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**DETERMINATION OF FREQUENCIES OF CONTAMINATION AND FIRE
RELATED INCIDENTS FOR DWPF SAR (U)**

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Performing Org.: Safety Information Management & Analysis (SIMA)

Requesting Org.: Risk Analysis Group (RAG)

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DETERMINATION OF FREQUENCIES OF CONTAMINATION AND FIRE RELATED INCIDENTS FOR DWPF SAR (U)

INTRODUCTION

At the request of the Risk Analysis group (RAG), and in support of the DWPF SAR, the Safety Information Management and Analysis group (SIMA) determined specific frequency and unavailability values dealing with contamination and fire related incidents. All results summarized herein are based upon actual facility operating data from the 200-Area Fault Tree Data Bank. The SAS statistical package was utilized to compute annual frequencies from appropriate event data. All calculations have been technically reviewed to ensure that they are accurate mathematical representations of actual operating history as recorded in the data bank.

SUMMARY

Results of the frequency analysis are summarized in Table 1. Unavailabilities are $5.77\text{e-}3$ for the fire water system, $1.71\text{e-}3$ for fire alarm system failures, and $1.13\text{e-}1$ for fire alarm system outages that are non-failure related (primarily system bypasses due to construction, maintenance, etc...).

Table 1. Summary of Frequency Analysis

Text Description	Mean Frequency (year ⁻¹)	Median Frequency (year ⁻¹)	Standard Deviation (year ⁻¹)
Fire Water System, Failure Rate	2.18	1.64	1.94
Fire Alarm System, Failure Rate	17.6	NA	4.1
Fire Alarm System Outage Frequency (non-failure)	71.4	25.6	126
False Fire Alarm Frequency	42.1	31.9	38.8
Process Related Fire Frequency(F-Canyon)	$2.43\text{e-}2$	NA	$1.56\text{e-}1$
Process Related Fire Frequency(H-Canyon)	NA	NA	NA
Any Type Fire Frequency (F-Canyon)	1.86	NA	1.36
Any Type Fire Frequency (H-Canyon)	1.86	NA	1.36
Surface Contamination Frequency	478	339	549
Inhalation Contam. Frequency During Maintenance	1.79	0.74	2.67
Skin Contamination Frequency During Maintenance	3.37	3.08	2.29
Airborne Contam. Frequency During Maintenance	1.84	1.26	2.17

REQUIREMENTS

The customer, RAG, made a request to SIMA for frequencies and unavailabilities applicable to the DWPF SAR. A Safety Document Task Agreement, EPD-RAG-94-0075 (ATTACHMENT 1) was used to document requested scope and deliverables. SIMA was asked to provide RAG with frequency of failure and unavailability for F-Area fire water system and F-Canyon fire alarm system. In addition to these values, SIMA was asked to produce frequencies of occurrence of fire and contamination related events in F and H-Areas. For details of requirements consult ATTACHMENT 1.

METHODOLOGY

The SRS Fault Tree Data Banks are a compilation of events and occurrences at SRS from 1954 to the present. SIMA maintains Fault Tree Data Banks for 200-Area, 300-Area, Tritium, Waste Management, and SRTC. The SRS Fault Tree Data banks were used to recall historical data for all requested frequency/unavailability values. The 200-Area data bank (specifically F and H Canyon) was selected as the source of data. This was done primarily for 2 reasons: (1) The 200-Area data bank contains the largest amount of data for the events of concern, and (2) F and H Canyon operations are adequately prototypical of expected DWPF operations to warrant use in predicting contamination and fire events.

The following sorts (i.e. data searches) were run on the 200-Area data bank. These sorts were run on October 6, 1994 using the code structure published in the most recent 200-Area data bank status report, WSRC-TR-94-0163, "Separations Facilities Fault Tree Data Bank (SEPR) 1993 Status Report (U)."

Table 2. Sort Descriptions

Text Description	Code Description				
	Area	Facil.	Source	Op.	Equipment
Fire Water System, Failure Rate & Unavailability	F	A. C	---	---	646 not 639
Fire Alarms, Failure Rate & Unavailability	F	A	---	44	646
False Fire Alarm Frequency	F	A	7C, 8B	44	646

Table 2. Sort Descriptions (continued from previous page)

Text Description	Code Description				
	Area	Facil.	Source	Op.	Equipment
Process Related Fire Frequency (F-Canyon)	F	A	---	---	076
Process Related Fire Frequency (H-Canyon)	H	A	---	---	076
Any Type Fire Frequency (F-Canyon)	F	A	---	---	076
Any Type Fire Frequency (H-Canyon)	H	A	---	---	076
Surface Contamination Freq. (tools, equip., walls, floors)	F	A	---	---	048
Inhalation Contam. Frequency During Maintenance	F	A	---	---	478
Skin Contamination Frequency During Maintenance	F	A	---	---	548
Airborne Contamination Frequency During Maintenance	F	A	---	---	153

Each entry from each data set was read to ensure applicability to the analysis. Duplicate and/or inappropriate entries were eliminated. Appendix I is the calc-note package associated with this work (calculation no. S-CLC-G-00019). Additional details on data editing are included in the calc-note.

When the data sorts were run, no restrictions were placed on date range. However during the analysis phase of this task data were excluded based upon date. This was done in four ways:

(1) In the case of false fire alarms, source codes 7C (Fire Department 30 Day Report) and 8B (Emergency Operations Activity Log) automatically restricted data output to the range 5/1/91 - present.

(2) Since only 10 months of 1994 data were in the data bank at the time of this analysis, 1994 data were excluded from yearly based analyses. Monthly based analyses (described in later sections) did include 1994 data where available.

(3) Data sources have improved over time. A step increase in the number of recorded incidents is sometimes attributable the addition of a new data source. A histogram indicating the number of incidents per year was utilized

to identify these areas and aid in selection of a chronological subset of data. In the case of fire water system failure, all data prior to 1974 were excluded due to the addition in 1974 of source 32 (Canyon Senior Supervisor Log). In the case of fire alarm system failure and unavailability, data prior to 1992 were excluded due to the collective effects of sources 7C, 8B, and 2F (221-F Shift Manager's Log). In the case of inhalation, data prior to 1974 were excluded as a result of source 61 (Health Protection Exposure Records), and in the case of skin contamination, data prior to 1975 were excluded as a result of source 28 (Health Protection Log).

(4) Beginning in 1991 the threshold reporting requirement for equipment surface contamination decreased by an order of magnitude. The result is a far greater number of contamination events (some 400-600 per year) in the data bank during and after 1991. Calendar years 1991 and 1992 provided a conservative representation of surface contamination events based upon the new reporting threshold, therefore data for these years were used in the analysis.

Once the subset of applicable events was compiled, the corresponding dates-of-occurrence were collected in a file for statistical analysis. A print-out of this file is included in Appendix I for each case.

The SAS statistical package was used to analyze the date-of-occurrence files and compute frequencies. This analysis produced an optimized frequency distribution as well as values for mean, median, and standard deviation. SAS version 6.09 on the SRS VAX cluster was used in this analysis. Section 10 of Appendix I gives the SAS instruction set for these frequency analyses.

Annual frequencies were determined in this work, however in cases where the applicable data spanned only 2-3 years, a monthly analysis was used to calculate annual frequency. That is, the numbers of incidents per month were compiled and used as SAS input. Once a monthly frequency was determined, annual frequencies were calculated by simply multiplying the result by 12. This technique offered the added advantage of utilizing 1994 data whenever available. A monthly analysis was used in the following cases:

Fire Alarm System Failure, Fire Alarm System Unavailability, and False Fire Alarm Frequency.

Unavailabilities were determined by computing the following product:

$$U = \lambda \tau \quad \text{where: } \lambda = \text{mean frequency of system failure/outage (year}^{-1}\text{)} \\ \tau = \text{duration of failure/outage (year)}$$

The SAS analysis produced values for frequency (λ). Duration (τ) is simply the arithmetic mean of "known" durations (i.e. those recorded in the data bank).

RESULTS

The following table gives results of the analysis. Mean and median frequency and standard deviation are reported for all cases. The best-fit frequency distribution is also given.

For the fire water system and fire alarm system, Table 4 reports duration of failure (τ) in hours and the computed value for system unavailability (U). For the fire alarm system, Table 4 provides additional unavailability information on non-failure system outages attributable primarily to system bypasses for construction and maintenance activities. In the period of October through December of 1992, a large number of non-failure outages were recorded, yielding an annual frequency of 71.4 per year.

Note that no H-Canyon process related fires were recorded in the data bank, therefore these results are labeled not available (NA). Only one process related fire was recorded in F-Canyon.

The reported fire alarm system failure and unavailability frequencies do not take into account any procedural requirements for "fire-watch" personnel. These individuals may compensate for failure of the fire alarm system.

TABLE 4. Results of Analysis

Text Description	Mean Frequency (year ⁻¹)	Median Frequency (year ⁻¹)	Standard Deviation (year ⁻¹)	Distribution	τ (hour)	U
Fire Water System, Failure Rate	2.18	1.64	1.94	Weibull	23.2	5.77e-3
Fire Alarm System, Failure Rate	17.6	NA for Binomial	4.1	Binomial	0.85	1.71e-3
Fire Alarm System Outage, (Non-Failure)	71.4	25.6	126	Weibull	13.8	1.13e-1
False Fire Alarm Frequency	42.1	31.9	38.8	Lognormal	--	--
Process Related Fire Frequency (F-Canyon)	2.43e-2	NA for Binomial	1.56e-1	Binomial	--	--
Process Related Fire Frequency (H-Canyon)	NA	NA	NA	NA	--	--
Any Type Fire Frequency (F-Canyon)	1.86	NA for Binomial	1.36	Binomial	--	--
Any Type Fire Frequency (H-Canyon)	1.86	NA for Binomial	1.36	Binomial	--	--
Surface Contamination Freq. (tools, equip., walls, floors)	478	339	549	Lognormal	--	--
Inhalation Contam. Frequency During Maintenance	1.79	0.74	2.67	Gamma	--	--
Skin Contamination Frequency During Maintenance	3.37	3.08	2.29	Weibull	--	--
Airborne Contamination Frequency During Maintenance	1.84	1.26	2.17	Lognormal	--	--

CONCLUSIONS

Frequencies and unavailabilities were developed for the DWPF SAR based upon F&H Canyon facility operating experience. The 200-Area Fault Tree Data Bank was the source for event data, and the SAS statistical package was used to develop frequencies. Since the values presented herein were based on site specific operating experience, they represent the best possible probabilistic representation of expected system performance. All calculations and computer runs were independently reviewed, and all calculations were made in accordance with E7, Procedure 2.31.

ATTACHMENT 1 - Safety Document Task Agreement

SAFETY DOCUMENT TASK AGREEMENT		EPD-RAG-94-0076
Title Determination of Frequencies/Probabilities for DWPF SAR		
CLS Code ESAR4MODC	Funding Level \$9720	
Performing Organization (Org Code) E4130	Issuing Organization (Org Code) E4120	
Scope/Deliverables <p>Develop the following frequencies/probabilities to support the DWPF SAR based on best (most current) available data. Deliverable shall be a referencable technical report or calculation.</p> <p><u>Fire-Related Events</u></p> <ul style="list-style-type: none"> • Failure rate and unavailability of the fire water system in F-Canyon • Failure rate and unavailability of fire alarms in F-Canyon • False fire alarm frequency in F-Canyon • Frequency of a process related fire in F-Canyon • Frequency of a process related fire in H-Canyon • Frequency of any type of fire in F-Canyon • Frequency of any type of fire in H-Canyon <p><u>Contamination-Related Events</u></p> <ul style="list-style-type: none"> • Frequency of surface contamination of tools, equipment, walls, and floors in F-Canyon • Frequency of contamination events by inhalation during maintenance of radiologically contaminated equipment in F-Canyon • Frequency of skin contamination events during maintenance of radiologically contaminated equipment in F-Canyon • Frequency of release of airborne activity events during maintenance of radiologically contaminated equipment in F-Canyon 		
Schedule/Milestones Complete approved calculation or technical report by 10/28/94		
Requirements Work per E7 procedures		
References None		
Performing Organization Technical Lead G. L. Hovis <i>[Signature]</i>		Issuing Organization Technical Lead H. A. Ford <i>[Signature]</i>
Performing Organization Management Approval D. J. Baker <i>[Signature]</i>		Issuing Organization Management Approval D. A. Sharp <i>[Signature]</i>
Date 10/6/94		Date 10/6/94

APPENDIX I - Calc-Note# S-CLC-G-00019

APPENDIX I appears in a separate volume labeled

WSRC-TR-940538
APPENDIX I
Calc-Note No. S-CLC-G-00019

APPENDIX I contains Unclassified Controlled Nuclear Information - UCNI