
7	2-E41-C001	8/2/95	0.4	5.96E-05	2.72E-09		ST	
8	2-DG4-GEN	8/7/95	0.8	2.15E-05	1.96E-09		ST	
9	2-2PB-E37-52 2-E4-AL2 2-SW-2B-CONV-PMP 2-SW-CS-319 2-SW-V16	8/14/95	3.3	7.12E-06	2.68E-09	 3.7.1.2	CMp CMp CMp CMp CMp	
10	2-2PB-E37-52 2-DG3-GEN 2-E4-AL2 2-SW-2B-CONV-PMP 2-SW-CS-319 2-SW-V16	8/14/95	0.3	2.27E-05	7.77E-10	 3.8.1.1 3.7.1.2	CMp ST CMp CMp CMp CMp	
11	2-2PB-E37-52 2-E4-AL2 2-SW-2B-CONV-PMP 2-SW-CS-319 2-SW-V16	8/14/95	38.3	7.12E-06	3.11E-08	 3.7.1.2	CMp CMp CMp CMp CMp	
12	2-2PB-E37-52 2-C41-F001 2-E4-AL2 2-SW-2B-CONV-PMP 2-SW-CS-319 2-SW-V16	8/15/95	0.7	7.12E-06	5.69E-10	 3.1.5 3.7.1.2	CMp ST CMp CMp CMp CMp	
13	2-2PB-E37-52 2-E4-AL2 2-SW-2B-CONV-PMP 2-SW-CS-319 2-SW-V16	8/16/95	1.4	7.12E-06	1.14E-09	 3.7.1.2	CMp CMp CMp CMp CMp	
14	1-1PA-BU9 1-1PA-BV0 1-E1-AF6 2-SW-CS-320 2-SW-V17 2-SW-V18	8/16/95	13.0	6.32E-06	9.38E-09		CL CL CL CL CL CL	
15	2-2PB-E38 2-SW-V20	8/17/95	36.4	6.51E-06	2.71E-08		CL CL	

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
16	1-E1 2-2PB-E38 2-SW-V20	8/19/95	1.0	6.51E-06	7.43E-10	3.8.2.1	ST CL CL	
17	2-2PB-E38 2-SW-2C-CONV-PMP 2-SW-V20	8/19/95	0.6	6.51E-06	4.46E-10	3.7.1.2	CL ST CL	
18	2-SW-2C-CONV-PMP	8/19/95	3.0	6.32E-06	2.16E-09	3.7.1.2	ST	
19	1-1PA-BU9 1-1PA-BV0 1-E1-AF6 2-SW-2C-CONV-PMP 2-SW-CS-320 2-SW-V17 2-SW-V18	8/19/95	12.0	6.32E-06	8.66E-09	3.7.1.2	CL CL CL ST CL CL CL	
20	2-SW-2C-CONV-PMP	8/19/95	7.0	6.32E-06	5.05E-09	3.7.1.2	ST	
21	1-E1-AF6-52 2-SW-2C-CONV-PMP	8/20/95	1.0	6.32E-06	7.21E-10	3.8.2.1 3.7.1.2	CL ST	
22	2-SW-2C-CONV-PMP	8/20/95	4.0	6.32E-06	2.89E-09	3.7.1.2	ST	
23	1-E1-AF6 2-SW-2C-CONV-PMP 2-SW-CS-320	8/20/95	33.3	6.32E-06	2.40E-08	3.7.1.2	CL ST CL	
24	1-E1-AF6 2-DG2-ENG 2-SW-2C-CONV-PMP 2-SW-CS-320	8/21/95	0.2	8.96E-06	2.05E-10	3.7.1.2	CL ST ST CL	
25	1-E1-AF6 2-SW-2C-CONV-PMP 2-SW-CS-320	8/21/95	34.5	6.32E-06	2.49E-08	3.7.1.2	CL ST CL	
26	1-E1-AF6 2-E11-F016B-MO 2-SW-2C-CONV-PMP 2-SW-CS-320	8/23/95	2.0	6.32E-06	1.44E-09	3.6.3 3.7.1.2	CL PM ST CL	
27	1-E1-AF6 2-E11-F016B-MO 2-E11-F021B 2-SW-2C-CONV-PMP 2-SW-CS-320	8/23/95	5.2	6.32E-06	3.75E-09	3.6.3 3.7.1.2	CL PM PM ST CL	
28	1-E1-AF6 2-E11-F016B-MO 2-E11-F021B 2-SW-2C-CONV-PMP 2-SW-CS-320 2-SW-PS-1176B	8/23/95	1.7	6.32E-06	1.23E-09	3.6.3 3.7.1.2	CL PM PM ST CL ST	
29	1-E1-AF6 2-E11-F016B-MO 2-E11-F021B 2-SW-2C-CONV-PMP 2-SW-CS-320	8/23/95	4.1	6.32E-06	2.96E-09	3.6.3 3.7.1.2	CL PM PM ST CL	
30	2-E11-F016B-MO 2-E11-F021B 2-SW-2C-CONV-PMP	8/23/95	0.7	6.32E-06	5.05E-10	3.6.3 3.7.1.2	PM PM ST	
31	2-E11-F016B-MO 2-E11-F021B	8/23/95	0.3	6.32E-06	2.16E-10	3.6.3	M PM	

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
32	2-E11-F016B-MO 2-E11-F021B 2-E11-PDV-F068B	8/23/95	9.0	1.46E-05	1.50E-08	3.6.3 3.6.5.1	PM PM CL	 RandomF
33	2-2XB-DN1 2-2XB-HL4-21 2-E11-CS-5572B 2-E11-PDV-F068B	8/24/95	15.0	1.46E-05	2.50E-08	 3.6.5.1	CL CL CL CM	 RandomF
34	1-E2-AG8-52 2-2XB-DN1 2-2XB-HL4-21 2-E11-CS-5572B 2-E11-PDV-F068B	8/24/95	17.8	1.46E-05	2.97E-08	 3.6.5.1	CL CL CL CL CM	 RandomF
35	1-E2-AG8-52 2-2XB-DN1 2-2XB-HL4-21 2-E11-CS-5572B	8/25/95	11.2	1.46E-05	1.87E-08		CL CL CL CL	
36	1-E2-AG8-52 2-2XB-DN1 2-E11-CS-5572B	8/25/95	1.0	1.46E-05	1.67E-09		CL CL CL	
37	2-E11-F015B	8/26/95	0.2	6.32E-06	1.44E-10		ST	
38	2-DG3-ENG	8/28/95	0.5	2.19E-05	1.25E-09	3.8.1.1	ST	
39	2-DG3-GEN	9/1/95	0.3	2.19E-05	7.50E-10	3.8.1.1	ST	
40	2-DG4-GEN	9/4/95	0.4	2.15E-05	9.82E-10	3.8.1.1	ST	
41	2-SW-V16	9/5/95	2.8	6.86E-06	2.19E-09	3.7.1.2	CL	
42	2-2PB-E37-52 2-E4-AL2 2-SW-CS-319 2-SW-V16 2-8W-V16	9/5/95	37.0	7.12E-06	3.01E-08	 3.7.1.2	CL CL CL CL	
43	2-SW-V16	9/6/95	3.9	6.86E-06	3.05E-09	3.7.1.2	CL	
44	2-E51-V8	9/7/95	0.5	1.64E-05	9.36E-10		CMp	
45	2-E4-AL2	9/7/95	0.3	6.39E-06	2.19E-10		CL	
46	2-DG1-GEN	9/11/95	0.4	7.91E-06	3.61E-10		ST	
47	2-C41-F001	9/12/95	1.7	1.61E-05	3.12E-09	3.1.5	ST	
48	2-SW-V123	9/13/95	0.7	6.32E-06	5.05E-10	3.5.3.1	CL	
49	2-RNA-IV-230 2-SW-V123	9/13/95	23.0	6.32E-06	1.66E-08	 3.5.3.1	CL CL	
50	2-RNA-IV-230 2-SW-V123 2-SW-V123-AO	9/14/95	2.0	6.32E-06	1.44E-09	 3.5.3.1	CL CL CMp	
51	2-SW-V123 2-SW-V123-AO	9/14/95	1.0	6.32E-06	7.21E-10	3.5.3.1	CL CMp	
52	2-SW-V123	9/14/95	0.9	6.32E-06	6.49E-10	3.5.3.1	CL	
53	2-2PB-E38-52 2-SW-V20	9/14/95	3.0	6.51E-06	2.23E-09		CMp CL	
54	2-SW-2B-CONV-PMP	9/14/95	0.7	6.39E-06	5.11E-10	3.7.1.2	ST	
55	2-2PB-E38-52 2-SW-V20	9/15/95	4.0	6.51E-06	2.97E-09		CL CL	
56	2-SW-2B-CONV-PMP	9/15/95	6.4	6.39E-06	4.67E-09	3.7.1.2	ST	
57	2-DG2-ENG	9/18/95	0.3	8.32E-06	2.85E-10	3.8.1.1	ST	

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
58	2-DG2-ENG	9/19/95	0.3	8.32E-06	2.85E-10	3.8.1.1	CM	RandomF
59	1-E2-AG7-52 2-DG2-ENG 2-DGB-DY3 2-EB-CS-957-2	9/19/95	3.0	9.82E-06	3.36E-09	3.8.1.1	CL CM CL CL	RandomF
60	2-DG2-ENG	9/19/95	1.7	8.32E-06	1.61E-09	3.8.1.1	CM	RandomF
61	2-C12-F013B	9/20/95	23.0	6.32E-06	1.66E-08		CMp	
62	2-2XB-DM6-52 2-C12-F013B 2-SW-CS-V102	9/21/95	9.0	7.74E-06	7.95E-09		DM CMp CL	
63	2-2XB-DM6-52 2-C12-F013B 2-E11-F015B 2-SW-CS-V102	9/21/95	0.2	7.74E-06	1.77E-10	3.5.3.2	DM CMp ST CL	
64	2-2XB-DM6-52 2-C12-F013B 2-E11-C002B 2-E11-F015B 2-SW-CS-V102	9/21/95	2.8	7.74E-06	2.47E-09	3.5.3.2	DM CMp ST ST CL	
65	2-2XB-DM6-52 2-C12-F013B 2-E11-C002B 2-SW-CS-V102	9/21/95	3.0	7.74E-06	2.65E-09		DM CMp ST CL	
66	2-C12-F013B 2-E11-C002B	9/21/95	1.0	6.32E-06	7.21E-10		CMp ST	
67	2-E11-C002B	9/21/95	9.0	6.32E-06	6.49E-09	3.7.1.1	ST	
68	2-E11-C002B 2-RCC-V32 2-RCC-V38	9/22/95	6.0	6.32E-06	4.33E-09		ST PM PM	
69	2-E11-C002B 2-E11-F015A 2-E3-AJ1-52 2-RCC-V32 2-RCC-V38	9/22/95	3.0	6.32E-06	2.16E-09	3.5.3.2 3.5.3.2	ST PM PM PM PM	
70	2-E11-C002B 2-E11-F015A 2-RCC-V32 2-RCC-V38	9/22/95	2.0	6.32E-06	1.44E-09	3.5.3.2	ST PM PM PM	
71	2-E11-C002B 2-RCC-V32 2-RCC-V38	9/22/95	19.0	6.32E-06	1.37E-08		ST PM PM	
72	2-E11-C002B	9/23/95	37.0	6.32E-06	2.67E-08		ST	
73	2-C12-F046A 2-C12-F047A 2-E11-C002B	9/24/95	11.0	6.32E-06	7.94E-09		CL CL ST	
74	2-C12-F046A 2-C12-F047A 2-DG3-GEN 2-E11-C002B	9/25/95	0.5	2.19E-05	1.25E-09	3.8.1.1	CL CL ST ST	
75	2-C12-F046A 2-C12-F047A 2-E11-C002B	9/25/95	3.5	6.32E-06	2.53E-09		CL CL ST	
76	2-E11-C002B	9/25/95	1.8	6.32E-06	1.30E-09	3.5.3.2	ST	

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
77	2-DG3-GEN 2-E11-C002B	9/25/95	1.6	2.19E-05	4.00E-09	 3.5.3.2	ST ST	
78	2-E11-C002B	9/25/95	11.6	6.32E-06	8.37E-09	3.5.3.2	ST	
79	2-2PA-E08 2-E11-C002B 2-SW-2A-CONV-PMP	9/26/95	14.0	6.32E-06	1.01E-08	3.7.1.2 3.5.3.2 3.7.1.2	DM ST DM	
80	2-E11-C002B	9/26/95	19.0	6.32E-06	1.37E-08		ST	
81	2-C12-C001A-M 2-E11-C002B	9/27/95	1.0	6.32E-06	7.21E-10		ST ST	
82	2-E11-C002B	9/28/95	93.4	6.32E-06	6.74E-08		ST	
83	2-DG4-GEN 2-E11-C002B	10/1/95	6.1	2.15E-05	1.50E-08		ST ST	
84	2-E11-C002B	10/1/95	7.5	6.32E-06	5.41E-09		ST	
85	2-E11-C002B 2-X33-L44-52	10/2/95	14.0	6.32E-06	1.01E-08		ST CMp	
86	2-E11-C002B	10/2/95	39.0	6.32E-06	2.81E-08		ST	
87	2-E11-C002B 2-X33-L43-52	10/4/95	8.0	6.32E-06	5.77E-09		ST CMp	
88	2-E11-C002B	10/4/95	2.0	6.32E-06	1.44E-09	3.5.3.2	ST	
89	2-E11-C002B 2-E11-F015B	10/4/95	1.4	6.32E-06	1.01E-09	3.5.3.2	ST ST	
90	2-E11-F015B	10/4/95	0.6	6.32E-06	4.33E-10		ST	
91	2-DGA-DR6-52	10/6/95	16.6	6.32E-06	1.20E-08		CL	
92	1-1CA-C06-52	10/9/95	6.1	6.32E-06	4.40E-09	3.8.2.4.1	PM	
93	1-1CA-C06-52 2-DG1-GEN	10/9/95	0.4	7.91E-06	3.61E-10		PM ST	
94	1-1CA-C06-52	10/9/95	26.6	6.32E-06	1.92E-08		PM	
95	2-C41-F001	10/10/95	3.7	1.61E-05	6.80E-09	3.1.5	ST	
96	1-1PA-BU9 1-1PA-BV0 2-SW-V17-MO	10/11/95	8.7	6.32E-06	6.28E-09	3.7.1.2 3.7.1.2 3.7.1.2	CMp CMp CMp	
97	1-1PA-BU9	10/12/95	5.8	6.32E-06	4.18E-09	3.7.1.2	CMp	
98	2-2XF-ED7 2-RCC-V36	10/13/95	11.0	6.32E-06	7.94E-09		CMp CMp	
99	1-E2-AG7-52 2-DGB-DY3 2-EB-CS-957-2	10/16/95	18.0	8.32E-06	1.71E-08		DM DM DM	
100	1-E2-AG7-52 2-EB-CS-957-2	10/16/95	3.1	8.32E-06	2.94E-09		DM DM	
101	1-E2-AG7-52 2-2XE-EA7 2-EB-CS-957-2	10/17/95	13.0	8.32E-06	1.23E-08		DM CMp DM	
102	1-E2-AG7-52 2-EB-CS-957-2	10/17/95	8.0	8.32E-06	7.60E-09		DM DM	
103	2-2XA-DH5-52 2-SW-CS-V101 2-SW-V101	10/18/95	10.0	9.68E-06	1.11E-08		PM PM PM	
104	1-E2-AG7-52 2-DGB-DY3 2-EB-CS-957-2	10/18/95	8.0	9.82E-06	8.97E-09		DM DM DM	

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
105	1-E2-AG7-52 2-DGB-DY3 2-EB-CS-957-2 2-SW-V107 2-SW-V133	10/19/95	12.4	9.82E-06	1.39E-08		DM DM DM CL CL	
106	2-SW-V107 2-SW-V133	10/19/95	0.6	6.32E-06	4.33E-10		CL CL	
107	2-DG2-ENG	10/19/95	4.0	8.32E-06	3.80E-09	3.8.1.1	ST	
108	2-E11-F002A	10/20/95	1.0	1.46E-05	1.67E-09	3.7.1.1	PM	
109	1-E1-AF4 2-E11-F002A 2-E3-AI7	10/20/95	4.3	1.46E-05	7.17E-09	3.7.1.1	PM PM PM	
110	1-E1-AF4 2-E11-F002A 2-E11-F015A 2-E3-AI7	10/20/95	0.4	1.46E-05	6.67E-10	3.7.1.1	PM PM ST PM	
111	1-E1-AF4 2-E11-F002A 2-E3-AI7	10/20/95	1.4	1.46E-05	2.33E-09	3.7.1.1	PM PM PM	
112	2-E11-F002A	10/20/95	0.3	1.46E-05	5.00E-10	3.7.1.1	PM	
113	2-DG3-GEN	10/23/95	0.5	2.19E-05	1.25E-09	3.8.1.1	ST	
114	2-SW-2A-CONV-PMP	10/23/95	11.2	6.32E-06	8.08E-09		CMp	
115	2-E41-F002 2-E41-F003	10/26/95	1.0	6.09E-05	6.95E-09	3.3.2 3.3.2	ST ST	
116	2-E11-C001A	10/26/95	12.3	6.32E-06	8.87E-09	3.6.2.2	CM	RandomF
117	1-E1-AF4 2-2A-120V-22 2-2XA-DH5 2-2XB-DM6 2-E11-C001A 2-E3-AI7 2-RNA-IV-241 2-RNA-IV-242 2-SW-CS-V101 2-SW-CS-V102 2-SW-V101 2-SW-V102 2-SW-V136 2-SW-V137	10/26/95	33.0	6.39E-06	2.41E-08		CL CL CL CL CM CL CL CL CL CL CL CL CL CL	RandomF
118	2-E11-C001A	10/28/95	4.3	6.32E-06	3.10E-09	3.6.2.2	CM	RandomF
119	2-E11-C001A 2-SW-2C-CONV-PMP	10/28/95	0.7	6.32E-06	5.05E-10	3.6.2.2	CM ST	RandomF
120	2-E11-C001A	10/28/95	3.1	6.32E-06	2.24E-09	3.6.2.2	CM	RandomF
121	2-SA-CS-453	10/29/95	10.0	6.32E-06	7.21E-09		CMp	
122	2-DG4-ENG 2-SA-CS-453	10/30/95	19.0	2.15E-05	4.66E-08	3.8.1.1	CMp CMp	
123	2-DG4-ENG 2-DGD-D53 2-SA-CS-453	10/30/95	13.0	2.15E-05	3.19E-08	3.8.1.1	CMp CMp CMp	
124	2-DG4-ENG 2-SA-CS-453	10/31/95	6.0	2.15E-05	1.47E-08	3.8.1.1	CMp CMp	
125	2-DG4-ENG	10/31/95	23.0	2.15E-05	5.64E-08	3.8.1.1	CMp	

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
126	2-E51-F029	11/2/95	1.3	6.32E-06	9.38E-10	3.6.3	ST	
127	2-2XA-DI0	11/2/95	14.0	7.94E-06	1.27E-08		PM	
128	2-SW-2B-CONV-PMP	11/3/95	3.5	6.39E-06	2.55E-09	3.7.1.2	CMp	
129	2-2PB-E37 2-E4-AL2 2-SW-2B-CONV-PMP 2-SW-CS-319 2-SW-V16	11/3/95	5.8	6.93E-06	4.59E-09	 3.7.1.2 	PM CL CMp CL CMp	
130	2-2PB-E37 2-E4-AL2 2-E51-V8 2-SW-2B-CONV-PMP 2-SW-CS-319 2-SW-V16	11/3/95	0.2	1.70E-05	3.88E-10	 3.7.1.2 	PM CL ST CMp CL CMp	
131	2-2PB-E37 2-E4-AL2 2-SW-2B-CONV-PMP 2-SW-CS-319 2-SW-V16	11/3/95	6.0	6.93E-06	4.75E-09	 3.7.1.2 	PM CL CMp CL CMp	
132	2-SW-2B-CONV-PMP	11/3/95	6.8	6.39E-06	4.96E-09	3.7.1.2	CMp	
133	2-DG4-GEN	11/5/95	0.6	2.15E-05	1.47E-09	3.8.1.1	ST	
134	2-DG1-ENG	11/6/95	0.6	7.61E-06	5.21E-10	3.8.1.1	ST	
135	1-1A-DG-12 1-E1-AE9 2-DG1-CS-209SS 2-DG1-CS-211SS 2-DG1-ENG 2-EB-CS-950-2	11/6/95	11.0	1.14E-05	1.43E-08	 3.8.1.1 	CL CL CL CL ST CL	
136	2-DG1-ENG	11/6/95	6.6	7.61E-06	5.73E-09	3.8.1.1	ST	
137	2-E21-F031A-MO	11/7/95	4.5	6.32E-06	3.25E-09		PM	
138	2-2XC-DT4 2-E21-F001A 2-E21-F004A 2-E21-F005A 2-E21-F031A-MO	11/7/95	8.2	7.59E-06	7.10E-09	3.5.3.1 3.5.3.1 3.5.3.1	PM PM PM PM PM	
139	2-2XC-DT4 2-DSA-DG3-CMP-2-M 2-E21-F001A 2-E21-F004A 2-E21-F005A 2-E21-F031A-MO	11/7/95	2.2	2.31E-05	5.80E-09	3.5.3.1 3.6.3 3.6.3 3.6.3 3.6.3	PM CMp PM PM PM PM	
140	2-2XC-DT4 2-E21-F001A 2-E21-F004A 2-E21-F005A 2-E21-F031A-MO	11/7/95	0.5	7.59E-06	4.33E-10	3.5.3.1 3.6.3 3.6.3 3.6.3 3.6.3	PM PM PM PM PM	
141	1-SW-1B-NUC-PMP	11/7/95	9.0	6.43E-06	6.61E-09	3.7.1.2	CM	RandomF
142	1-SW-1B-NUC-PMP 2-C41-F001	11/8/95	0.6	1.62E-05	1.11E-09	3.7.1.2 3.1.5	CM ST	RandomF
143	1-SW-1B-NUC-PMP	11/8/95	2.4	6.43E-06	1.76E-09	3.7.1.2	CM	RandomF

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
144	1-SW-1B-NUC-PMP 2-2XC-DS9 2-2XC-DT0 2-2XC-DT1 2-2XC-DT3 2-E21-F001A 2-E21-F004A 2-E21-F005A	11/8/95	8.1	7.70E-06	7.12E-09	3.7.1.2 3.6.3 3.5.3.1 3.5.3.1 3.5.3.1 3.5.3.1	CM ST ST ST ST ST ST ST	RandomF
145	1-SW-1B-NUC-PMP 2-2XC-DS9 2-2XC-DT0 2-2XC-DT1 2-2XC-DT3 2-E21-F004A 2-E21-F005A	11/8/95	1.7	7.70E-06	1.49E-09	3.7.1.2 3.6.3 3.5.3.1 3.5.3.1	CM ST ST ST ST ST ST	RandomF
146	1-SW-1B-NUC-PMP 2-2XC-DS9 2-2XC-DT0 2-2XC-DT1 2-2XC-DT3 2-E21-F004A	11/8/95	2.9	7.70E-06	2.55E-09	3.7.1.2 3.6.3 3.5.3.1 3.6.3 3.5.3.1	CM ST ST ST ST ST	RandomF
147	1-SW-1B-NUC-PMP 2-E21-F004A	11/8/95	0.3	6.43E-06	2.20E-10	3.7.1.2 3.5.3.1	CM ST	RandomF
148	1-SW-1B-NUC-PMP	11/10/95	70.2	6.43E-06	5.15E-08	3.7.1.2	CM	RandomF
149	1-E2-AG7-81D	11/13/95	0.9	8.32E-06	8.55E-10	3.8.1.1	CMp	
150	1-E2-AG7-52 1-E2-AG7-81D 2-DG2-CS-209SS 2-DG2-CS-211SS 2-EB-CS-957-2	11/13/95	31.2	8.32E-06	2.96E-08		CMp CMp CMp CMp CMp	
151	1-E2-AG7-81D	11/14/95	24.9	8.32E-06	2.36E-08		CMp	
152	2-SW-2A-CONV-PMP	11/17/95	0.2	6.32E-06	1.44E-10		DM	
153	2-E11-F048B 2-SW-2A-CONV-PMP	11/17/95	2.1	1.46E-05	3.50E-09		PM DM	
154	2-SW-2A-CONV-PMP	11/17/95	2.8	6.32E-06	2.02E-09		DM	
155	2-E11-F015B	11/18/95	1.2	6.32E-06	8.66E-10	3.5.3.2	ST	
156	2-2XF-ED5	11/20/95	9.1	6.32E-06	6.57E-09		PM	
157	2-2XF-ED5 2-DG3-GEN	11/20/95	0.4	2.19E-05	1.00E-09		PM ST	
158	2-2XF-ED5	11/20/95	7.5	6.32E-06	5.41E-09		PM	
159	2-SW-2A-CONV-PMP	11/21/95	12.0	6.32E-06	8.66E-09		PM	
160	2-DG4-GEN	11/27/95	0.2	2.15E-05	4.91E-10		ST	
161	2-2XB-DP2 2-SW-V117	11/28/95	10.0	6.32E-06	7.21E-09		CL CL	
162	2-SW-2C-CONV-PMP	11/28/95	7.0	6.32E-06	5.05E-09	3.7.1.2	CM	
163	1-1PA-BU9 1-1PA-BV0 1-E1-AF6 2-SW-2C-CONV-PMP 2-SW-CS-320 2-SW-V17 2-SW-V18	11/29/95	21.1	6.51E-06	1.57E-08	 3.7.1.2 	CL CL CL CM CL CL CL	

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
164	1-1PA-BU9 1-1PA-BV0 1-E1-AF6 2-2PB-E38 2-SW-2C-CONV-PMP 2-SW-CS-320 2-SW-V17 2-SW-V18	11/30/95	15.9	6.51E-06	1.18E-08	 3.7.1.2	CL CL CL CL CM CL CL CL	
165	2-2PB-E38 2-SW-2C-CONV-PMP	11/30/95	0.3	6.32E-06	2.16E-10	 3.7.1.2	CL CM	
166	2-SW-2C-CONV-PMP	11/30/95	3.7	6.32E-06	2.67E-09	3.7.1.2	CM	
167	1-E1-AE9-52 2-DG1-EGA-CTRL-BOX 2-EB-CS-950-2	12/4/95	0.1	8.32E-06	9.50E-11	 3.8.1.1	DM DM DM	
168	1-E1-AE9-52 2-DG1-EGA-CTRL-BOX 2-DG1-ENG 2-EB-CS-950-2	12/4/95	28.9	8.32E-06	2.74E-08	 3.8.1.1 3.8.1.1	DM DM DM DM	
169	2-DG1-EGA-CTRL-BOX 2-DG1-ENG	12/4/95	26.0	8.32E-06	2.47E-08	3.8.1.1 3.8.1.1	DM DM	
170	2-DG1-EGA-CTRL-BOX 2-DG1-ENG 2-EB-CS-950-2	12/6/95	2.0	8.32E-06	1.90E-09	3.8.1.1 3.8.1.1	DM DM DM	
171	2-DG1-EGA-CTRL-BOX 2-DG1-ENG	12/6/95	17.0	8.32E-06	1.61E-08	3.8.1.1 3.8.1.1	DM DM	
172	1-E1-AE9-52 2-DG1-EGA-CTRL-BOX 2-DG1-ENG 2-EB-CS-950-2 2-SW-CS-V105	12/7/95	3.0	1.17E-05	4.01E-09	 3.8.1.1 3.8.1.1	DM DM DM DM PM	
173	1-E1-AE9-52 2-DG1-EGA-CTRL-BOX 2-DG1-ENG 2-DGD-D68 2-EB-CS-950-2 2-SW-CS-V105	12/7/95	1.1	1.17E-05	1.47E-09	 3.8.1.1 3.8.1.1	DM DM DM ST PM PM	
174	1-E1-AE9-52 2-C41-F001 2-DG1-EGA-CTRL-BOX 2-DG1-ENG 2-DGD-D68 2-EB-CS-950-2 2-SW-CS-V105	12/7/95	2.4	1.37E-05	3.75E-09	 3.8.1.1 3.8.1.1	DM ST DM DM ST PM PM	
175	1-E1-AE9-52 2-DG1-EGA-CTRL-BOX 2-DG1-ENG 2-DGD-D68 2-EB-CS-950-2 2-SW-CS-V105	12/7/95	0.5	1.17E-05	6.68E-10	 3.8.1.1 3.8.1.1	DM DM DM ST PM PM	
176	1-E1-AE9-52 2-DG1-EGA-CTRL-BOX 2-DG1-ENG 2-DGD-D68 2-EB-CS-950-2	12/7/95	4.0	8.32E-06	3.80E-09	 3.8.1.1 3.8.1.1	DM DM DM ST PM	

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
177	1-E1-AE9-52 2-DG1-EGA-CTRL-BOX 2-DG1-ENG 2-EB-CS-950-2	12/7/95	6.0	8.32E-06	5.70E-09	 3.8.1.1 3.8.1.1	DM DM DM DM	
178	2-DG1-EGA-CTRL-BOX 2-DG1-ENG	12/7/95	7.7	8.32E-06	7.31E-09	3.8.1.1 3.8.1.1	DM DM	
179	2-DG1-EGA-CTRL-BOX 2-DG1-ENG 2-DG1-GEN	12/8/95	4.3	8.32E-06	4.08E-09	3.8.1.1 3.8.1.1 3.8.1.1	DM DM ST	
180	2-DG1-ENG 2-DG1-GEN	12/8/95	0.4	8.32E-06	3.80E-10	3.8.1.1 3.8.1.1	DM ST	
181	2-SW-V102-MO	12/14/95	6.3	7.74E-06	5.57E-09	3.7.1.1	CMp	
182	2-2XB-DM6-52 2-SW-CS-V102 2-SW-V102-MO	12/15/95	18.0	7.74E-06	1.59E-08	 3.7.1.1	CMp CMp CMp	
183	2-DG3-GEN	12/18/95	0.3	2.19E-05	7.50E-10	3.8.1.1	ST	
184	2-DG3-PS-6525-3	12/18/95	2.3	6.32E-06	1.66E-09		ST	
185	2-DGD-D68	12/22/95	4.0	6.32E-06	2.89E-09		PM	
186	2-DG4-GEN	12/26/95	0.4	2.15E-05	9.82E-10	3.8.1.1	ST	
187	1-E2-AG9-52	12/27/95	4.0	6.32E-06	2.89E-09	3.6.2.2	CM	RandomF
188	2-E51-F008	12/27/95	2.5	6.32E-06	1.80E-09	3.7.4	ST	
189	2-DG1-GEN	1/1/96	0.5	7.91E-06	4.51E-10	3.8.1.1	ST	
190	2-DGB-D99	1/2/96	1.0	6.32E-06	7.21E-10		CL	
191	2-DGB-D99 2-E21-F031A 2-E21-FS-N006A	1/2/96	2.0	6.32E-06	1.44E-09	 3.6.3 3.5.3.1	CL CL DM	
192	2-2XC-DT4-52 2-DGB-D99 2-E21-CS-S3A 2-E21-F031A 2-E21-FS-N006A 2-E3-AI6	1/2/96	7.0	7.21E-06	5.76E-09	 3.6.3 3.5.3.1	CL CL CL CL DM CL	
193	2-2XC-DT4-52 2-E21-CS-S3A 2-E3-AI6	1/2/96	1.1	7.21E-06	9.05E-10		CL CL CL	
194	2-2XC-DT4-52 2-C41-F001 2-E21-CS-S3A 2-E3-AI6	1/2/96	0.9	1.70E-05	1.75E-09		CL ST CL CL	
195	2-2XC-DT4-52 2-E21-CS-S3A 2-E3-AI6	1/2/96	3.0	7.21E-06	2.47E-09		CL CL CL	
196	2-E21-C001B-M 2-E21-F031B 2-E21-FS-N006B	1/3/96	2.0	6.32E-06	1.44E-09	3.5.3.1 3.6.3 3.5.3.1	CL CL DM	
197	2-2XD-DW9-52 2-E21-C001B-M 2-E21-CS-S3B 2-E21-CS-S5B 2-E21-F031B 2-E21-FS-N006B 2-E4-AK5	1/3/96	0.3	6.32E-06	2.16E-10	 3.5.3.1 3.6.3 3.5.3.1	CL CL CL CL CL DM CL	

Conf.	Component Outage Combinations	Date	Duration (hr)	New CDF Estimate (events/ry)	Core Damage Prob.	Tech. Spec. No.	Oper. Act.	Failure Type
198	2-2XD-DW9-52 2-DGA-DR6-52 2-E21-C001B-M 2-E21-CS-S3B 2-E21-CS-S5B 2-E21-F031B 2-E21-FS-N006B 2-E4-AK5	1/3/96	5.7	6.32E-06	4.11E-09		CL PM CL CL CL CL DM CL	
199	2-DGA-DR6-52	1/3/96	13.0	6.32E-06	9.38E-09		PM	
200	2-DG3-GEN	1/8/96	0.7	2.19E-05	1.75E-09		ST	
201	2-DG4-GEN	1/8/96	0.3	2.15E-05	7.36E-10		ST	
202	1-E2-AG7-52 2-DG2-CS-209SS 2-DG2-CS-211SS 2-EB-CS-957-2	1/8/96	11.0	8.32E-06	1.04E-08		CL CL CL CMp	
203	2-DG2-ENG	1/8/96	2.1	8.32E-06	1.99E-09		ST	
204	2-SW-V137 2-SW-V137-AO	1/11/96	24.0	6.32E-06	1.73E-08	3.7.1.1 3.7.1.1	CL CM	
205	2-DG3-ENG	1/15/96	0.8	2.19E-05	2.00E-09	3.8.1.1	CMp	
206	2-DG3-CS-209SS 2-DG3-CS-211SS 2-DG3-ENG 2-DGC-DJ0-52 2-E3-AI5-52 2-EB-CS-962-2	1/15/96	28.6	4.79E-05	1.56E-07	 3.8.1.1	CL CL CMp CL CL CL	
207	2-DG3-CS-209SS 2-DG3-CS-211SS 2-DG3-ENG 2-E3-AI5-52 2-EB-CS-962-2	1/16/96	14.4	4.79E-05	7.87E-08	 3.8.1.1	CL CL CMp CL CL	
208	2-DG3-ENG	1/17/96	9.6	2.19E-05	2.40E-08	3.8.1.1	CMp	
209	2-DG3-GEN	1/22/96	0.3	2.19E-05	7.50E-10	3.8.1.1	ST	
210	2-E51-F062	1/24/96	0.6	6.32E-06	4.33E-10		ST	
211	2-E51-F008	1/26/96	0.3	6.32E-06	2.16E-10		ST	
212	2-DG2-ENG	1/26/96	2.3	8.32E-06	2.18E-09	3.8.1.1	CMp	
213	2-E21-C001B	1/28/96	0.3	6.32E-06	2.16E-10		ST	

INEL
Idaho National Engineering Laboratory

LOCKHEED MARTIN

Lockheed Idaho Technologies Company
P. O. Box 1625 Idaho Falls, ID 83415-3850
Telephone: 526-9804 Facsimile: 526-2930

May 20, 1996

Dr. Jin Wook Chung
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Mailstop O10 E4
Rockville, MD 20852

TRIP REPORT FOR BRUNSWICK PLANT SITE VISIT - CLS-20-96

Dear Dr. Chung:

Curtis Smith and Steven Eide of the Idaho National Engineering Laboratory (INEL) traveled to the Brunswick Nuclear Plant to attend a plant site visit on April 29 through May 2. This trip was taken in support of the U.S. Nuclear Regulatory Commission (NRC) Assistance in Probabilistic Risk Assessment (PRA) Implementation Project, Job Code Number (JCN) J2292-6. The purpose of the four-day plant site visit was to work with Brunswick, NRC, and Brookhaven National Laboratory (BNL) personnel to verify the assumptions and inputs used to generate six-month risk profiles for Brunswick. NRC attendees were J. Trapp, P. Wilson, and J. Chung, BNL attendees were S. Wong and W. He, and Brunswick personnel included G. Miller, S. Lauer, T. Pierce, and R. Creech (coordinator).

Following the entrance meeting at 2:30 pm on Monday, April 29, the INEL outlined a quality assurance (QA) plan of attack for the rest of the week. The plan included three major areas of focus: review of the plant configurations developed by BNL, review of the overall calculational philosophy (e.g., treatment of common cause failures), and comparison of BNL and INEL risk profile results. A schedule was established that met the requirements for the exit meeting at 3:00 pm on Thursday, May 2. The QA plan and brief notes on various tasks are presented as Attachment A.

Specific INEL tasks during the rest of the week included derivation of the common cause failure basic event modifications for each configuration, presented in Attachment B, coordination with BNL on the final calculational philosophy, review of the SAPHIRE risk model with Brunswick risk analysts, recalculation of the Brunswick risk profile using the final plant configurations (approximately 225), and preparation of a ten-minute presentation given by C. Smith during the exit meeting.

The presentation slides are shown in Attachment C. The profile results are displayed as part of the slides. The numeric profile values that were used to obtain the risk profile slides are shown in Attachment D. These values include core damage frequency and cumulative core damage probability.

The INEL thanks the Brunswick personnel for the outstanding support during the week, especially T. Pierce and R. Creech.

If you have any questions, please contact me on (208) 526-9804, E-mail cls2@inel.gov or Steven Eide on (208) 526-3797, E-mail eidesa@inel.gov.

Sincerely,

Steven A. Eide for

Curtis L. Smith
Nuclear Risk Management Technologies

Attachments

cc: S. A. Eide, LITCO, MS 3850
D. L. Kelly, LITCO, Rockville
T. J. Leahy, LITCO, MS 3850
C. L. Smith File

QUALITY ASSURANCE PLAN

General

This quality assurance (QA) plan was developed following the entrance meeting for the Brunswick plant site visit. This QA plan outlines the issues addressed, the personnel involved, and the team consensus on certain issues.

Issues

1. Configuration Interpretation and Mapping to PRA Components

   P. Wilson and J. Trapp will review the risk profile peaks to decide if outage events actually failed PRA components.

2. Calculation Philosophy

   2a. Component outage modeling

   CAFTA/RELMCS

   Single basic event set to 1.0. Test/maintenance (TM) event used if it exists in the PRA model. Other associated basic events set to 0.0.

   SAPHIRE

   Basic event from configuration task set to "True". Also set associated TM event to "True". Other associated basic events left unchanged (have nominal PRA values).

   2b. Common cause modifications

   For component outages that were planned, reduce the redundance of the fail to start common cause failure (CCF) event by the number of components out for TM. The fail to run CCF event will not be changed.

   For a 3-train system, with 1 component out, the CCF event probability changes from $Q\beta\gamma$ to $Q\beta$, where Q is the individual component failure probability.

   For component outages that were causes by actual component failures, the CCF event probability changes from $Q\beta\gamma$ to $\beta\gamma$.

T. Pierce will identify the component outages as either TM events or failures.
S. Eide will document the actual CCF changes for each dominant configuration.

2c. Initiator modification

The INEL will modify the nuclear service water initiating event frequency for configurations that include components affecting nuclear service water. (This was already done by BNL in their CAFTA plant model.)

2d. Logic changes

The fault tree gate V1NX-HVAC needs to be modified in two places in the fault trees.

2e. Truncation

All risk profile runs will be performed with a 1.0E-10/y truncation.

2f. Uncertainty analysis

The INEL will coordinate with the BNL approach. However, the initial BNL uncertainty calculations included approximate 150 basic events with no error factors. Error factors are needed for these events.

2g. Treatment of test outage events

Test outages will not be counted as unavailabilities if the system automatically recovers (from the test configuration) if an actuation signal is generated. Otherwise, the test outages are treated as unavailabilities.

3. Checking of Calculational Results

C. Smith and W. He will compare CAFTA/RELMCS and SAPHIRE results (probabilities and cut sets) for the dominant peaks in the risk profile.

COMMON CAUSE FAILURE EVENT MODIFICATIONS

Configuration	Outage Type	CCF Event	Q	β	γ	Revised Equation	Probability	Notes
3	Maint.	RHR-MOV-CF-2CC07	3.0E-3	0.04	1.0	None	0.0	2 components
6	Maint.	DGP-DGN-CF-XFRX2	2.4E-2	0.03	1.0	Unchanged	7.2E-4	DGs 3,4 FTR
	Maint.	DGP-DGN-CF-XFRX4	2.4E-2	0.03	0.2	Unchanged	1.44E-4	4 DGs FTR
	Maint.	DGP-DGN-CF-XFSX1	8.1E-3	0.02	1.0	None	0.0	DGs 3,4 FTS
	Maint.	DGP-DGN-CF-XFSX3	8.1E-3	0.02	0.2	Qβ	1.62E-4	4 DGs FTS (assumes only 3 DGs)
9	Maint.	Same as config. 6						
10	Maint.	Same as config. 6						
15	Maint.	SWS-MDP-CF-XFRX2		0.05?	0.2?	Unchanged	2.64E-6	4 SWS MDPs FTR
16	Failure	DGP-DGN-CF-XFRX2	2.4E-2	0.03	1.0	Unchanged	7.2E-4	DGs 3,4 FTR
	Failure	DGP-DGN-CF-XFRX4	2.4E-2	0.03	0.2	Unchanged	1.44E-4	4 DGs FTR
	Failure	DGP-DGN-CF-XFSX1	8.1E-3	0.02	1.0	β	0.02	DGs 3,4 FTS
	Failure	DGP-DGN-CF-XFSX3	8.1E-3	0.02	0.2	βγ	4.0E-3	4 DGs FTS (assumes only 3 DGs)
18	Maint.	Same as config. 15						
20	Maint.	Same as config. 15						
23. 24, 25, 29	Maint.	Same as config. 15						
30	Maint.	Same as config. 15 and						
	Maint.	DGP-DGN-CF-XFSX3	8.1E-3	0.02	0.2	Qβ	1.62E-4	4 DGs FTS (assumes only 3 DGs)

Configuration	Outage Type	CCF Event	Q	β	γ	Revised Equation	Probability	Notes
	Maint.	DGP-DGN-CF-XFRX4	2.4E-2	0.03	0.2	Unchanged	1.44E-4	4 DGs FTR
	Maint.	DGP-DGN-CF-XFSX5	8.1E-3	0.02	1.0	None	0.0	DGs 1,2 FTS
	Maint.	DGP-DGN-CF-XFRX6	2.4E-2	0.03	1.0	Unchanged	7.2E-4	DGs 1,2 FTR
33	Maint.	Same as config. 15						
34	Maint.	Same as config. 15 and						
	Maint.	SWS-MDP-CF-1FSBP	2.2E-3	0.06	0.2	Qβ	1.32E-4	4 SWS RHR MDPs FTS (assumes only 3 pumps)
36	Maint.	Same as config. 15						
38, 39, 40	Failure	SWS-MOV-CF-2CC68	3.0E-3	0.04	1.0	β	0.04	2 components
45	Maint.	Same as config. 6						
48	Maint.	Same as config. 15						
51	Maint.	Same as config. 15						
52	Maint.	None						
63, 64, 65, 66	Failure	DGP-DGN-CF-XFSX3	8.1E-3	0.02	0.2	βγ	4.0E-3	4 DGs FTS (assumes only 3 DGs)
	Failure	DGP-DGN-CF-XFRX4	2.4E-2	0.03	0.2	Unchanged	1.44E-4	4 DGs FTR
	Failure	DGP-DGN-CF-XFSX5	8.1E-3	0.02	1.0	β	0.02	DGs 1,2 FTS
	Failure	DGP-DGN-CF-XFRX6	2.4E-2	0.03	1.0	Unchanged	7.2E-4	DGs 1,2 FTR
70	Maint.	RHR-MDP-CF-2FRAB		0.07	0.2	Unchanged	2.18E-5	4 RHR MDP FTR
	Maint.	RHR-MDP-CF-2FSAB		0.09	0.2	Qβ	1.89E-4	4 RHR MDP FTS (3 assumed)
71, 72, 73, 74	Maint.	Same as config. 70						

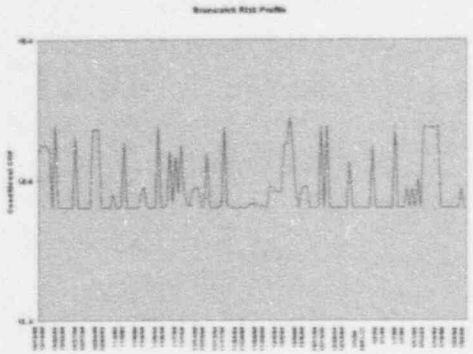
Configuration	Outage Type	CCF Event	Q	β	γ	Revised Equation	Probability	Notes
75	Maint.	Same as config. 70 and						
	Maint.	RHR-MOV-CF-2CC15				None	0.0	2 components
79	Maint.	Same as config. 70						
80	Maint.	Same as config. 70 and config. 6						
83	Maint.	Same as config. 70 and config. 6						
85	Maint.	Same as config. 70						
88	Failure	RHR-MDP-CF-2FSAB and		0.09	0.2	$\beta\gamma$	0.018	RHR MDP FTS (3 pumps assumed, 1 failure)
	Maint.	Same as config 6 and						
	Maint.	CRD-MDP-CF-2FRAB				Unchanged	5.76E-5	2CRD MDP FTR
	Maint.	CRD-MDP-CF-2FSHB				None	0.0	2 CRD MDP FTS
91	Maint.	Same as config. 70 and config. 6						
93, 95, 97	Maint.	Same as config. 70						
106	Maint.	RBC-MDP-CF-2FRAC				Unchanged	9.5E-6	2 RBC MDP FTR
	Maint.	RBC-MDP-CF-2FSCW				Unchanged	9.5E-6	2 RBC MDP FTR
107	Maint.	Same as config. 30						
109	Maint.	Same as config. 30 and config. 106						
113, 114	Maint.	Same as config. 30						

Configuration	Outage Type	CCF Event	Q	β	γ	Revised Equation	Probability	Notes
117	Maint.	SWS-MDP-CF-1FSBP	2.2E-3	0.06	0.2	Q β	1.32 E-4	4 SWS RHR MDPs FTS (2 pumps out)
224	Maint.	CSS-MDP-CF-2FRAB				Unchanged	5.83E-5	2 CSS MDP FTR
		CSS-MDP-CF-2FSAB				None	0.0	2 CSS MDP FTS
217	Maint.	Same as config. 6 and						
	Maint.	SWS-MOV-CF-2CC51				None	0.0	2 MOVs
215	Maint.	Same as config. 6						
211	Maint.	Same as config. 30 (but no config. 15)						
205	Maint.	Same as config. 224 and						
	Maint.	CSS-STR-CF-S2AB				None	0.0	2 strainers
203	Maint.	Same as config. 205						
202	Maint.	Same as config. 205						
201	Maint.	Same as config. 205						
200	Maint.	CSS-STR-CF-S2AB				None	0.0	2 strainers
196	Failure	RHR-MDP-CF-2FRAB		0.07	0.2	Unchanged		4 RHR MDP FTR (assume 3, 1 failure)
		RHR-MDP-CF-2FSAB		0.09	0.2	β γ	0.018	4 RHR MDP FTS
185	Maint.	Same as config. 30 (but no config. 15)						
183	Maint.	Same as config. 30 (but no config. 15) and						

Configuration	Outage Type	CCF Event	Q	β	γ	Revised Equation	Probability	Notes
		SWS-MOV-CF-2CC51				None	0.0	2 MOVs
182	Maint.	Same as config. 183						
181	Maint.	Same as config. 183						
176	Maint.	Same as config. 185						
175	Maint.	Same as config. 15						
173A	Maint.	SWS-MDP-CF-2FSSW				None	0.0	2 nuclear SWS MDP FS
		SWS-MDP-CF-2FRSW				Unchanged	1.32E-5	2 nuclear SWS MDP FR
	Maint.	SWS-MDP-CF-XFRX2				Unchanged	2.64E-6	≥4 MDPs FTR
173B	Maint.	Similar to config. 173A						
172	Maint.	Similar to config. 173A						
171B	Maint.	Similar to config. 173A						
165	Maint.	Similar to config. 6						
161	Maint.	Same as config. 15 and						
	Maint.	RHR-MOV-CF-20048				None	0.0	2 MOVs
160	Maint.	Same as config. 15						
158	Maint.	Similar to config. 30 (but no config. 15)						
153	Failure	SWS-MDP-CF-2FSSW		0.06		β	0.06	
	Maint.	CSS-STR-CF-S2AB				None	0.0	2 strainers
	Maint.	CSS-MOV-CF-2CCAB				None	0.0	2 MOVs
152	Failure	SWS-MDP-CF-2FSSW		0.06		β	0.06	2 MDF FTS (failure event)

Configuration	Outage Type	CCF Event	Q	β	γ	Revised Equation	Probability	Notes
149	Failure	SWS-MDP-CF-2FSSW		0.06		β	0.06	
147	Maint.	CSS-STR-CF-S2AB				None	0.0	
	Maint.	CSS-MOV-CF-2CCAB and				None	0.0	
	Maint.	Same as config. 6						
143	Maint.	Similar to config. 30 (but no config. 15)						
142	Maint.	Same as config. 143						
138	Maint.	Same as config. 173A						
137	Maint.	SWS-MDP-CF-XFRX2				Unchanged	2.64E-6	≥ 4 MDPs FTR
136	Maint.	SWS-MDP-CF-XFRX2				Unchanged	2.64E-6	≥ 4 MDPs FTR
130	Maint.	Similar to config. 6						
127	Failure	SWS-MDP-CF-1FSBP	2.2E-3	0.06	0.2	β γ	0.012	4 SWS RHR MDPs FTS (assume only 3 pumps)
	Maint.	SWS-MDP-CF-XFRX2				Unchanged	2.64E-6	
125	Failure of 1 pump	SWS-MDP-CF-1FSBP	2.2E-3	0.06	0.2	β γ	0.012	4 SWS RHR MDPs FTS (2 pumps out)
124	Failure	SWS-MDP-CF-1FSBP				β γ	0.012	4 SWS RHR MDPs FTS (assume only 3 pumps)
118	Failure	SWS-MDP-CF-1FSBP				β γ	0.012	(2 pumps out)
	Maint.	RHR-MOV-CF-2CC15				None	0.0	2 MOVs

Attachment C
May 20, 1996
CLS-20-96



Brunswick Risk Profile Pilot Program

Idaho National Engineering Laboratory

Curtis L. Smith
Steven A. Eide

Topics of Discussion

- ✓ Risk Models for Brunswick
- ✓ Analysis Software Used for Analysis
- ✓ Risk Profile Results
- ✓ Observations

Risk Models for Brunswick

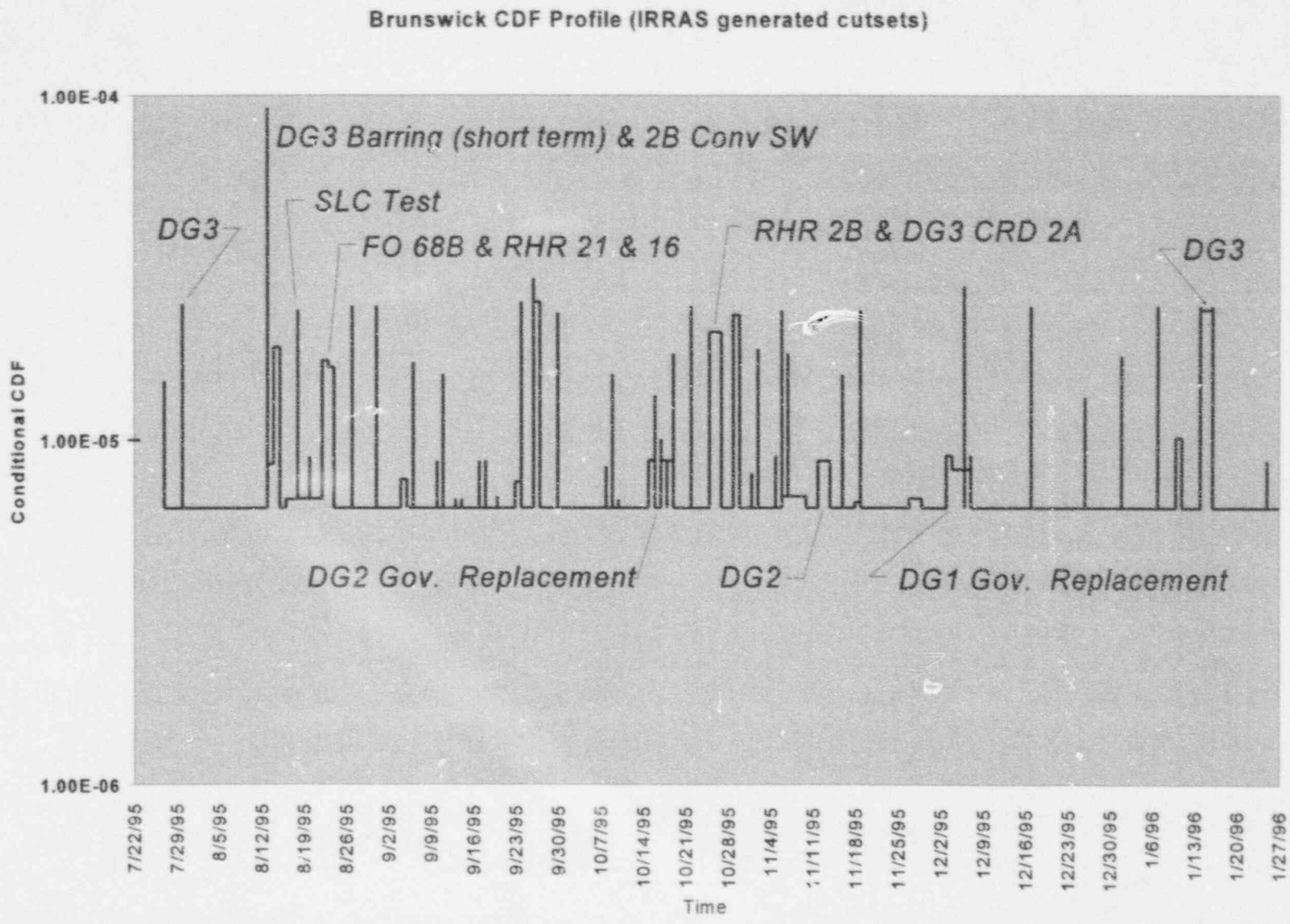
- ✓ Level 1 (internal events including flooding) Brunswick PRA used as basis for profile risk model
  - Large fault tree/small event tree model (i.e., linked logic)
  - Fault tree/event tree model converted to a single fault tree model (a.k.a. master logic diagram)
  - Model issues resolved with utility personnel
- ✓ Profile model did *not* include testing and maintenance unavailabilities
- ✓ Baseline core damage frequency (CDF) = 6.3E-6/yr

Analysis Software Used for Analysis

- ✓ CAFTA/RELMCS (DOS-based) software used by utility
- ✓ EOOS (R&R Workstation) application under development and trial usage (utility/BNL/INEL)
- ✓ SAPHIRE (DOS version) used by INEL
  - Utility PRA model converted for use in IRRAS
  - IRRAS used for...
    - > cutset generation of configurations
    - > importance measure determination
    - > sensitivity calculations (e.g., truncation, common-cause failure, human actions)
    - > parameter uncertainty analysis

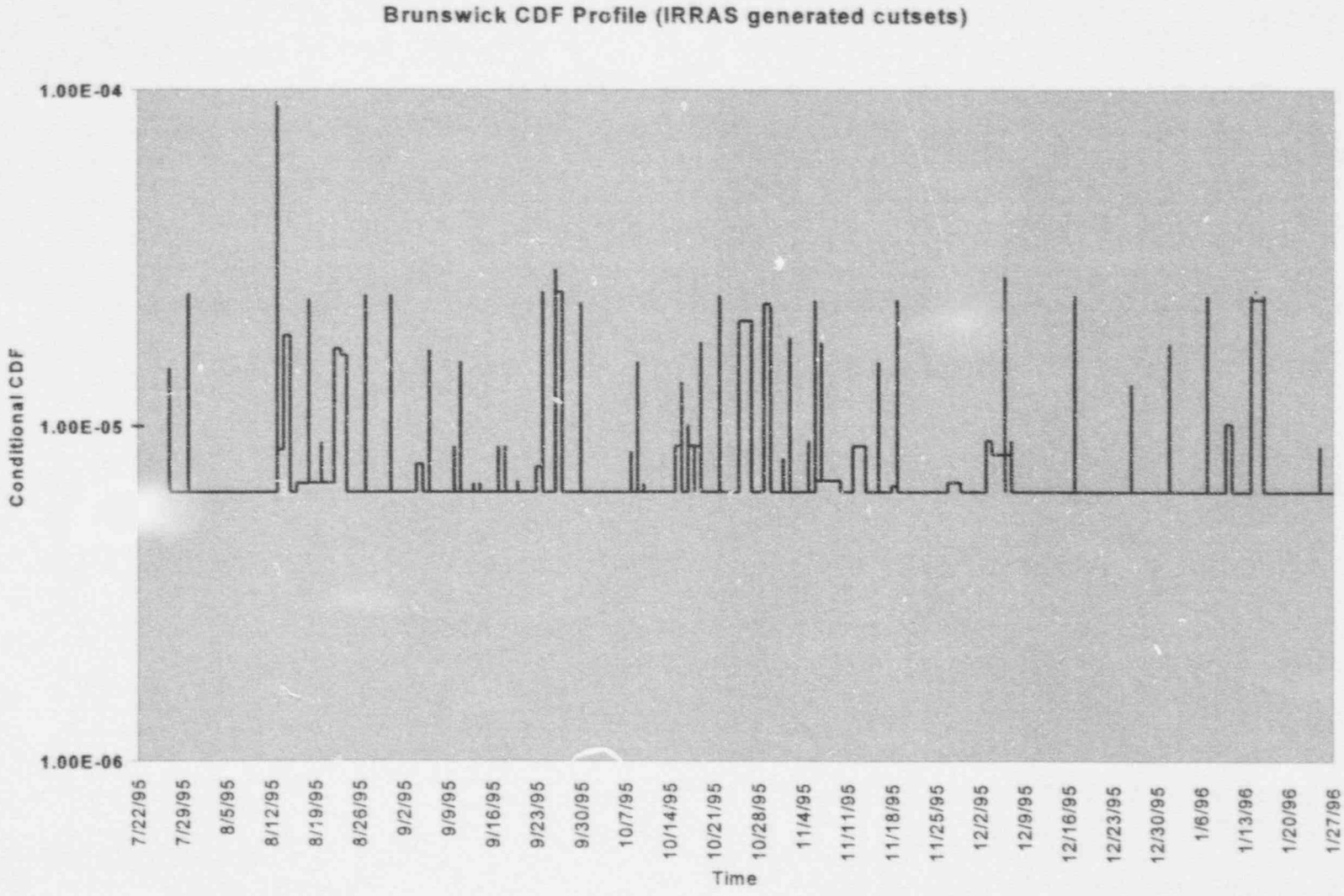
Risk Profile Results

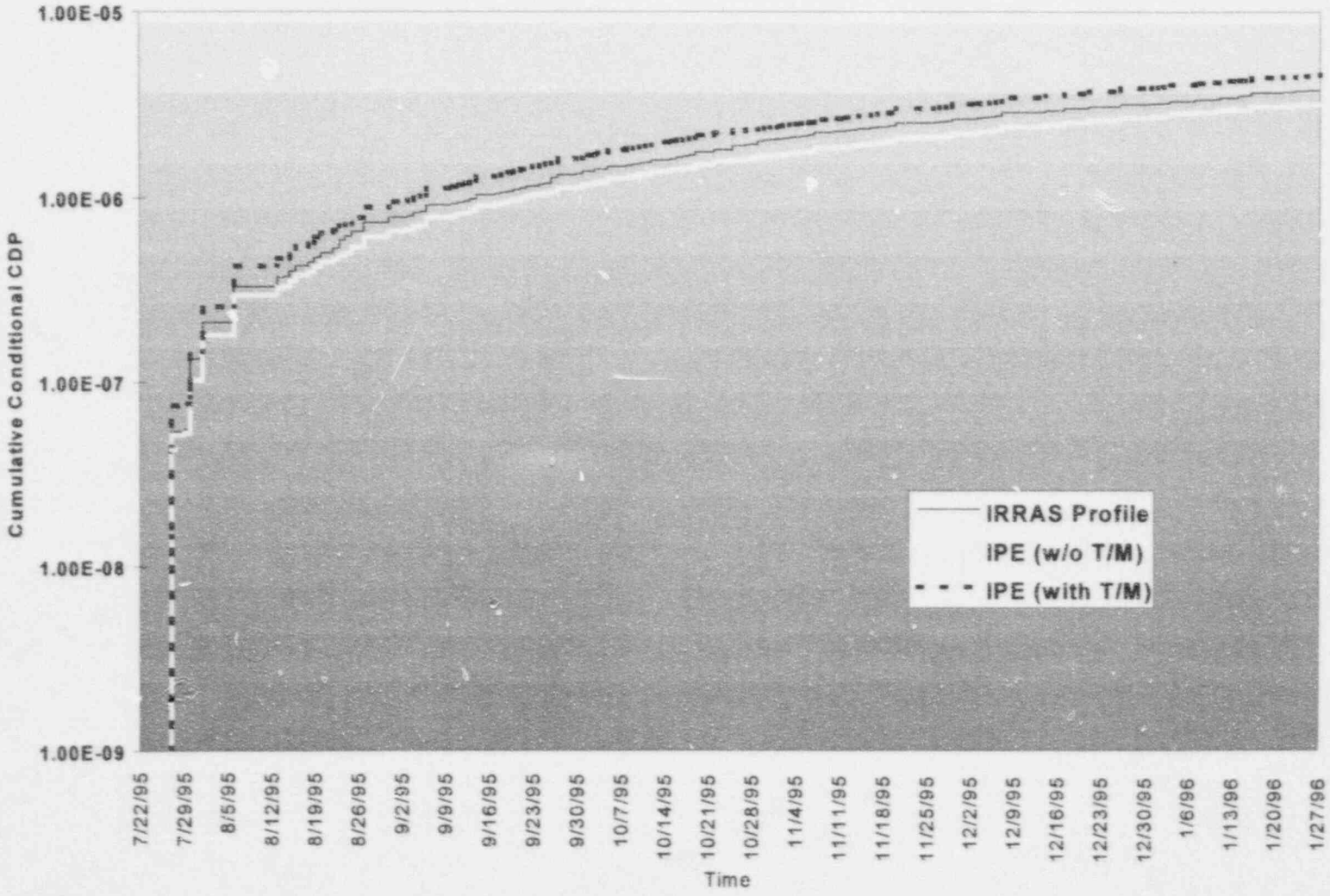
- ✓ **Very good agreement between IRRAS and CAFTA/RELMCS model results**
- ✓ **"Peak" conditional CDF = 9.2E-5/yr (SWS MDP/DG3)**
- ✓ **"Peak" conditional core damage probability (CDP) = 7.8E-8**
- ✓ **Profiles were obtained by generating cutsets using IRRAS**
  - **CDF profile**
  - **Cumulative CDP profile**


Brunswick CDF Profile (IRRAS generated cutsets)
1.00E-04
1.00E-05
1.00E-06
Conditional CDF
DG3 Barring (short term) & 2B Conv SW
SLC Test
DG3
FO 68B & RHR 21 & 16
RHR 2B & DG3 CRD 2A
DG3
DG2 Gov. Replacement
DG2
DG1 Gov. Replacement
7/22/95
7/29/95
8/5/95
8/12/95
8/19/95
8/26/95
9/2/95
9/9/95
9/16/95
9/23/95
9/30/95
10/7/95
10/14/95
10/21/95
10/28/95
11/4/95
11/11/95
11/18/95
11/25/95
12/2/95
12/9/95
12/16/95
12/23/95
12/30/95
1/6/96
1/13/96
1/20/96
1/27/96
Time

Observations

- ✓ Data gathering for risk profile is important and could lead to insights
- ✓ Brunswick PRA results reflect calculated profile cumulative probability
- ✓ Effective planning for testing and maintenance is reflected by...
  - lack of high peaks
  - lack of wide peaks


Brunswick CDF Profile (IRRAS generated cutsets)
1.00E-04
1.00E-05
1.00E-06
Conditional CDF
7/22/95
7/29/95
8/5/95
8/12/95
8/19/95
8/26/95
9/2/95
9/9/95
9/16/95
9/23/95
9/30/95
10/7/95
10/14/95
10/21/95
10/28/95
11/4/95
11/11/95
11/18/95
11/25/95
12/2/95
12/9/95
12/16/95
12/23/95
12/30/95
1/6/96
1/13/96
1/20/96
1/27/96
Time


Brunswick Cumulative CDP Profile (IRRAS generated cutsets)
Cumulative Conditional CDP
1.00E-05
1.00E-06
1.00E-07
1.00E-08
1.00E-09
7/22/95
7/29/95
8/5/95
8/12/95
8/19/95
8/26/95
9/2/95
9/9/95
9/16/95
9/23/95
9/30/95
10/7/95
10/14/95
10/21/95
10/28/95
11/4/95
11/11/95
11/18/95
11/25/95
12/2/95
12/9/95
12/16/95
12/23/95
12/30/95
1/6/96
1/13/96
1/20/96
1/27/96
Time
IRRAS Profile
IPE (w/o T/M)
IPE (with T/M)

Configuration	Start (Min.)	End (Min.)	CDF	Start (Date)	End (Date)	CDF	CDP	Cumulative CDP
CONF001	0	60	6.34E-06	7/27/95	7/27/95	6.34E-06	7.24E-10	7.24E-10
CONF002	60	600	6.34E-06	7/27/95	7/27/95	6.34E-06	6.51E-09	7.24E-09
CONF003	600	720	1.49E-05	7/27/95	7/27/95	1.49E-05	3.39E-09	1.06E-08
CONF004	720	840	6.34E-06	7/27/95	7/27/95	6.34E-06	1.45E-09	1.21E-08
CONF005	840	900	6.34E-06	7/27/95	7/27/95	6.34E-06	7.24E-10	1.28E-08
NOMINAL	900	4319	6.34E-06	7/27/95	7/29/95	6.34E-06	4.12E-08	5.40E-08
CONF006	4320	4440	6.34E-06	7/30/95	7/30/95	6.34E-06	1.45E-09	5.55E-08
CONF007	4440	4620	6.34E-06	7/30/95	7/30/95	6.34E-06	2.17E-09	5.77E-08
CONF008	4620	4800	6.34E-06	7/30/95	7/30/95	6.34E-06	2.17E-09	5.98E-08
CONF009	4800	4860	2.45E-05	7/30/95	7/30/95	2.45E-05	2.80E-09	6.26E-08
CONF010	4860	5280	2.45E-05	7/30/95	7/30/95	2.45E-05	1.96E-08	8.22E-08
CONF011	5280	5640	2.49E-05	7/30/95	7/30/95	2.49E-05	1.71E-08	9.93E-08
CONF012	5640	5700	6.34E-06	7/30/95	7/30/95	6.34E-06	7.24E-10	1.00E-07
NOMINAL	5700	8504	6.34E-06	7/30/95	8/1/95	6.34E-06	3.38E-08	1.34E-07
CONF013	8505	8528	6.34E-06	8/1/95	8/1/95	6.34E-06	2.77E-10	1.34E-07
NOMINAL	8528	14949	6.34E-06	8/1/95	8/6/95	6.34E-06	7.75E-08	2.12E-07
CONF014	14950	14995	6.34E-06	8/6/95	8/6/95	6.34E-06	5.43E-10	2.12E-07
NOMINAL	14995	24839	6.34E-06	8/6/95	8/13/95	6.34E-06	1.19E-07	3.31E-07
CONF015	24840	25039	8.50E-06	8/13/95	8/13/95	8.50E-06	3.22E-09	3.34E-07
CONF016	25039	25058	9.18E-05	8/13/95	8/13/95	9.18E-05	3.32E-09	3.37E-07
CONF017	25058	27356	8.50E-06	8/13/95	8/14/95	8.50E-06	3.72E-08	3.75E-07
CONF018	27356	27397	1.86E-05	8/14/95	8/15/95	1.86E-05	1.45E-09	3.76E-07
CONF019	27397	27480	8.50E-06	8/15/95	8/15/95	8.50E-06	1.34E-09	3.77E-07
NOMINAL	27480	27599	6.34E-06	8/15/95	8/15/95	6.34E-06	1.44E-09	3.79E-07
CONF020	27600	28380	6.74E-06	8/15/95	8/15/95	6.74E-06	9.99E-09	3.89E-07
NOMINAL	28380	29579	6.34E-06	8/15/956	8/16/95	6.34E-06	1.45E-08	4.03E-07
CONF021	29580	31762	6.72E-06	8/16/95	8/18/95	6.72E-06	2.79E-08	4.31E-07
CONF022	31762	31823	2.39E-05	8/18/95	8/18/95	2.39E-05	2.77E-09	4.34E-07
CONF023	31823	31860	8.65E-06	8/18/95	8/18/95	8.65E-06	6.09E-10	4.34E-07
CONF024	31860	32040	6.74E-06	8/18/95	8/18/95	6.74E-06	2.31E-09	4.37E-07
CONF025	32040	32760	6.75E-06	8/18/95	8/18/95	6.75E-06	9.25E-09	4.46E-07
CONF026	32760	33180	6.74E-06	8/18/95	8/19/95	6.74E-06	5.39E-09	4.51E-07
CONF027	33180	33240	6.74E-06	8/19/95	8/19/95	6.74E-06	7.69E-10	4.52E-07
CONF028	33240	33480	6.74E-06	8/19/95	8/19/95	6.74E-06	3.08E-09	4.55E-07

Configuration	Start (Min.)	End (Min.)	CDF	Start (Date)	End (Date)	CDF	CDP	Cumulative CDP
CONF029	33480	35480	6.74E-06	8/19/95	8/20/95	6.74E-06	2.56E-08	4.81E-07
CONF030	35480	35490	8.93E-06	8/20/95	8/20/95	8.93E-06	1.70E-10	4.81E-07
CONF031	35490	37560	6.74E-06	8/20/95	8/22/95	6.74E-06	2.65E-08	5.08E-07
CONF032	37560	37680	6.74E-06	8/22/95	8/22/95	6.74E-06	1.54E-09	5.09E-07
CONF033	37680	37990	6.74E-06	8/22/95	8/22/95	6.74E-06	3.98E-09	5.13E-07
CONF034	37990	38092	6.98E-06	8/22/95	8/22/95	6.98E-06	1.35E-09	5.15E-07
CONF035	38092	38340	6.74E-06	8/22/95	8/22/95	6.74E-06	3.18E-09	5.18E-07
CONF036	38340	38380	6.74E-06	8/22/95	8/22/95	6.74E-06	5.13E-10	5.18E-07
CONF037	38380	38400	6.70E-06	8/22/95	8/22/95	6.70E-06	2.55E-10	5.18E-07
CONF038	38400	38940	1.70E-05	8/22/95	8/23/95	1.70E-05	1.75E-08	5.36E-07
CONF039	38940	39840	1.63E-05	8/23/95	8/23/95	1.63E-05	2.79E-08	5.64E-07
CONF040	39840	40906	1.63E-05	8/23/95	8/24/95	1.63E-05	3.31E-08	5.97E-07
CONF041	40906	41580	1.63E-05	8/24/95	8/24/95	1.63E-05	2.09E-08	6.18E-07
CONF042	41580	41640	1.63E-05	8/24/95	8/24/95	1.63E-05	1.86E-09	6.20E-07
NOMINAL	41640	41984	6.34E-06	8/24/95	8/25/95	6.34E-06	4.15E-09	6.24E-07
CONF043	41985	41995	6.34E-06	8/25/95	8/25/95	6.34E-06	1.21E-10	6.24E-07
NOMINAL	41995	45185	6.34E-06	8/25/95	8/27/95	6.34E-06	3.85E-08	6.62E-07
CONF044	45186	45214	2.45E-05	8/27/95	8/27/95	2.45E-05	1.31E-09	6.64E-07
NOMINAL	45214	51423	6.34E-06	8/27/95	8/31/95	6.34E-06	7.49E-08	7.39E-07
CONF045	51424	51444	2.45E-05	8/31/95	8/31/95	2.45E-05	9.32E-10	7.40E-07
NOMINAL	51444	55269	6.34E-06	8/31/95	9/3/95	6.34E-06	4.61E-08	7.86E-07
CONF046	55270	55292	6.34E-06	9/3/95	9/3/95	6.34E-06	2.65E-10	7.86E-07
NOMINAL	55292	56172	6.34E-06	9/3/95	9/4/95	6.34E-06	1.06E-08	7.97E-07
CONF047	56173	56340	7.10E-06	9/4/95	9/4/95	7.10E-06	2.26E-09	7.99E-07
CONF048	56340	58560	7.70E-06	9/4/95	9/5/95	7.70E-06	3.25E-08	8.31E-07
CONF049	58560	58793	7.10E-06	9/5/95	9/5/95	7.10E-06	3.15E-09	8.34E-07
NOMINAL	58793	59644	6.34E-06	9/5/95	9/6/95	6.34E-06	1.03E-08	8.45E-07
CONF050	59645	59675	1.69E-05	9/6/95	9/6/95	1.69E-05	9.63E-10	8.46E-07
NOMINAL	59675	59859	6.34E-06	9/6/95	9/6/95	6.34E-06	2.22E-09	8.48E-07
CONF051	59860	59876	6.34E-06	9/6/95	9/6/95	6.34E-06	1.93E-10	8.48E-07
NOMINAL	59876	65368	6.34E-06	9/6/95	9/10/95	6.34E-06	6.62E-08	9.14E-07
CONF052	65369	65390	8.69E-06	9/10/95	9/10/95	8.69E-06	3.47E-10	9.15E-07
NOMINAL	65390	66455	6.34E-06	9/10/95	9/11/95	6.34E-06	1.28E-08	9.28E-07
CONF053	66456	66555	1.55E-05	9/11/95	9/11/95	1.55E-05	2.93E-09	9.30E-07

Configuration	Start (Min.)	End (Min.)	CDF	Start (Date)	End (Date)	CDF	CDP	Cumulative CDP
NOMINAL	66555	67695	6.34E-06	9/11/95	9/12/95	6.34E-06	1.38E-08	9.44E-07
CONF054	67696	67740	6.34E-06	9/12/95	9/12/95	6.34E-06	5.31E-10	9.45E-07
CONF055	67740	69120	6.34E-06	9/12/95	9/13/95	6.34E-06	1.66E-08	9.61E-07
CONF056	69120	69240	6.34E-06	9/13/95	9/13/95	6.34E-06	1.45E-09	9.63E-07
CONF057	69240	69300	6.34E-06	9/13/95	9/13/95	6.34E-06	7.24E-10	9.64E-07
CONF058	69300	69351	6.34E-06	9/13/95	9/13/95	6.34E-06	6.15E-10	9.64E-07
NOMINAL	69351	69899	6.34E-06	9/13/95	9/13/95	6.34E-06	6.61E-09	9.71E-07
CONF059	69900	70080	6.72E-06	9/13/95	9/13/95	6.72E-06	2.30E-09	9.73E-07
NOMINAL	70080	70131	6.34E-06	9/13/95	9/13/95	6.34E-06	6.15E-10	9.74E-07
CONF060	70132	70176	6.34E-06	9/13/95	9/13/95	6.34E-06	5.31E-10	9.74E-07
NOMINAL	70176	71219	6.34E-06	9/13/95	9/14/95	6.34E-06	1.26E-08	9.87E-07
CONF061	71220	71460	6.72E-06	9/14/95	9/14/95	6.72E-06	3.07E-09	9.90E-07
NOMINAL	71460	71529	6.34E-06	9/14/95	9/14/95	6.34E-06	8.32E-10	9.91E-07
CONF062	71530	71914	6.34E-06	9/14/95	9/14/95	6.34E-06	4.63E-09	9.95E-07
NOMINAL	71914	75426	6.34E-06	9/14/95	9/17/95	6.34E-06	4.24E-08	1.04E-06
CONF063	75427	75446	8.68E-06	9/17/95	9/17/95	8.68E-06	3.14E-10	1.04E-06
NOMINAL	75446	76782	6.34E-06	9/17/95	9/18/95	6.34E-06	1.61E-08	1.05E-06
CONF064	76783	76800	8.68E-06	9/18/95	9/18/95	8.68E-06	2.81E-10	1.05E-06
CONF065	76800	76980	8.68E-06	9/18/95	9/18/95	8.68E-06	2.97E-09	1.06E-06
CONF066	76980	77082	8.68E-06	9/18/95	9/18/95	8.68E-06	1.68E-09	1.06E-06
NOMINAL	77082	77939	6.34E-06	9/18/95	9/19/95	6.34E-06	1.03E-08	1.07E-06
CONF067	77940	79320	6.34E-06	9/19/95	9/20/95	6.34E-06	1.66E-08	1.09E-06
CONF068	79320	79860	6.34E-06	9/20/95	9/20/95	6.34E-06	6.51E-09	1.09E-06
CONF069	79860	79873	6.34E-06	9/20/95	9/20/95	6.34E-06	1.57E-10	1.09E-06
CONF070	79873	80040	6.84E-06	9/20/95	9/20/95	6.84E-06	2.17E-09	1.09E-06
CONF071	80040	80220	6.34E-06	9/20/95	9/20/95	6.34E-06	2.17E-09	1.10E-06
CONF072	80220	80280	6.34E-06	9/20/95	9/20/95	6.34E-06	7.24E-10	1.10E-06
CONF073	80280	80820	6.34E-06	9/20/95	9/21/95	6.34E-06	6.51E-09	1.10E-06
CONF074	80820	81180	6.34E-06	9/21/95	9/21/95	6.34E-06	4.34E-09	1.11E-06
CONF075	81180	81360	6.34E-06	9/21/95	9/21/95	6.34E-06	2.17E-09	1.11E-06
CONF076	81360	81480	6.34E-06	9/21/95	9/21/95	6.34E-06	1.45E-09	1.11E-06
CONF077	81480	82620	6.34E-06	9/21/95	9/22/95	6.34E-06	1.38E-08	1.13E-06
CONF078	82620	84840	6.34E-06	9/22/95	9/23/95	6.34E-06	2.68E-08	1.15E-06
CONF079	84840	85501	7.53E-06	9/23/95	9/24/95	7.53E-06	9.47E-09	1.16E-06

Configuration	Start (Min.)	End (Min.)	CDF	Start (Date)	End (Date)	CDF	CDP	Cumulative CDP
CONF080	85501	85529	2.52E-05	9/24/95	9/24/95	2.52E-05	1.34E-09	1.16E-06
CONF081	85529	85740	7.53E-06	9/24/95	9/24/95	7.53E-06	3.02E-09	1.17E-06
CONF082	85740	85847	6.34E-06	9/24/95	9/24/95	6.34E-06	1.29E-09	1.17E-06
CONF083	85847	85942	2.52E-05	9/24/95	9/24/95	2.52E-05	4.55E-09	1.17E-06
CONF084	85942	86640	6.34E-06	9/24/95	9/25/95	6.34E-06	8.42E-09	1.18E-06
CONF085	86640	87480	6.34E-06	9/25/95	9/25/95	6.34E-06	1.01E-08	1.19E-06
CONF086	87480	88140	6.34E-06	9/25/95	9/26/95	6.34E-06	7.96E-09	1.20E-06
CONF087	88140	88620	2.52E-05	9/26/95	9/26/95	2.52E-05	2.30E-08	1.22E-06
CONF088	88620	88680	2.94E-05	9/26/95	9/26/95	2.94E-05	3.36E-09	1.23E-06
CONF089	88680	89820	2.52E-05	9/26/95	9/27/95	2.52E-05	5.47E-08	1.28E-06
CONF090	89820	94282	6.34E-06	9/27/95	9/30/95	6.34E-06	5.38E-08	1.33E-06
CONF091	94282	94650	2.34E-05	9/30/95	9/30/95	2.34E-05	1.64E-08	1.35E-06
CONF092	94650	95100	6.34E-06	9/30/95	10/1/95	6.34E-06	5.43E-09	1.36E-06
CONF093	95100	95940	6.34E-06	10/1/95	10/1/95	6.34E-06	1.01E-08	1.37E-06
CONF094	95940	98280	6.34E-06	10/1/95	10/3/95	6.34E-06	2.82E-08	1.39E-06
CONF095	98280	98760	6.34E-06	10/3/95	10/3/95	6.34E-06	5.79E-09	1.40E-06
CONF096	98760	98880	6.34E-06	10/3/95	10/3/95	6.34E-06	1.45E-09	1.40E-06
CONF097	98880	98965	6.34E-06	10/3/95	10/3/95	6.34E-06	1.03E-09	1.40E-06
CONF098	98965	99000	6.34E-06	10/3/95	10/3/95	6.34E-06	4.22E-10	1.40E-06
NOMINAL	99000	100859	6.34E-06	10/3/95	10/5/95	6.34E-06	2.24E-08	1.43E-06
CONF099	100860	101854	6.34E-06	10/5/95	10/5/95	6.34E-06	1.20E-08	1.44E-06
NOMINAL	101854	105299	6.34E-06	10/5/95	10/8/95	6.34E-06	4.16E-08	1.48E-06
CONF100	105300	105666	6.34E-06	10/8/95	10/8/95	6.34E-06	4.41E-09	1.48E-06
CONF101	105666	105687	8.38E-06	10/8/95	10/8/95	8.38E-06	3.35E-10	1.48E-06
CONF102	105687	107280	6.34E-06	10/8/95	10/9/95	6.34E-06	1.92E-08	1.50E-06
NOMINAL	107280	107436	6.34E-06	10/9/95	10/9/95	6.34E-06	1.88E-09	1.50E-06
CONF103	107437	107658	1.55E-05	10/9/95	10/9/95	1.55E-05	6.53E-09	1.51E-06
NOMINAL	107658	108493	6.34E-06	10/9/95	10/10/95	6.34E-06	1.01E-08	1.52E-06
CONF104	108494	109013	6.70E-06	10/10/95	10/10/95	6.70E-06	6.62E-09	1.53E-06
NOMINAL	109013	109916	6.34E-06	10/10/95	10/11/95	6.34E-06	1.09E-08	1.54E-06
CONF105	109917	110265	6.34E-06	10/11/95	10/11/95	6.34E-06	4.20E-09	1.54E-06
NOMINAL	110265	111179	6.34E-06	10/11/95	10/12/95	6.34E-06	1.10E-08	1.55E-06
CONF106	111180	111840	6.34E-06	10/12/95	10/12/95	6.34E-06	7.96E-09	1.56E-06
NOMINAL	111840	115499	6.34E-06	10/12/95	10/15/95	6.34E-06	4.41E-08	1.61E-06

Configuration	Start (Min.)	End (Min.)	CDF	Start (Date)	End (Date)	CDF	CDP	Cumulative CDP
CONF107	115500	116577	8.70E-06	10/15/95	10/15/95	8.70E-06	1.78E-08	1.62E-06
CONF108	116577	116760	8.70E-06	10/15/95	10/16/95	8.70E-06	3.03E-09	1.63E-06
CONF109	116760	117540	1.35E-05	10/16/95	10/16/95	1.35E-05	2.00E-08	1.65E-06
CONF110	117540	118017	8.70E-06	10/16/95	10/16/95	8.70E-06	7.90E-09	1.65E-06
NOMINAL	118017	118319	6.34E-06	10/16/95	10/17/95	6.34E-06	3.64E-09	1.66E-06
CONF111	118320	118920	1.01E-05	10/17/95	10/17/95	1.01E-05	1.15E-08	1.67E-06
NOMINAL	118920	119279	6.34E-06	10/17/95	10/17/95	6.34E-06	4.33E-09	1.67E-06
CONF112	119280	119760	8.70E-06	10/17/95	10/18/95	8.70E-06	7.95E-09	1.68E-06
CONF113	119760	120505	8.77E-06	10/18/95	10/18/95	8.77E-06	1.24E-08	1.69E-06
CONF114	120505	120540	6.34E-06	10/18/95	10/18/95	6.34E-06	4.22E-10	1.70E-06
NOMINAL	120540	120902	6.34E-06	10/18/95	10/18/95	6.34E-06	4.37E-09	1.70E-06
CONF115	120903	121145	8.68E-06	10/18/95	10/19/95	8.68E-06	4.00E-09	1.70E-06
NOMINAL	121145	121501	6.34E-06	10/19/95	10/19/95	6.34E-06	4.29E-09	1.71E-06
CONF116	121502	121560	1.60E-05	10/19/95	10/19/95	1.60E-05	1.76E-09	1.71E-06
CONF117	121560	121815	1.76E-05	10/19/95	10/19/95	1.76E-05	8.54E-09	1.72E-06
CONF118	121815	121839	1.78E-05	10/19/95	10/19/95	1.78E-05	8.13E-10	1.72E-06
CONF119	121839	121920	1.76E-05	10/19/95	10/19/95	1.76E-05	2.71E-09	1.72E-06
CONF120	121920	121940	1.60E-05	10/19/95	10/19/95	1.60E-05	6.08E-10	1.72E-06
NOMINAL	121940	125804	6.34E-06	10/19/95	10/22/95	6.34E-06	4.66E-08	1.77E-06
CONF121	125805	125837	2.45E-05	10/22/95	10/22/95	2.45E-05	1.49E-09	1.77E-06
NOMINAL	125837	125889	6.34E-06	10/22/95	10/22/95	6.34E-06	6.27E-10	1.77E-06
CONF122	125890	126560	6.34E-06	10/22/95	10/22/95	6.34E-06	8.08E-09	1.78E-06
NOMINAL	126560	129767	6.34E-06	10/22/95	10/25/95	6.34E-06	3.87E-08	1.82E-06
CONF123	129768	129830	6.34E-06	10/25/95	10/25/95	6.34E-06	7.48E-10	1.82E-06
NOMINAL	129830	130119	6.34E-06	10/25/95	10/25/95	6.34E-06	3.49E-09	1.82E-06
CONF124	130120	130860	6.34E-06	10/25/95	10/25/95	6.34E-06	8.93E-09	1.83E-06
CONF125	130860	132840	2.06E-05	10/25/95	10/27/95	2.06E-05	7.76E-08	1.91E-06
CONF126	132840	133097	6.34E-06	10/27/95	10/27/95	6.34E-06	3.10E-09	1.91E-06
CONF127	133097	133137	6.34E-06	10/27/95	10/27/95	6.34E-06	4.82E-10	1.91E-06
CONF128	133137	133320	6.34E-06	10/27/95	10/27/95	6.34E-06	2.21E-09	1.91E-06
NOMINAL	133320	134999	6.34E-06	10/27/95	10/28/95	6.34E-06	2.03E-08	1.93E-06
CONF129	135000	135600	6.34E-06	10/28/95	10/29/95	6.34E-06	7.24E-09	1.94E-06
CONF130	135600	136740	2.32E-05	10/29/95	10/29/95	2.32E-05	5.03E-08	1.99E-06
CONF131	136740	137520	2.32E-05	10/29/95	10/30/95	2.32E-05	3.44E-08	2.03E-06

Configuration	Start (Min.)	End (Min.)	CDF	Start (Date)	End (Date)	CDF	CDP	Cumulative CDP
CONF132	137520	137880	2.32E-05	10/30/95	10/30/95	2.32E-05	1.59E-08	2.04E-06
CONF133	137880	139260	6.34E-06	10/30/95	10/31/95	6.34E-06	1.66E-08	2.06E-06
NOMINAL	139260	139805	6.34E-06	10/31/95	11/1/95	6.34E-06	6.57E-09	2.07E-06
CONF134	139806	139883	6.34E-06	11/1/95	11/1/95	6.34E-06	9.29E-10	2.07E-06
NOMINAL	139883	139919	6.34E-06	11/1/95	11/1/95	6.34E-06	4.34E-10	2.07E-06
CONF135	139920	140760	7.99E-06	11/1/95	11/1/95	7.99E-06	1.28E-08	2.08E-06
NOMINAL	140760	141272	6.34E-06	11/1/95	11/2/95	6.34E-06	6.18E-09	2.09E-06
CONF136	141273	141480	6.34E-06	11/2/95	11/2/95	6.34E-06	2.50E-09	2.09E-06
CONF137	141480	141830	6.34E-06	11/2/95	11/2/95	6.34E-06	4.22E-09	2.09E-06
CONF138	141830	141839	1.84E-05	11/2/95	11/2/95	1.84E-05	3.15E-10	2.09E-06
CONF139	141839	142200	6.34E-06	11/2/95	11/2/95	6.34E-06	4.35E-09	2.10E-06
CONF140	142200	142610	6.34E-06	11/2/95	11/3/95	6.34E-06	4.95E-09	2.10E-06
NOMINAL	142610	144183	6.34E-06	11/3/95	11/4/95	6.34E-06	1.90E-08	2.12E-06
CONF141	144184	144217	6.34E-06	11/4/95	11/4/95	6.34E-06	3.98E-10	2.12E-06
NOMINAL	144217	145762	6.34E-06	11/4/95	11/5/95	6.34E-06	1.86E-08	2.14E-06
CONF142	145763	145800	8.19E-06	11/5/95	11/5/95	8.19E-06	5.77E-10	2.14E-06
CONF143	145800	146460	9.00E-06	11/5/95	11/5/95	9.00E-06	1.13E-08	2.15E-06
CONF144	146460	146854	6.34E-06	11/5/95	11/5/95	6.34E-06	4.75E-09	2.16E-06
NOMINAL	146854	146931	6.34E-06	11/5/95	11/6/95	6.34E-06	9.29E-10	2.16E-06
CONF145	146932	147200	6.34E-06	11/6/95	11/6/95	6.34E-06	3.23E-09	2.16E-06
CONF146	147200	147690	6.34E-06	11/6/95	11/6/95	6.34E-06	5.91E-09	2.17E-06
CONF147	147690	147822	2.38E-05	11/6/95	11/6/95	2.38E-05	5.98E-09	2.17E-06
CONF148	147822	147851	6.34E-06	11/6/95	11/6/95	6.34E-06	3.50E-10	2.17E-06
NOMINAL	147851	147863	6.34E-06	11/6/95	11/6/95	6.34E-06	1.45E-10	2.17E-06
CONF149	147864	148405	6.85E-06	11/6/95	11/7/95	6.85E-06	7.05E-09	2.18E-06
CONF150	148405	148439	1.63E-05	11/7/95	11/7/95	1.63E-05	1.05E-09	2.18E-06
CONF151	148439	148582	6.85E-06	11/7/95	11/7/95	6.85E-06	1.86E-09	2.18E-06
CONF152	148582	149066	1.49E-05	11/7/95	11/7/95	1.49E-05	1.37E-08	2.20E-06
CONF153	149066	149168	8.01E-06	11/7/95	11/7/95	8.01E-06	1.55E-09	2.20E-06
CONF154	149168	149340	1.78E-05	11/7/95	11/7/95	1.78E-05	5.82E-09	2.20E-06
CONF155	149340	149356	8.01E-06	11/7/95	11/7/95	8.01E-06	2.44E-10	2.20E-06
CONF156	149356	153569	6.85E-06	11/7/95	11/10/95	6.85E-06	5.49E-08	2.26E-06
NOMINAL	153569	155699	6.34E-06	11/10/95	11/12/95	6.34E-06	2.57E-08	2.29E-06
CONF157	155700	155755	8.68E-06	11/12/95	11/12/95	8.68E-06	9.08E-10	2.29E-06

Configuration	Start (Min.)	End (Min.)	CDF	Start (Date)	End (Date)	CDF	CDP	Cumulative CDP
CONF158	155755	157625	8.68E-06	11/12/95	11/13/95	8.68E-06	3.09E-08	2.32E-06
CONF159	157625	159120	8.68E-06	11/13/95	11/14/95	8.68E-06	2.47E-08	2.34E-06
NOMINAL	159120	161797	6.34E-06	11/14/95	11/16/95	6.34E-06	3.23E-08	2.37E-06
CONF160	161798	161810	6.34E-06	11/16/95	11/16/95	6.34E-06	1.45E-10	2.37E-06
CONF161	161810	161935	1.55E-05	11/16/95	11/16/95	1.55E-05	3.69E-09	2.38E-06
CONF162	161935	162104	6.34E-06	11/16/95	11/16/95	6.34E-06	2.04E-09	2.38E-06
NOMINAL	162104	163262	6.34E-06	11/16/95	11/17/95	6.34E-06	1.40E-08	2.39E-06
CONF163	163263	163335	6.34E-06	11/17/95	11/17/95	6.34E-06	8.68E-10	2.39E-06
NOMINAL	163335	165599	6.34E-06	11/17/95	11/18/95	6.34E-06	2.73E-08	2.42E-06
CONF164	165600	166146	6.59E-06	11/19/95	11/19/95	6.59E-06	6.85E-09	2.43E-06
CONF165	166146	166168	2.39E-05	11/19/95	11/19/95	2.39E-05	1.00E-09	2.43E-06
CONF166	166168	166620	6.59E-06	11/19/95	11/19/95	6.59E-06	5.67E-09	2.44E-06
NOMINAL	166620	167279	6.34E-06	11/19/95	11/20/95	6.34E-06	7.95E-09	2.44E-06
CONF167	167280	168000	6.34E-06	11/20/95	11/20/95	6.34E-06	8.68E-09	2.45E-06
NOMINAL	168000	176303	6.34E-06	11/20/95	11/26/95	6.34E-06	1.00E-07	2.55E-06
CONF168	176304	176318	6.34E-06	11/26/95	11/26/95	6.34E-06	1.69E-10	2.55E-06
NOMINAL	176318	177359	6.34E-06	11/26/95	11/27/95	6.34E-06	1.26E-08	2.57E-06
CONF169	177360	177960	6.34E-06	11/27/95	11/27/95	6.34E-06	7.24E-09	2.57E-06
NOMINAL	177960	178439	6.34E-06	11/27/95	11/27/95	6.34E-06	5.78E-09	2.58E-06
CONF170	178440	178860	6.74E-06	11/27/95	11/28/95	6.74E-06	5.39E-09	2.58E-06
CONF171	178860	180225	6.75E-06	11/28/95	11/29/95	6.75E-06	1.75E-08	2.60E-06
CONF172	180225	180300	6.75E-06	11/29/95	11/29/95	6.75E-06	9.63E-10	2.60E-06
CONF173	180300	181080	6.34E-06	11/29/95	11/29/95	6.34E-06	9.41E-09	2.61E-06
CONF174	181080	181180	6.74E-06	11/29/95	11/29/95	6.74E-06	1.28E-09	2.61E-06
CONF175	181180	181320	6.34E-06	11/29/95	11/29/95	6.34E-06	1.69E-09	2.61E-06
NOMINAL	181320	185999	6.34E-06	11/29/95	12/3/95	6.34E-06	5.64E-08	2.67E-06
CONF176	186000	186005	9.00E-06	12/3/95	12/3/95	9.00E-06	8.56E-11	2.67E-06
CONF177	186005	187740	9.00E-06	12/3/95	12/4/95	9.00E-06	2.97E-08	2.70E-06
CONF178	187740	189300	8.19E-06	12/4/95	12/5/95	8.19E-06	2.43E-08	2.72E-06
CONF179	189300	189420	8.19E-06	12/5/95	12/5/95	8.19E-06	1.87E-09	2.73E-06
CONF180	189420	190440	8.19E-06	12/5/95	12/6/95	8.19E-06	1.59E-08	2.74E-06
CONF181	190440	190620	1.80E-05	12/6/95	12/6/95	1.80E-05	6.16E-09	2.75E-06
CONF182	190620	190684	1.80E-05	12/6/95	12/6/95	1.80E-05	2.19E-09	2.75E-06
CONF183	190684	190830	2.81E-05	12/6/95	12/6/95	2.81E-05	7.81E-09	2.76E-06

Configuration	Start (Min.)	End (Min.)	CDF	Start (Date)	End (Date)	CDF	CDP	Cumulative CDP
CONF184	190830	190860	1.80E-05	12/6/95	12/6/95	1.80E-05	1.03E-09	2.76E-06
CONF185	190860	191100	9.00E-06	12/6/95	12/6/95	9.00E-06	4.11E-09	2.76E-06
CONF186	191100	191460	6.34E-06	12/6/95	12/6/95	6.34E-06	4.34E-09	2.77E-06
CONF187	191460	191920	8.19E-06	12/6/95	12/7/95	8.19E-06	7.17E-09	2.78E-06
CONF188	191920	192180	9.00E-06	12/7/95	12/7/95	9.00E-06	4.45E-09	2.78E-06
CONF189	192180	192204	9.00E-06	12/7/95	12/7/95	9.00E-06	4.11E-10	2.78E-06
NOMINAL	192204	201459	6.34E-06	12/7/956	12/13/95	6.34E-06	1.12E-07	2.89E-06
CONF190	201460	201840	6.34E-06	12/13/95	12/14/95	6.34E-06	4.58E-09	2.90E-06
CONF191	201840	202920	6.34E-06	12/14/95	12/14/95	6.34E-06	1.30E-08	2.91E-06
NOMINAL	202920	206439	6.34E-06	12/14/95	12/17/95	6.34E-06	4.24E-08	2.95E-06
CONF192	206440	206459	2.45E-05	12/17/95	12/17/95	2.45E-05	8.86E-10	2.95E-06
NOMINAL	206459	206744	6.34E-06	12/17/95	12/17/95	6.34E-06	3.44E-09	2.96E-06
CONF193	206745	206880	2.45E-05	12/17/95	12/17/95	2.45E-05	6.29E-09	2.96E-06
NOMINAL	206880	212219	6.34E-06	12/17/95	12/21/95	6.34E-06	6.44E-08	3.03E-06
CONF194	212220	212460	6.34E-06	12/21/95	12/21/95	6.34E-06	2.89E-09	3.03E-06
NOMINAL	212460	217985	6.34E-06	12/21/95	12/25/95	6.34E-06	6.66E-08	3.10E-06
CONF195	217986	218010	6.34E-06	12/25/95	12/25/95	6.34E-06	2.89E-10	3.10E-06
NOMINAL	218010	219719	6.34E-06	12/25/95	12/26/95	6.34E-06	2.06E-08	3.12E-06
CONF196	219720	219960	6.34E-06	12/26/95	12/26/95	6.34E-06	2.89E-09	3.12E-06
NOMINAL	219960	220157	6.34E-06	12/26/95	12/26/95	6.34E-06	2.38E-09	3.12E-06
CONF197	220158	220309	1.33E-05	12/26/95	12/26/95	1.33E-05	3.82E-09	3.13E-06
NOMINAL	220309	226618	6.34E-06	12/26/95	12/31/95	6.34E-06	7.61E-08	3.20E-06
CONF198	226619	226648	6.34E-06	12/31/95	12/31/95	6.34E-06	3.50E-10	3.20E-06
NOMINAL	226648	227819	6.34E-06	12/31/95	1/1/96	6.34E-06	1.41E-08	3.22E-06
CONF199	227820	227880	6.34E-06	1/1/96	1/1/96	6.34E-06	7.24E-10	3.22E-06
CONF200	227880	228000	6.34E-06	1/1/96	1/1/96	6.34E-06	1.45E-09	3.22E-06
CONF201	228000	228420	6.34E-06	1/1/96	1/1/96	6.34E-06	5.07E-09	3.22E-06
CONF202	228420	228486	6.34E-06	1/1/96	1/1/96	6.34E-06	7.96E-10	3.23E-06
CONF203	228486	228540	1.76E-05	1/1/96	1/1/96	1.76E-05	1.81E-09	3.23E-06
CONF204	228540	228720	6.34E-06	1/1/96	1/1/96	6.34E-06	2.17E-09	3.23E-06
NOMINAL	228720	229199	6.34E-06	1/1/96	1/2/96	6.34E-06	5.78E-09	3.23E-06
CONF205	229200	229320	6.34E-06	1/2/96	1/2/96	6.34E-06	1.45E-09	3.24E-06
CONF206	229320	229340	6.34E-06	1/2/96	1/2/96	6.34E-06	2.41E-10	3.24E-06
CONF207	229340	229680	6.34E-06	1/2/96	1/2/96	6.34E-06	4.10E-09	3.24E-06

Configuration	Start (Min.)	End (Min.)	CDF	Start (Date)	End (Date)	CDF	CDP	Cumulative CDP
CONF208	229680	230460	6.34E-06	1/2/96	1/3/96	6.34E-06	9.41E-09	3.25E-06
NOMINAL	230460	236345	6.34E-06	1/3/96	1/7/96	6.34E-06	7.10E-08	3.32E-06
CONF209	236346	236385	2.45E-05	1/7/96	1/7/96	2.45E-05	1.82E-09	3.32E-06
NOMINAL	236385	236395	6.34E-06	1/7/96	1/7/96	6.34E-06	1.21E-10	3.32E-06
CONF210	236396	236411	6.34E-06	1/7/96	1/7/96	6.34E-06	1.81E-10	3.32E-06
NOMINAL	236411	236519	6.34E-06	1/7/96	1/7/96	6.34E-06	1.30E-09	3.32E-06
CONF211	236520	237180	8.68E-06	1/7/96	1/7/96	8.68E-06	1.09E-08	3.34E-06
NOMINAL	237180	237306	6.34E-06	1/7/96	1/7/96	6.34E-06	1.52E-09	3.34E-06
CONF212	237307	237435	8.68E-06	1/7/96	1/7/96	8.68E-06	2.11E-09	3.34E-06
NOMINAL	237435	241498	6.34E-06	1/7/96	1/10/96	6.34E-06	4.90E-08	3.39E-06
CONF213	241499	242940	1.01E-05	1/10/96	1/11/96	1.01E-05	2.78E-08	3.42E-06
NOMINAL	242940	246494	6.34E-06	1/11/96	1/14/96	6.34E-06	4.29E-08	3.46E-06
CONF214	246495	246540	2.45E-05	1/14/96	1/14/96	2.45E-05	2.10E-09	3.46E-06
CONF215	246540	248256	2.39E-05	1/14/96	1/15/96	2.39E-05	7.80E-08	3.54E-06
CONF216	248256	248340	2.39E-05	1/15/96	1/15/96	2.39E-05	3.82E-09	3.54E-06
CONF217	248340	248400	2.39E-05	1/15/96	1/15/96	2.39E-05	2.73E-09	3.55E-06
CONF218	248400	249120	2.39E-05	1/15/96	1/16/96	2.39E-05	3.27E-08	3.58E-06
CONF219	249120	249696	2.45E-05	1/16/96	1/16/96	2.45E-05	2.68E-08	3.61E-06
NOMINAL	249696	256861	6.34E-06	1/16/96	1/21/96	6.34E-06	8.64E-08	3.69E-06
CONF220	256862	256878	6.34E-06	1/21/96	1/21/96	6.34E-06	1.93E-10	3.69E-06
NOMINAL	256878	259817	6.34E-06	1/21/96	1/23/96	6.34E-06	3.55E-08	3.73E-06
CONF221	259818	259852	6.34E-06	1/23/96	1/23/96	6.34E-06	4.10E-10	3.73E-06
NOMINAL	259852	262184	6.34E-06	1/23/96	1/25/96	6.34E-06	2.81E-08	3.76E-06
CONF222	262185	262200	6.34E-06	1/25/96	1/25/96	6.34E-06	1.81E-10	3.76E-06
NOMINAL	262200	262859	6.34E-06	1/25/96	1/25/96	6.34E-06	7.95E-09	3.76E-06
CONF223	262860	262995	8.68E-06	1/25/96	1/25/96	8.68E-06	2.23E-09	3.77E-06
NOMINAL	262995	265755	6.34E-06	1/25/96	1/27/96	6.34E-06	3.33E-08	3.80E-06
CONF224	265756	265776	6.34E-06	1/27/96	1/27/96	6.34E-06	2.41E-10	3.80E-06

Development of Plant Configuration Risk Profiles at Brunswick Nuclear Plant

James M. Trapp
Peter R. Wilson

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Quality Assurance of Risk Profile Data and
Inspection Planning Applications of Risk Profile Results

I. Quality Assurance of Risk Profile Data

A. Phase 1 - Review of raw data

The first step of developing a risk profile is to collect the information sources necessary to establish the availability of plant systems and components. Several sources of information are needed to develop a complete description of plant equipment status. The following are examples of references that would provide the necessary information for developing a risk profile.

- Maintenance and Surveillance Work Schedules,
- Operations Logs,
- Equipment Tagout Logs,
- Event Notifications (50.72) and Licensee Event Reports (LERS, 50.73),
- Equipment Failure Root Cause Evaluations,
- NRC and Quality Assurance Inspection Reports,
- Plant Procedures
- 10 CFR 50.59 reviews

The unavailability duration is the total time a component incapable of performing its function. The risk profile is based on the time that equipment is unavailable. In some cases it's important to distinguish between the time a component is unavailable and the time it's inoperable. For example, an operating log entry may provide the start time that a pump was inoperable due to its failure to operate during a surveillance test. The root cause maybe identified as the failure to have properly "racked-in" the pump breaker following the last breaker maintenance. Therefore, the time the component was unavailable would exceed time inoperable, since the pump would not have been declared inoperable until the problem was identified. For this case, a review of the information sources other than logs and schedules would be necessary to properly establish the unavailability duration.

In certain cases specific plant procedures need to be referenced to determine if the maintenance or surveillance activity actually caused the equipment to be unavailable. For example, during certain surveillance tests, equipment is declared inoperable for the complete test evolution, while the equipment was actually unavailable for only a short period of time. Safety evaluations (10 CFR 50.59) which provide a basis for continued operation for degraded equipment may also need to be reflected in the risk profile. The analyst needs to review several information sources to develop a detailed understanding of plant equipment status before developing the risk profile input.

B. Phase 2 - Evaluation plant configurations used in the risk profile

The equipment configurations are established using the equipment status references. Each plant configuration reflects a specific combination of equipment that is simultaneously unavailable. The time duration that each plant configuration exists is also determined. After the configurations are established, a qualitative check should be performed on those configurations

that appear to have several important systems out-of-service simultaneously or have configurations which are not consistent with requirements. Since these configurations will most likely be the dominant contributors to the plant risk profile, a detailed assessment of these configurations should be performed to verify that the configurations have been properly characterized. The detailed assessment should include a verification of the equipment status references, discussion with cognizant plant personnel, and a review of additional references to positively establish that the configuration and durations are correct. The detailed assessments can be made prior to quantifying the configuration risk using the PRA.

The analyst should provide a description of unavailable equipment for each configuration. When possible, conventional equipment descriptions such as HPCI pump or #21 EDG (do not use breaker identification tag numbers or PRA tag numbers) should be used. Using conventional equipment descriptions, will simplify conducting the quality checks and the assessment of the risk profile. If conventional equipment descriptions cannot be used, the analyst must provide a cross-reference used to define the unavailable equipment for each configuration.

The top level unavailable component event should be the only event probability revised in the PRA and documented in the equipment configuration. For example, if several clearance tags are hung on various components to remove a diesel generator from service, it is not desirable to fail each individual component in the PRA model. If the end result is to remove the diesel from service then only the probability for the diesel needs to be adjusted. Failing each tagged component in the PRA model adds unnecessary confusion to the plant equipment configuration and adds unnecessary data input.

II. Inspection Planning Applications of Risk Profile Results

Once the risk profile is completed, the results need to be reviewed to identify areas for the development of risk-informed, performance-based inspection plans. Ideally, the risk profile should cover a licensee's SALP period. This will provide a sufficient duration to identify cumulative risk trends, instances of significant risk increase and risks associated with licensee risk management practices. Also, this will allow the risk profile to be used in the planning for Integrated Performance Assessment Process (IPAP) inspections.

The areas of interest that need to be identified for inspection planning purposes include significant risk peaks, risk peaks of unusually long duration, and the frequency and/or clusters of risk peaks. The event(s) and/or plant configuration that caused each peak needs to be understood.

The next step is to apply the insights gained from the risk profile to inspection planning. The following is a discussion on how the risk profile insights can be used to develop inspection plans in several functional areas.

B. Functional Area Evaluations

1. Operations

a. Evaluate initiating event spikes to assess cause/operator

response. If there has been a significant contribution to risk resulting from plant events during the assessment period, then an area of inspection should focus on actions the licensee may be taking to minimize transients and operator event response training.

b. Assess risk peaks and identify operator errors. If several of the risk peaks have resulted from operator errors, then the focus of the inspection should be on operator training.

c. Assess how operations manages risk while differing plant configuration. If several risk peaks are the result of risk significant plant configurations, then the inspection of the operations configuration management controls would be appropriate. The clustering of risk peaks is also an indication of weak configuration management.

d. Evaluate compensatory actions when safety significant components are out of service. If several of the risk peaks could have been avoided via compensatory actions, then the inspection of the operations configuration management controls would be appropriate.

2. Maintenance and Test

a. Evaluate safety significant post maintenance test failures. If several risk peaks were the result of inadequate maintenance, the inspection should focus on licensee maintenance practices and training.

b. Assess risk management of the planning and scheduling of on-line maintenance. If several risk peaks were the result of risk significant plant configurations due to maintenance planning and scheduling , then inspection of how the licensee plans and schedules work would be appropriate. The clustering of risk peaks is also an indication of weak planning and scheduling.

c. Evaluate quality and timeliness of maintenance/test activities by reviewing actual out of service times versus the planned time. If there are several risk peaks of significant duration that were not accounted for when scheduling maintenance, then assess the licensee's planning and scheduling programs. Also review the licensee's equipment clearance process.

d. Evaluate common mode failures due to maintenance practices. If the risk peaks were due to common weaknesses in maintenance (multiple bearing failures, failures due to inadequate foreign material exclusion controls, etc.), then maintenance programs should be reviewed as well as maintenance training.

3. Engineering

a. Assess repeat failures due to inadequate design. For example, if several instances of strainer key failures are identified as relatively risk significant failures, then an inspection of the design of the strainer keys would be conducted to verify the robustness of the design.

b. Assess failures caused by design processes. The risk profile will reflect safety system that are removed from service to implement a design change or to correct a deficiency that resulted from a previously installed design change. For example, a relatively large CDP peak, caused by a planned modification to a diesel generator governor, was observed in the risk profile. Upon further review, the new governor did not function properly and the old governor was reinstalled. The inspection effort for design changes could then be focused on this design change.

c. Evaluate the timeliness and quality of engineering response to risk significant events. Forced equipment maintenance often requires engineering support to correct the deficiencies and to conduct root cause evaluations for the equipment failures. The risk profile will identify those equipment failures that had the higher CDPs so that the inspection effort can be optimized.

4. Safety Assessment/Corrective Actions

a. Assess the reliability/unavailability trend of safety significant components. The cumulative risk profile provides a risk informed assessment of the overall performance of plant safety equipment. The cumulative profile shows the relative performance of equipment during the period profile period to that during the IPE data was collection period. The cumulative risk profile provides a direct and simple means of assessing the changes in performance of plant equipment. The root causes for significant changes in equipment performance should be identified during the inspection effort.

b. Verify the quality of corrective actions on safety significant components/systems. The risk profile can be used to identify the more risk significant failures to assess the corrective action program. The risk profile will also identify repetitive failures of risk significance during the profile assessment period. The inspection of the corrective action program can then focus on the more risk significant equipment failures.