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**Examination of Criticality  
Accident Alarm Coverage on the  
Operating Floors of Buildings  
X-333, X-330, and X-326 at the  
Portsmouth Gaseous Diffusion  
Plant**

By  
Angela S. Brown  
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March 1997

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**POEF-SH-38**  
**Revision 1**

**Examination of Criticality Accident Alarm Coverage  
on the Operating Floors of Buildings X-333, X-330,  
and X-326 at the Portsmouth Gaseous Diffusion Plant**

**February 1997**

**by**

**Angela S. Brown  
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**Battelle**

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## FOREWORD TO REVISION 1

The Henderson Free-in-Air Flux-to-Dose response function [He93] was used in the first issuance of this report and in earlier analyses [We83, Ne94a, and Ne94b] of the Portsmouth Gaseous Diffusion Plant's (PORTS') Criticality Accident Alarm System (CAAS). This analysis was conservative in terms of determining detector response. It calculated the dose rate at CAAS detectors from a minimum accident of concern. A disadvantage of the Henderson Free-in-Air Flux-to-Dose response function was that the response fell off to insignificant values below neutron energies of 17 keV. Subsequent to the first issuance of this report, the actual CAAS detector response function was determined [Ro96]. The PORTS CAAS detectors were found to have a better response to neutrons of lower energies than was determined using the Henderson response function. Some detectors were located where the predicted Henderson dose rates were not expected to cause them to alarm. Detectors at these locations were reevaluated using the CAAS detector response function.

In the calculations performed for the first issuance of this report, the operating floors of the PORTS cascade buildings X-333, X-330, and X-326 were analyzed as isolated systems from the cell floors. Because cascade buildings X-333 and X-330 had regions within their operating floors where detector coverage was questionable, the analyses were extended to include the cell floors. The responses of selected cell floor detectors to specific operating floor accident sources were analyzed.

CAAS detectors are calibrated to alarm at, or slightly before, the attainment of a count rate of 60,000 counts per minute (cpm) [Ca96]. The CAAS detector response function is more accurately characterized in terms of detector count rate than absorbed dose rate. A unit called a Detector Response Unit, or DRU, has been adopted and is used throughout this report as the equivalent of a count rate of 60,000 cpm. Thus, for example, a calculated detector response of

300,000 cpm is reported as 5 DRU or 5 times the response necessary to meet the alarm set-point.

## EXECUTIVE SUMMARY

This report summarizes the results of an analysis of the Criticality Accident Alarm System (CAAS) coverage of the operating floors (first floors) of cascade buildings X-333, X-330, and X-326 at the Portsmouth Gaseous Diffusion Plant (PORTS). CAAS coverage of the cascade buildings' cell floors (second floors) was evaluated in previous reports [Do95, Ne94a, and We83]. Coverage of the roadways around the three cascade buildings by the cell floor detectors was also described in an earlier report [Ne94b].

In order to evaluate coverage, the cascade buildings were modeled using the Monte Carlo N-Particle Transport Computer Code (MCNP) [Br93]. The MCNP was then used to calculate the CAAS detector response to neutrons from radiation sources equivalent to minimum accidents-of-concern [Am86, Le95]. The calculated CAAS detector count rate was compared with the PORTS criticality accident alarm set-point [Ca96].

The results of this evaluation indicate that the CAAS might not alarm if a minimum accident-of-concern occurs at certain locations on the Building X-333 operating floor. The lack of CAAS response is attributed to shielding provided by numerous concrete columns used to support the second floor (the cell floor) of the building, substructure buildings, containerized waste stored within the building, and the large distances to the CAAS detectors.

All potential accident locations evaluated on the operating floors of cascade buildings X-326 and X-330 were calculated to meet the alarm criteria. In some instances, a minimum accident-of-concern on the operating floor will be detected by a CAAS detector located on the cell floor.

## 1.0 INTRODUCTION

The Portsmouth Gaseous Diffusion Plant (PORTS), located in Piketon, Ohio, is one of two operating gaseous diffusion plants leased from the U.S. Department of Energy (DOE) by the United States Enrichment Corporation (USEC) and operated by Lockheed Martin Utility Services (LMUS). At these plants, uranium (U) in the form of uranium hexafluoride ( $UF_6$ ) is enriched, using a gaseous diffusion process, from its naturally occurring isotopic concentration of about 0.7 weight percent  $^{235}U$ , to approximately 5 weight percent  $^{235}U$ . Throughout this report, enrichment values are given in weight percent  $^{235}U$ .

The diffusion cascade processing equipment at PORTS is located in Buildings X-333, X-330, and X-326. These buildings were referred to as the cascade buildings. The highest enrichments were found in Building X-326.

Because enriched uranium operations are performed within the cascade buildings, the potential for a criticality accident in these buildings exists. A Criticality Accident Alarm System (CAAS) is in place to alarm in the event of a criticality accident. The CAAS is required to be designed to immediately detect the minimum accident-of-concern. A minimum accident-of-concern in an area with nominal shielding delivers the equivalent of an absorbed dose rate in free air of 20 rads per minute at a distance of 2 meters from the reacting material [Am86]. CAAS detectors are located throughout the PORTS cascade buildings.

This report summarizes the analysis that was performed to evaluate the CAAS response to selected minimum accidents-of-concern on the operating floor of the cascade buildings. Selection of potential accident locations was based, in part, on the maximum distance to the closest CAAS detector. The other factor in selecting potential accident locations for analysis was the amount of intervening shielding between the accident location and CAAS detector. If

the CAAS was predicted to alarm under conditions of significant shielding, then the system presumably would alarm in response to all accidents greater than the minimum accident-of-concern, at closer distances, and with less shielding.

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## 2.0 BUILDING DESCRIPTIONS

Cascade buildings X-333, X330, and X-326 are steel-framed, transite-covered, two-story buildings. These three buildings are briefly described below.

Diffusion equipment in each cascade building is located on the cell floor (second floor), and electrical switchgear and control instrumentation are located on the operating floor (first floor). The cell floor in Building X-333 is supported by concrete columns. The cell floors of Buildings X-326 and X-330 are supported by steel I-beams, each identified by a unique alphanumeric designation. Figures 1, 2, and 3 illustrate the grid structure of the support columns in the cascade buildings. Table 1 lists the locations of the CAAS detectors in each cascade building.

**Table 1. Location of CAAS Detectors**

See Figures 1, 2, and 3 for the Column Locations

Building	Detector	Column Location
X-333	SE-1	41-Mb
	33-LS-1	LAW Station
	33-1G	20-C
	33-1	10-Fy*
	33-2	26-Fy*
	33-3	42-Fy*
	33-4	58-G*
	33-5	58-U*
	33-6	42-U*
	33-7	26-U*
	33-8	10-U*

Building	Detector	Column Location
X-330	TAILS	87-DD
	SE-2	65-Q
	CR	40-AA
	SE-3	30-S
	IP	7-AA
	29-1-E	86-BB*
	31-2-E	70-BB*
	31-4-E	54-BB*
	29-2-E	38-BB*
	29-4-E	22-BB*
	29-6-E	6-BB*
	29-1-W	86-F*
	31-2-W	70-F*
	31-4-W	54-F*
	29-2-W	38-F*
	29-4-W	22-F*
	29-6-W	6-F*
X-326	ERP	5-A
	SE-4	23-H
	SE-5	63-H
	SE-6	93-H
	PW	101-W
	NDA	NDA Lab
	27-1-E	7-E*
	27-3-E	27-E*
	25-2-E	48-E*
	25-4-E	67-E*

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Building	Detector	Column Location
	25-6-E	87-E*
	25-7-E	97-E*
	27-1-W	7-S*
	27-3-W	27-S*
	25-2-W	47-S*
	25-4-W	67-S*
	25-6-W	87-S*
	25-7-W	97-S*

\* Indicates detector located on cell floor

In addition to housing diffusion equipment, the cascade buildings are also used to store containers of low-level radioactively contaminated waste. This stored waste can shield the CAAS detectors from criticality accidents. The analysis described here included the shielding effects from areas where substantial quantities of containerized waste was stored. These areas are identified in Figures 1, 2, and 3.

## 2.1 Building X-333

Building X-333 is approximately 1,456 feet long, 970 feet wide, and 82 feet high. Its two floors have a combined space of about 65 acres. The cell floor (second floor) of the building is supported by approximately 2,925 18-inch square concrete columns. CAAS detectors are placed at eleven locations throughout Building X-333. Three detectors are located on the operating floor, as shown in Figure 1.

The largest diffusion equipment is housed in Building X-333. In addition, except for the stripping part of the cascade in Building X-330, Building X-333 has the lowest level of

enrichment [Po87]. The larger size of the cell housings and the low enrichments were considered in the analysis of Building X-333.

The enrichment in Building X-333 is typically below 2 percent  $^{235}\text{U}$  [Po87]. However, the low assay withdrawal (LAW) station located on the west side of the building can receive  $\text{UF}_6$  enriched up to 10 percent.

## 2.2 Building X-330

Building X-330 is approximately 2,176 feet long, 640 feet wide, and 66 feet high. Its two floors have combined floor space of about 55 acres. CAAS detectors are placed at seventeen locations throughout the building. Five detectors are located on the operating floor, as shown in Figure 2.

$\text{UF}_6$  entering Building X-330 is typically enriched to approximately 2 percent  $^{235}\text{U}$ . In Building X-330, the  $\text{UF}_6$  is further enriched. Normal operational conditions result in a  $^{235}\text{U}$  enrichment of less than 5 percent. The further enriched  $\text{UF}_6$  is then sent to Building X-326. The facility for withdrawing depleted  $\text{UF}_6$ , known as the TAILS facility, is located in the north-east end of Building X-330.

## 2.3 Building X-326

Building X-326 is approximately 2,230 feet long, 552 feet wide, and 62 feet high. Its two floors have a combined floor space of about 58 acres. CAAS detectors are placed at 18 locations throughout the building. Six of these locations are on the operating floor, as shown in Figure 3.

Equipment for producing highly enriched uranium (currently out of service) is located in Building X-326. Some of the equipment is used to purge light molecular weight gases, N<sub>2</sub> and O<sub>2</sub>, from the cascade.

An extended range product (ERP) withdrawal facility is located at the north-east corner of Building X-326. Building X-326 also houses a <sup>252</sup>Cf Shuffler in the non-destructive assay (NDA) laboratory. This equipment is used to measure the fissile material content of waste. Beneath the shuffler is a small pit, constructed to house support equipment for the shuffler. A criticality accident in this pit would be very well shielded. Thus, this pit and the shuffler were specifically included in the analysis, and the response of a nearby CAAS detector to a shuffler criticality accident was calculated.

During operations, solid deposits of various uranium compounds form as "hold-up" material in all cascade equipment. This hold-up material has largely been recovered from the out of service equipment in Building X-326. However, it is still desirable for CAAS coverage to be maintained throughout the building.

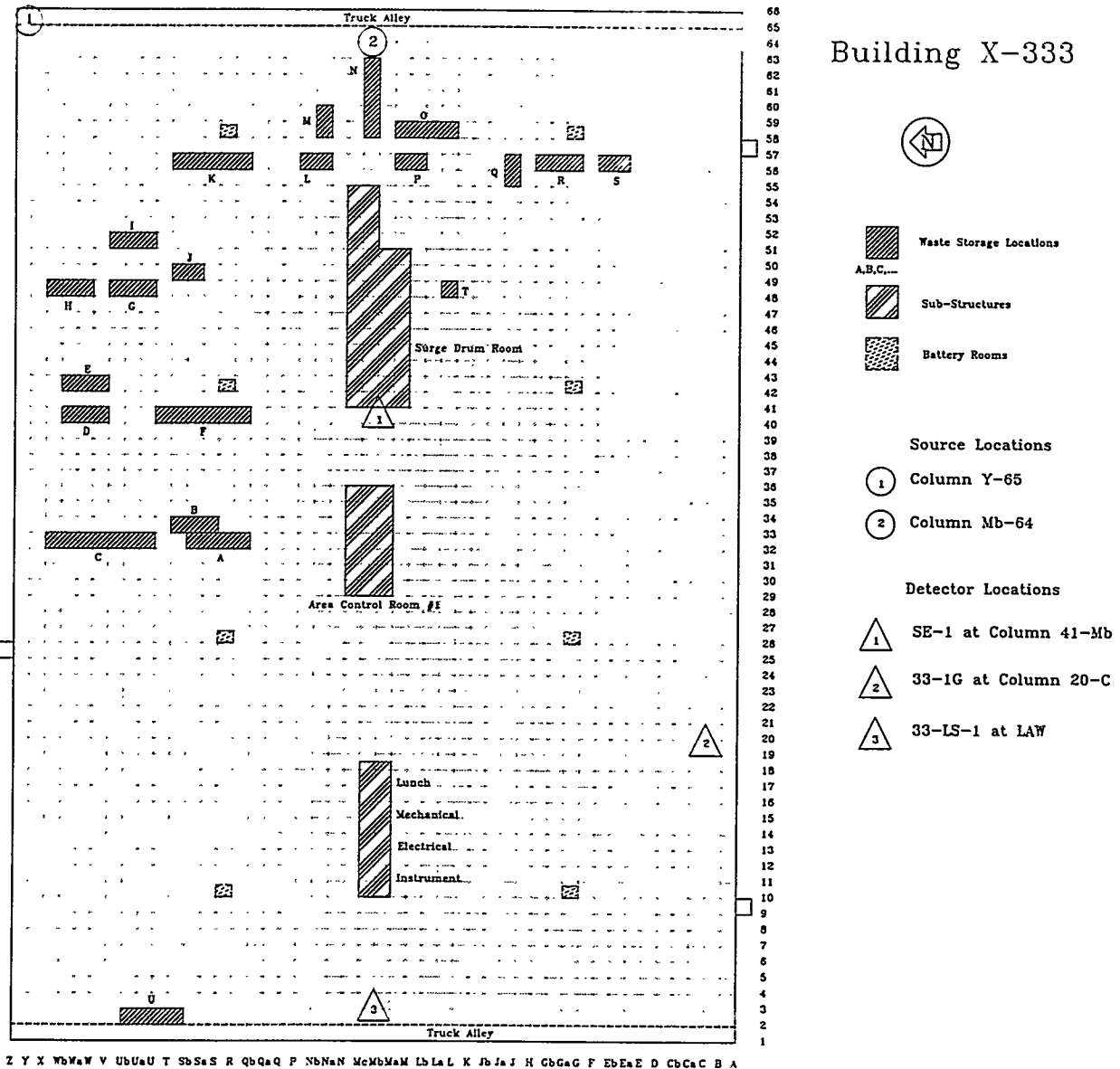


Figure 1. Building X-333 Operating Floor

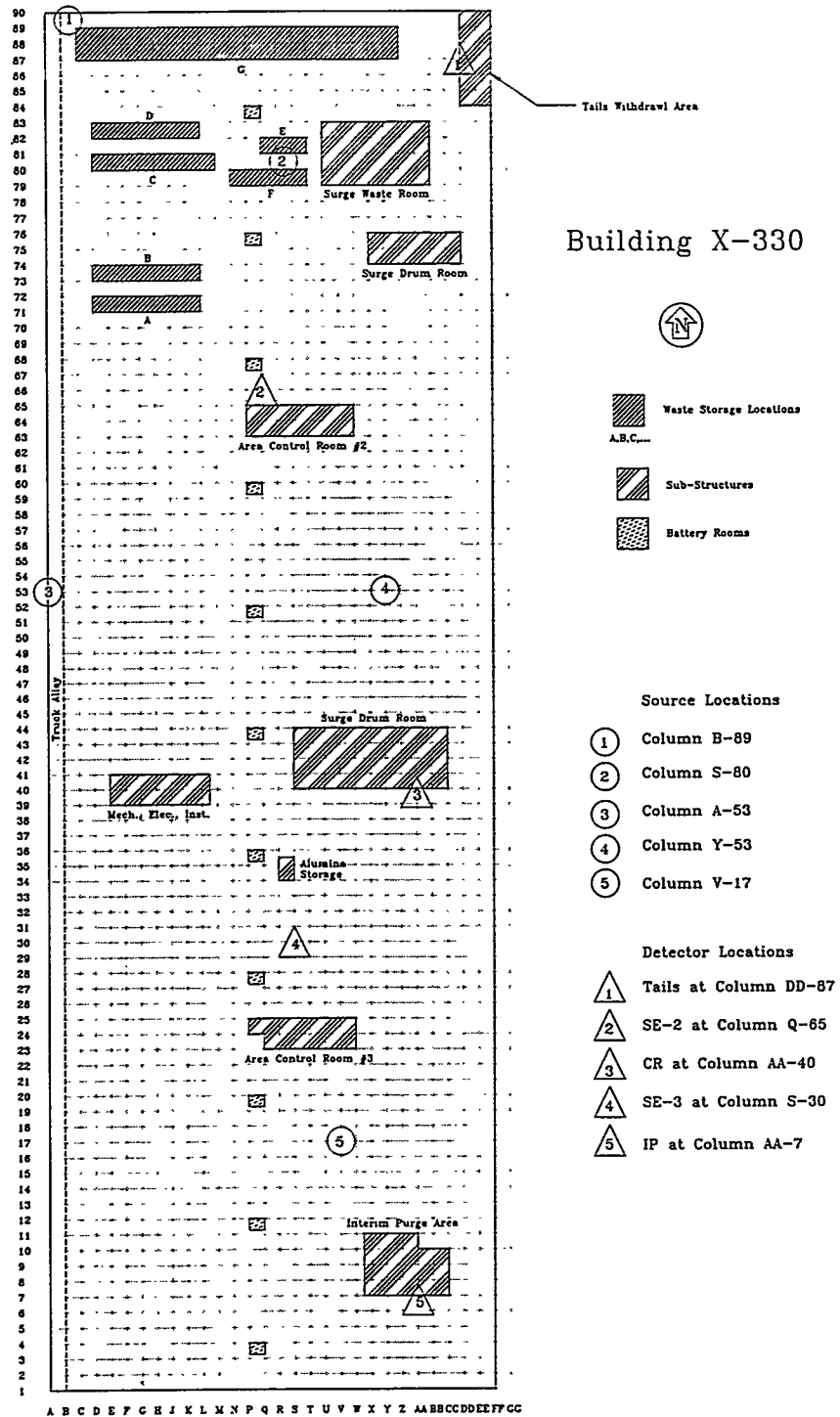


Figure 2. Building X-330 Operating Floor

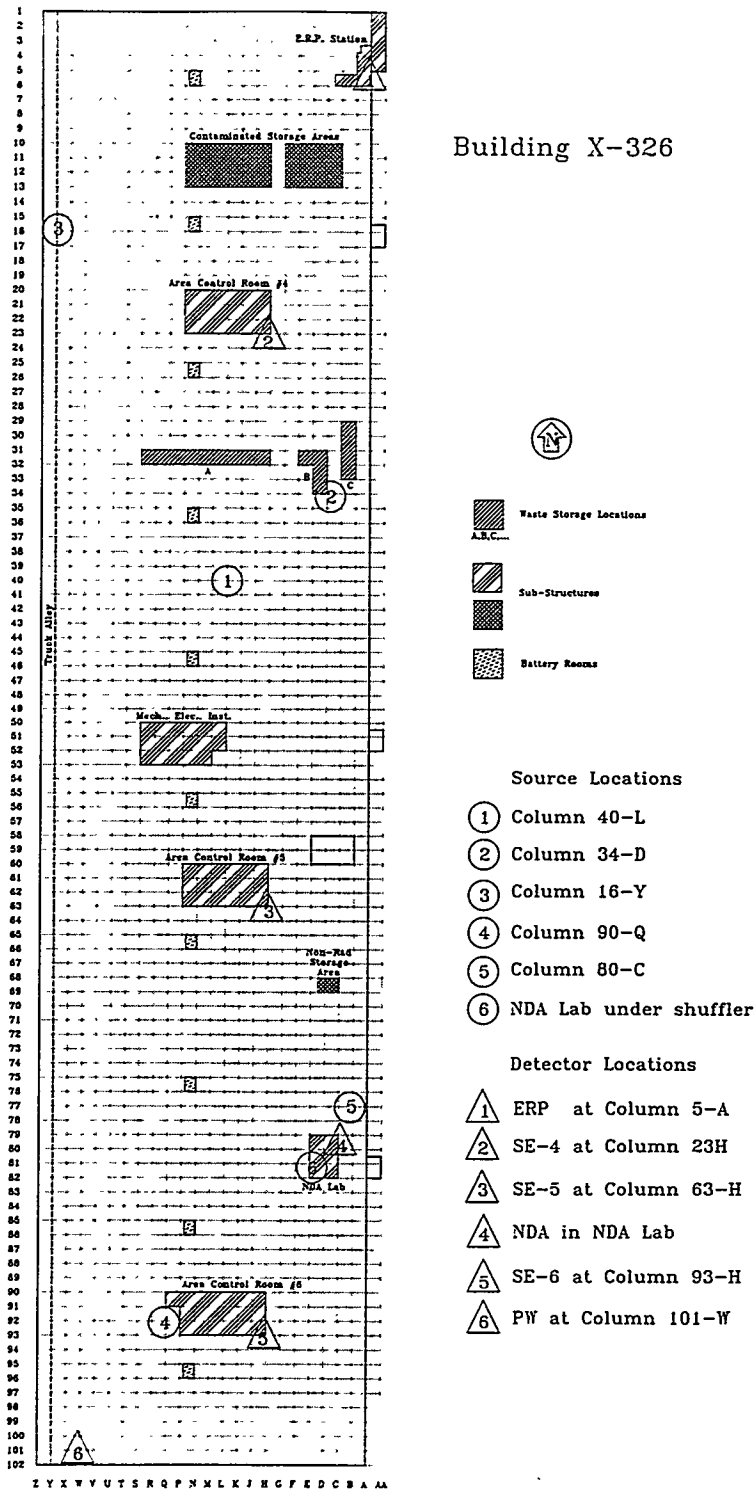


Figure 3. Building X-326 Operating Floor

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### 3.0 ANALYSIS

The analysis of CAAS coverage of the cascade buildings' operating floors was performed using the Monte Carlo N-Particle Transport Code (MCNP) [Br93]. Three dimensional models of physical objects were created with MCNP by representing the surfaces of objects using surface equation parameters. The surfaces were combined using Boolean logic to describe volumetric regions. Each region was assigned elements or mixtures properties and respective densities. From these material descriptions, macroscopic cross sections were calculated by the MCNP for each region. Point-wise cross sections, derived from evaluated nuclear data files (ENDF/B-V) and supplied with the MCNP, were used [Mc94]. The trajectories and interactions of the neutrons were simulated using the Monte Carlo method. The cumulative result of tracking a large number of neutron histories gives rise to results called "tallies." Because of the statistical nature of simulations, every tally has an associated uncertainty or variance. Several methods were used to reduce the variance more quickly to allow the calculations to be completed more quickly. The SABRINA code [Va93] was used to obtain a graphical representation of an object modeled with the MCNP.

An approximation of the geometry and significant shielding within the cascade buildings was developed and incorporated into the MCNP input format. The power level and neutron source spectrum characteristics of a minimum accident-of-concern were taken from earlier work [Le95] to determine the source term. Flux tallies were collected at CAAS detector coordinates. Variance reduction methods, such as splitting and source biasing, were used in a manner which maintained a "fair game" to accurately represent the neutron flux spectrum at the detector coordinates. Finally, the detector response function was applied to the tally results to determine the detector response.

### 3.1 Building Models

The cascade buildings X-333, X-330, and X-326 were analyzed individually. Building components were simplified in order to allow the computer analysis to be completed in a reasonable amount of time. Simplifications included the elimination of doors and windows. All significant concrete walls and support columns were included in the models. Each facility was modeled as sitting on a 30-meter-thick concrete "ground" and surrounded by a hemisphere of air with a radius of 8 km. The concrete block walls of the buildings were modeled as half-density concrete of appropriate thickness. Interior structures, such as Area Control Rooms (ACRs), process cells, and battery rooms, were included in each model. SABRINA images of the operating floors of the cascade buildings, as modeled, are provided as Figures 4, 5, and 6. The concrete support columns in Building X-333 were included in the building model. The steel I-beam support columns in Buildings X-330 and X-326 were also included in their building models. Figure 7 shows the operating and cell floors of the Building X-330 model. A rectangular section of the cell floor is transparent in order to show the ground floor structures below.

The cell floors were included in the X-333 and X-330 building models as part of revision 1 of this report. The cell floors were modeled as being separated from the ground floors by a full density concrete floor. The roofs of the X-333 and X-330 building models were modeled as a 4-inch-thick homogenized roof material. The composition of this material is listed in Table 2. All of the process cells in Buildings X-333 and X-330 were modeled individually as rectangular parallelepipeds. The size of the process cell models varies according to the actual size of the process cells in the X-333 and X-330 facilities. The process cell floor model coupled to the ground floor model is shown graphically in Figure 7.

Waste storage areas were included in the models. These areas are identified in Figures 1, 2, and 3. Waste stored in the cascade buildings includes used Personal Protective Equipment (PPE), pea gravel from the roofs of the process buildings, dirt, scrap metal, floor sweepings, and oil absorbing media. The waste is not segregated by type. The shielding equivalent for this waste was assumed equivalent to oak wood at 50 percent density. The atomic number densities for wood were taken from the Standard Composition Library for SCALE [Bu93].

Each cascade building has several rooms for battery storage. Because the batteries stored in these rooms provide significant shielding, the rooms were included in the building models as homogeneous material with a density of one gram per cubic centimeter and an effective chemical formula of  $H_2O_{1.5}$ . The atomic number densities of air, concrete, steel, homogenized cell material, and the cascade building roofs were taken from a previous analysis [We83]. Table 2 lists the elemental components of materials used in the models and their atomic number densities.

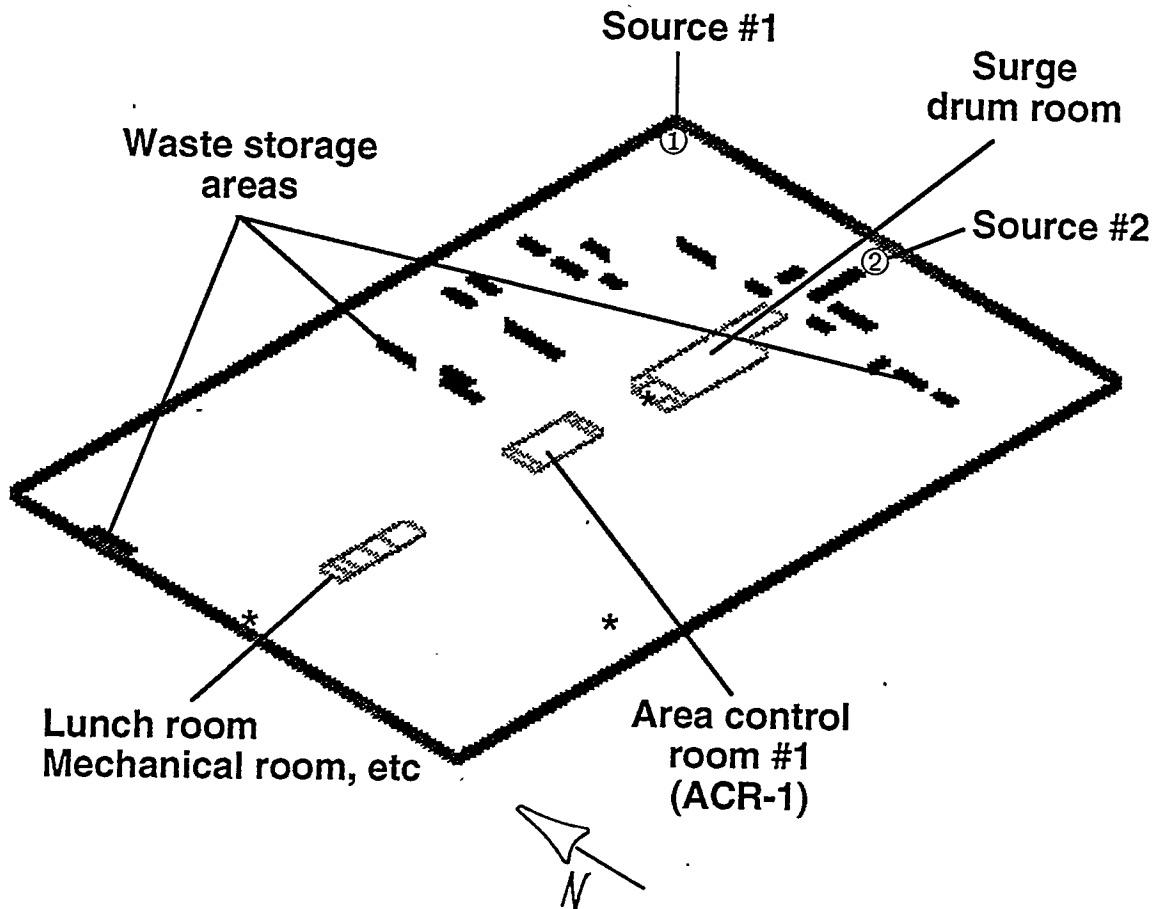


Figure 4. SABRINA Representation of the Building X-333 Operating Floor

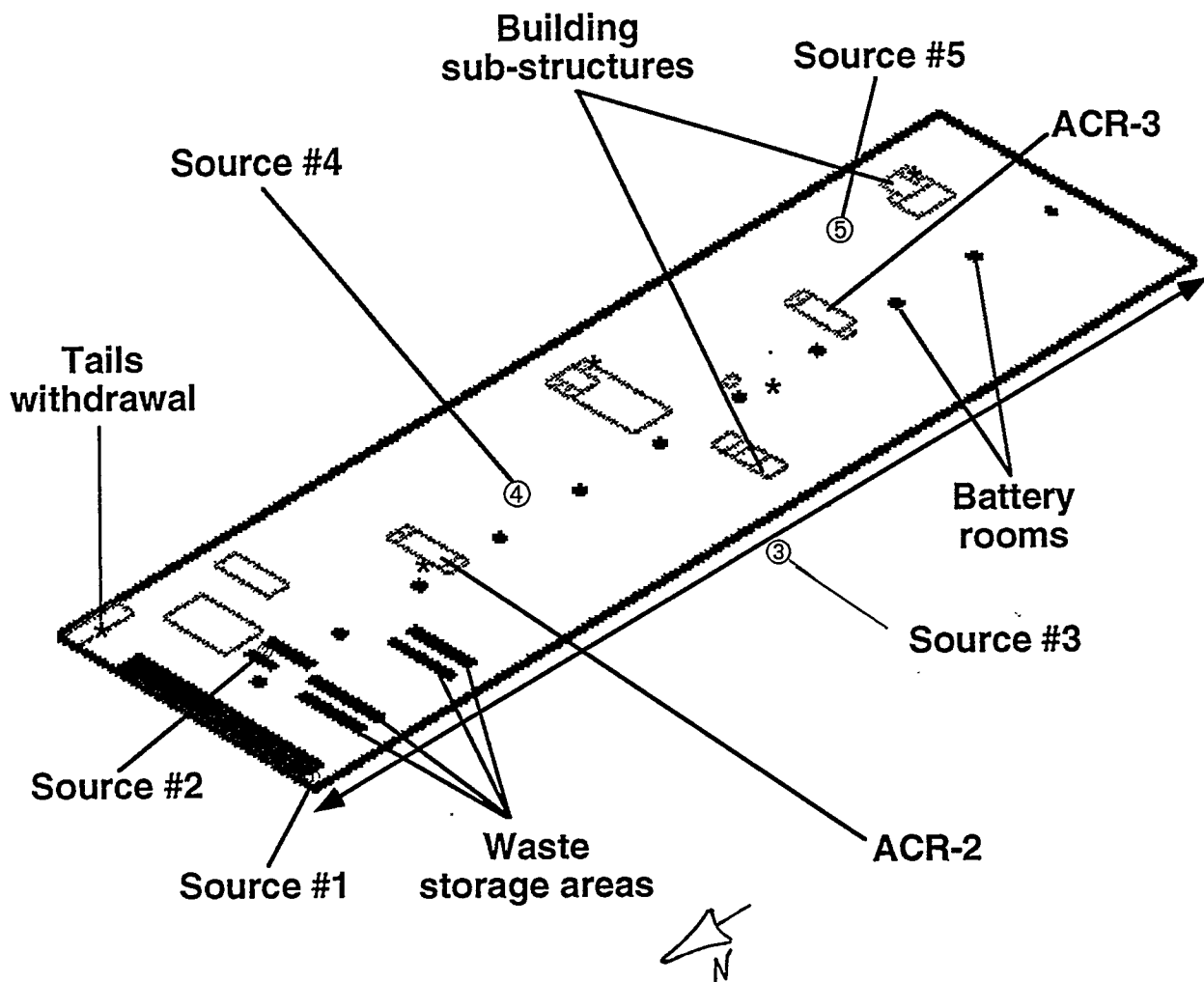


Figure 5. SABRINA Representation of the Building X-330 Operating Floor

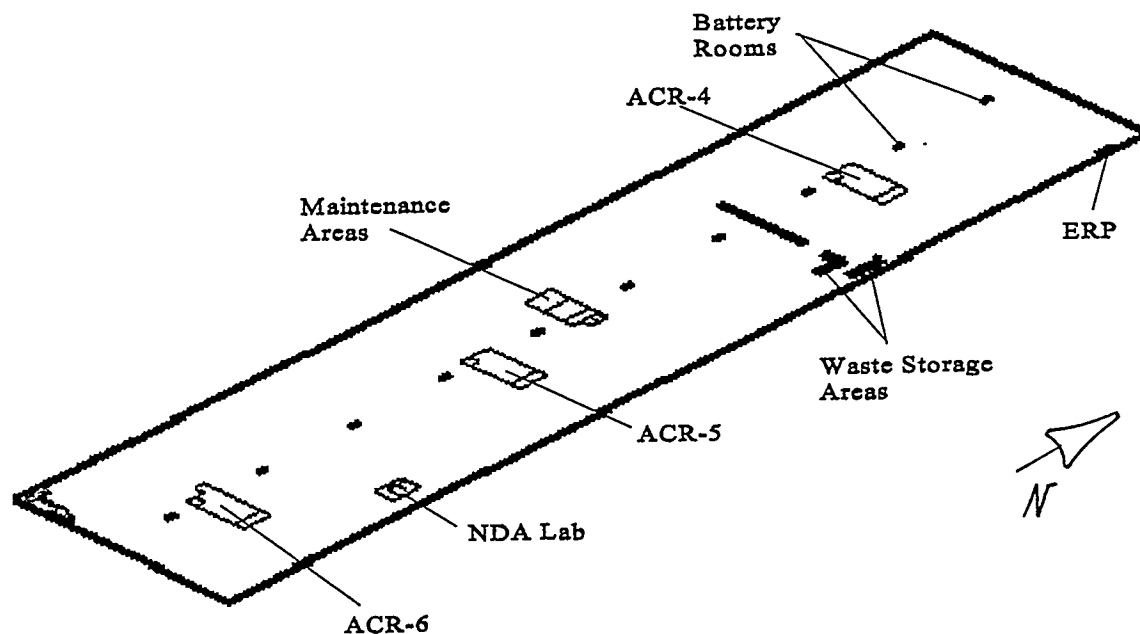


Figure 6. SABRINA Representation of the Building X-326 Operating Floor

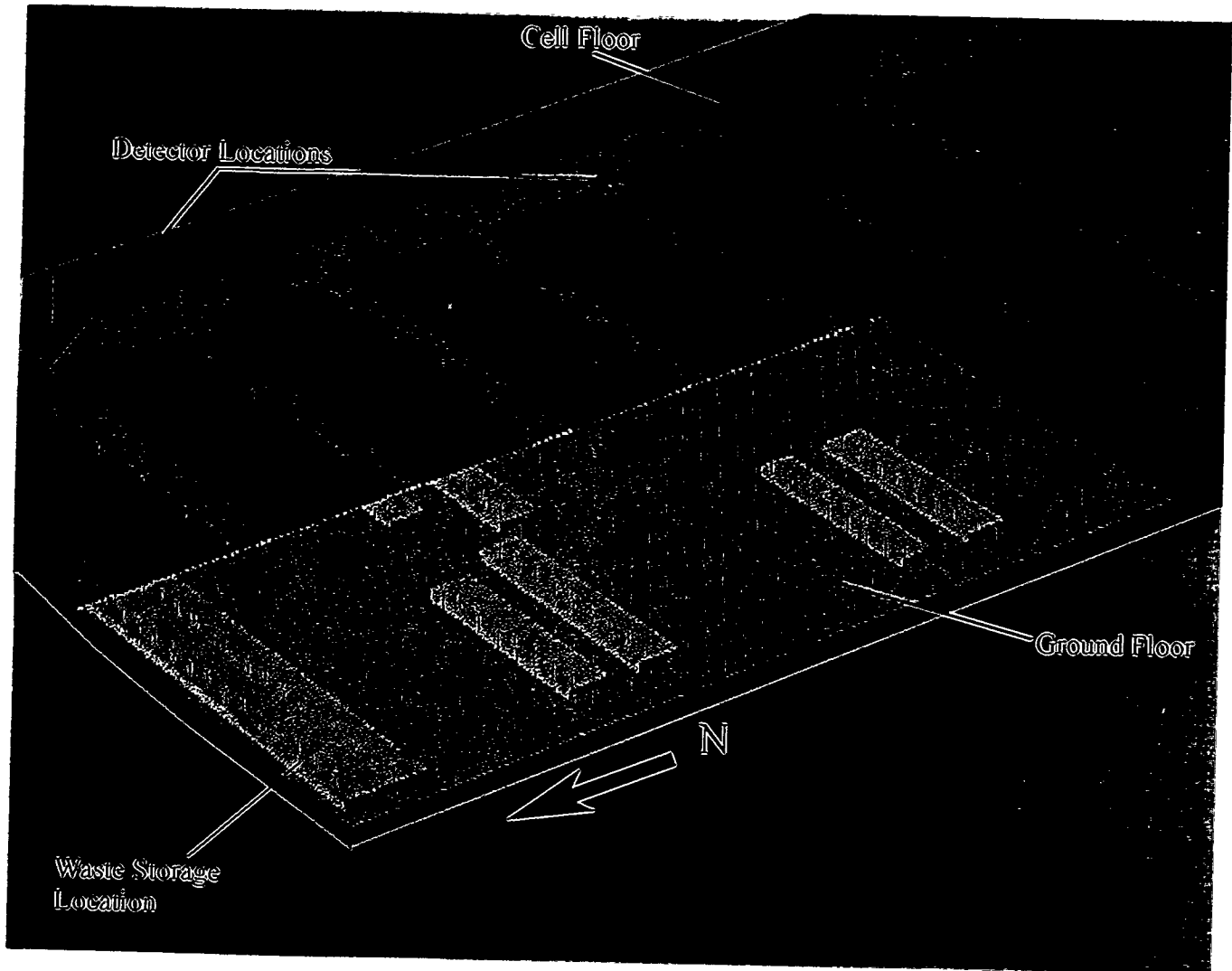


Figure 7. SABRINA Representation of the Building X-330 Cell and Operating Floors

**Table 2. Material Compositions**

Material	Element	Number Density (Atom barn <sup>-1</sup> cm <sup>-1</sup> )
Air	Nitrogen	3.57E-05
	Oxygen	7.84E-06
Concrete	Hydrogen	1.49E-02
	Carbon	3.81E-03
	Oxygen	4.15E-02
	Sodium	3.04E-04
	Magnesium	5.87E-04
	Aluminum	7.35E-04
	Silicon	6.04E-03
	Calcium	1.16E-02
	Iron	1.97E-04
Hydrogeneous material in battery room, H <sub>2</sub> O <sub>1.5</sub> , 1 g cm <sup>-3</sup>	Hydrogen	4.63E-02
	Oxygen	3.47E-02
Steel	Carbon	3.92E-03
	Iron	8.35E-02
Homogenized Cell Material	Carbon	6.23E-05
	Fluorine	8.88E-05
	Aluminum	8.42E-05
	Silicon	1.67E-05
	Chlorine	8.88E-05
	Chromium	1.62E-04
	Manganese	1.70E-05
	Iron	5.93E-04
	Nickel	4.56E-04
Copper	3.27E-05	

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Material	Element	Number Density (Atom barn <sup>-1</sup> cm <sup>-1</sup> )
Homogenized Roof	Hydrogen	4.29E-02
	Carbon	1.81E-02
	Oxygen	1.90E-03
	Iron	2.78E-02
Wood	Carbon	2.86E-01
	Hydrogen	4.76E-01
	Oxygen	2.38E-01

### 3.2 Source Term

To model the criticality accident sources used in the MCNP analysis completely, the source location, the source neutron production rate (power level) and the source neutron energy spectra must be known. The development of each is discussed below.

#### 3.2.1 Source Locations

Source locations were chosen to maximize the distance between the source and the detector. Consideration was also given to the amount of intervening shielding between potential accident locations and the CAAS detectors. Physical inspection of the cascade buildings and inspection of the drawings of the operating floors of the buildings [Gr71, Gr77, Gr79, No56, and So56] showed that certain locations had significant shielding. Coordinates for sources representing potential accident locations were selected to maximize the distance between the source and the detector. Other locations, with smaller distances or lesser shielding between the source and detector, are expected to result in higher responses at the CAAS detector. Criticality accidents were considered possible throughout the cascade buildings.

Thus, a source could be located in a walkway rather than within equipment in order to determine the CAAS response. An outcome greater than 1 DRU at the CAAS implies that coverage is provided to other closer and less heavily shielded potential accident locations. Several different source locations were used in this analysis. These source locations are tabulated in Table 3 and are briefly described below.

Two source locations within cascade building X-333 were selected to evaluate the CAAS response. These locations, shown in Figure 1, were chosen to maximize the distance between the source and detector. Figure 1 shows the significant shielding between the sources and detector. Both sources were modeled using a  $^{235}\text{U}$  enrichment of 5 percent.

Five source locations within cascade building X-333 were selected to evaluate the CAAS response. These locations, shown in Figure 2, were selected to maximize the distance between the source and the detector. Figure 2 shows significant shielding between the sources and detector. Sources 1 through 4 were modeled using an enrichment of 5 percent  $^{235}\text{U}$ . The  $^{235}\text{U}$  enrichment level for source 5 was raised to 20 percent. The  $^{235}\text{U}$  enrichment increases as  $\text{UF}_6$  moves up the cascade. With other conditions equal, the power level and neutron production rate required to produce a minimum accident-of-concern decrease with increasing  $^{235}\text{U}$  enrichment [Le95].

Six source locations within cascade building X-326 were selected to evaluate the CAAS response. These locations are shown in Figure 3. Sources 1,2,4,5, and 6 were modeled using a  $^{235}\text{U}$  enrichment of 100 percent. Source 3 was modeled using a  $^{235}\text{U}$  enrichment of 20 percent. Although current plant operations do not enrich uranium to these levels, higher enriched material from past operations may be held up in the equipment. Source 6 was assumed to be located within the  $^{252}\text{Cf}$  Shuffler pit. This pit is heavily shielded. A specific calculation was performed to determine the response of the nearby CAAS detector.

### 3.2.2 Source Power Level and Energy Spectrum

Source locations were modeled as isotropic point sources. The associated power level and neutron energy leakage spectrum were taken from other reports [Le95]. The level of enrichment was varied because enrichment increases as UF<sub>6</sub> moves up the cascade. In each model, however, the power level and neutron energy leakage spectrum satisfied the definition of a minimum accidents-of-concern [Am86].

**Table 3. Criticality Accident Source Locations**

Source	Building	Description	<sup>235</sup> U Enrichment (%)	Power Level (W)
333-1	X-333	NE Corner of Building	5	2881
333-2	X-333	East side of storage area "N" in Figure 1	5	2881
330-1	X-330	NW corner of building	5	2881
330-2	X-330	Column S-80	5	2881
330-3	X-330	Column A-53 (on West wall)	5	2881
330-4	X-330	Column Y-53 (South of ACR-2)	5	2881
330-5	X-330	Column V-16 (South of ACR-3)	20	1722
326-1	X-326	Midway between ACR-4 & ACR-5	100	1281
326-2	X-326	Column 34-D	100	1281
326-3	X-326	Column 16-Y	20	1722
326-4	X-326	Column 90-Q	100	1281
326-5	X-326	Column 80-C	100	1281
326-6	X-326	Beneath <sup>252</sup> Cf Shuffler	100	1281

### 3.3 Flux Tallies

The CAAS detectors used at the PORTS site are calibrated to alarm at or slightly below a count rate of 60,000 counts per minute [Ca96]. A detector response unit (DRU) is defined as equivalent to a CAAS detector count rate of 60,000 counts per minute. A calculated detector response greater or equal to 1 DRU indicates that the CAAS is expected to alarm.

The CAAS detectors modeled in the MCNP calculation were located at coordinates corresponding to the currently installed CAAS detectors. A "tally" of the number and the energy of neutrons that pass through the detector volume is tracked during the Monte Carlo calculation along with relevant statistical information. The uncertainty associated with the tally is a measure of how well the tally is known. Other statistical tests also performed by MCNP aid in judging when a sufficient number of neutron histories have been tallied.

### 3.4 Flux to Detector Count Rate Conversion

The MCNP tally, normally given as neutron fluence per source neutron, was converted to detector count rate by applying the detector's response function. Details of the determination of the detector's response function are available [Ro96]. The CAAS detector response function is given in tabular form in Table 4 and in graphical form in Figure 8. The MCNP output gives the value of the integral (detector counts per source neutron). This quantity must be multiplied by the source neutron production rate to obtain the detector count rate.

Because the criticality accident sources used in this analysis have different levels of moderation and  $^{235}\text{U}$  enrichments, different power levels and neutron spectra correspond to the minimum accident-of-concern. Using the appropriate values [Le95], the neutron source rates

for each source term were calculated. The neutron source rates, in neutrons per second, correspond to enrichments of 5, 20, and 100 percent  $^{235}\text{U}$  were  $6.52 \times 10^{13}$ ,  $5.20 \times 10^{13}$ , and  $5.47 \times 10^{13}$ , respectively. Representative MCNP input listings for each of the cascade buildings are included in Appendix A.

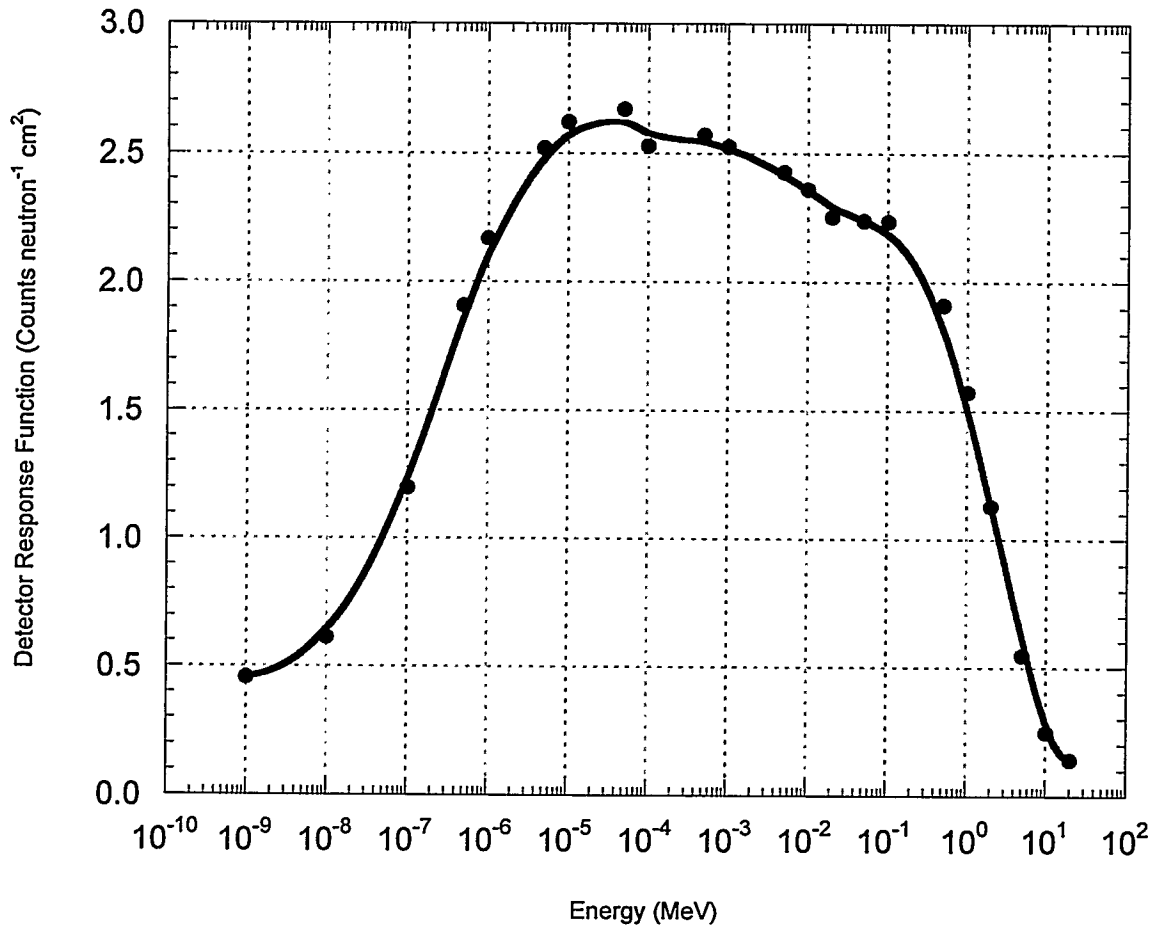


Figure 8. CAAS Detector Response Function

**Table 4. Detector Response Function**

Energy (MeV)	Detector Response Function (detector counts neutron <sup>-1</sup> cm <sup>2</sup> )
1.00E-09	0.46
1.00E-08	0.61
1.00E-07	1.20
5.00E-07	1.91
1.00E-06	2.17
5.00E-06	2.52
1.00E-05	2.62
5.00E-05	2.67
1.00E-04	2.53
5.00E-04	2.57
1.00E-03	2.53
5.00E-03	2.43
1.00E-02	2.36
2.00E-02	2.25
5.00E-02	2.24
1.00E-01	2.24
5.00E-01	1.91
1.00E+00	1.58
2.00E+00	1.13
5.00E+00	0.55
1.00E+01	0.25
2.00E+01	0.14

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## 4.0 RESULTS

The results of the CAAS coverage analysis presented in Table 5, indicates the calculated detector response for the minimum accident-of-concern source location. The uncertainty calculated for each response is also given. Generally, the CAAS detector closest to the source was found to have the largest response. However, if the closest detector was significantly shielded, other detectors sometimes provided higher responses. Because of the thicknesses of materials between sources and detectors, only the detectors nearest the sources yielded statistically significant responses for the number of neutron histories in the analysis.

Table 5. Detector Responses

Source Location	Detector Location	Detector Response Units (DRU's)	Monte Carlo Uncertainty (DRU's)
333-1	Column 58-U <sup>(1)</sup>	4.6	0.3
333-2	Column 58-U <sup>(1)</sup>	0.3	>5 <sup>(2)</sup>
330-1	Column 86-F <sup>(1)</sup>	26.1	2.6
330-2	Column 87-DD	passed <sup>(3)</sup>	
330-3	Column 65-Q	5.7	0.5
330-4	Column 40-AA	13.7	1.6
330-5	Column 30-S	passed <sup>(3)</sup>	
326-1	Column 23-H	passed <sup>(3)</sup>	
326-2	Column 23-H	passed <sup>(3)</sup>	
326-3	Column 23-H	passed <sup>(3)</sup>	
326-4	Column 63-H	passed <sup>(3)</sup>	
326-5	Column 93-H	passed <sup>(3)</sup>	
326-6	NDA Lab	114.9	9.2

<sup>(1)</sup> This detector is located on the cell floor.

<sup>(2)</sup> This analysis was discontinued before the normal acceptance criteria were satisfied because of the long execution time and the low response of the detector. This source is unlikely to cause the CAAS to alarm.

<sup>(3)</sup> The response of this detector was previously calculated (see report POEF-SH-38, rev. 0) using the Henderson Free-In-Air Flux to Dose response function. The values, while not accurately characterized by the detector's actual response, indicated that the detector was expected to alarm under conditions of a minimum accident-of-concern.

## 5.0 DISCUSSION

The source locations denoted as having "passed" in Table 5 were calculated to have a dose rate expected to cause the CAAS to alarm. The criterion for determining that a given source would cause a nearby CAAS detector to alarm, was based on a dose rate at the detector. The dose rate was calculated using the Henderson Free-in-Air Flux-to-Dose response function [He93]. Figure 8 shows the neutron response function of the CAAS detector. Figure 9 shows the Henderson Free-in-Air Flux-to-Dose response function. The CAAS detector has a higher response for neutrons in the thermal region than does the Henderson Free-in-Air Flux-to-Dose response function. Figure 10 is a neutron spectrum from the SHEBA critical assembly measured at a distance of 69 meters, with 13.3 centimeters of steel in front of the assembly [Fi83]. SHEBA is a critical assembly which uses uranyl fluoride solution enriched to 4.5 percent  $^{235}\text{U}$ . One of the original functions of the SHEBA critical assembly was to evaluate CAAS detectors for uranium enrichment facilities in radiation fields expected in realistic accident scenarios.

The response of the PORTS CAAS detector to the SHEBA spectrum, using the CAAS detector response function in Figure 8, was calculated to be a factor of 4 greater than the response obtained using the Henderson Free-in-Air Flux-to-Dose response function [Ro96]. Critical accidents occurring in the cascade buildings will have neutron spectra similar to the SHEBA spectrum illustrated in Figure 10. Thus, any of the source locations shown as having previously "passed" with the Henderson Free-in-Air Flux-to-Dose response function are also likely to pass with the CAAS detector response function. These analyses were not reevaluated due to time and cost constraints.

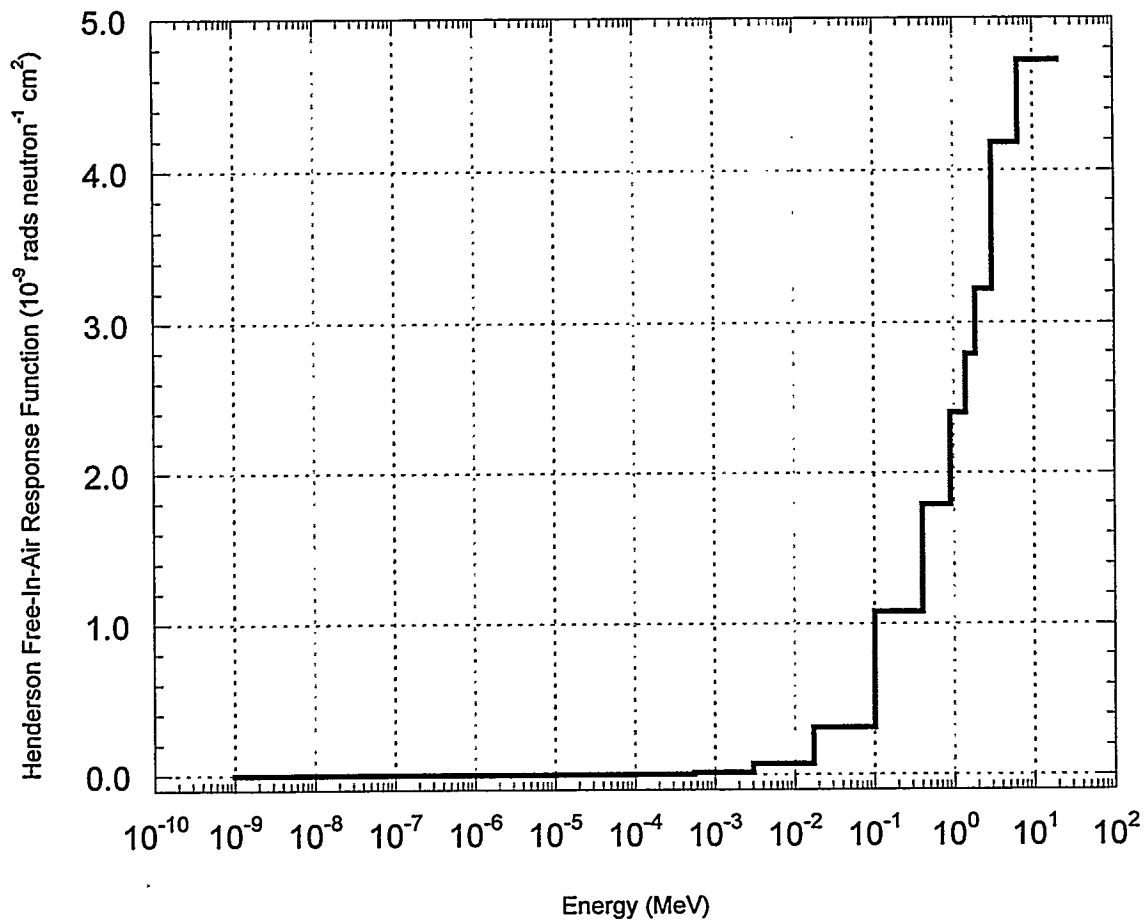


Figure 9. Henderson Free-In-Air Flux-to-Dose Response Function

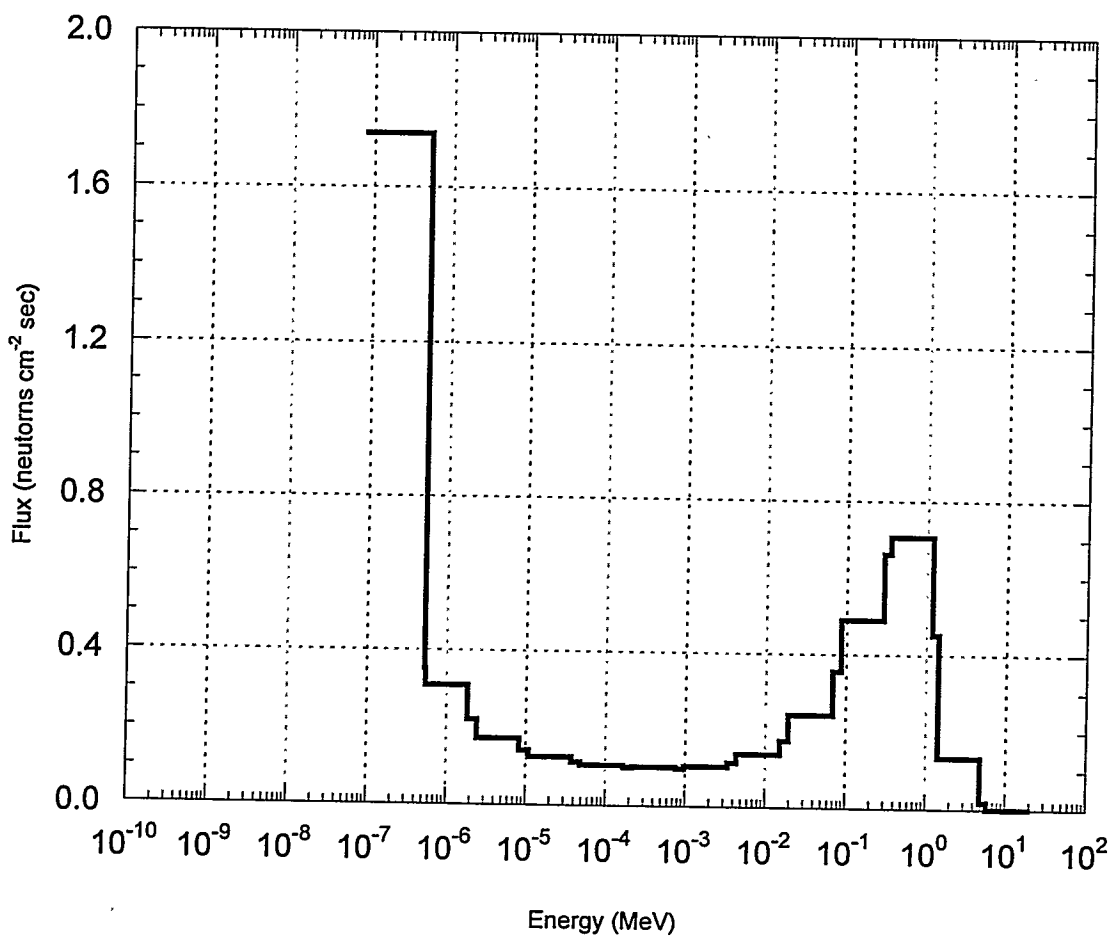


Figure 10. SHEBA Neutron Spectrum at 69 meters with 13.3 cm Steel Shield

Each MCNP calculation was executed until the detector tallies had a fractional uncertainty of about 10 percent and most of the other calculational criteria outlined in the MCNP manual [Br93] were satisfied. Judgement was used in ascertaining if an MCNP calculation was valid. For example, the figure-of-merit (FOM) criterion is related to the number of neutron histories tracked per unit CPU time. Because a given calculation can be executed on computers of differing speed, the FOM criterion might not be satisfied. However, we believe the result accurately reflects a realistic answer.

If a calculated detector response was greater than or equal to 1 DRU, the source location was considered to be covered by the CAAS. All source locations on the ground floor of Building X-330 generated a response of 1 DRU or greater in the detector nearest the source. All source locations examined in Building X-326 also generated detector responses greater than 1 DRU. Thus, criticality accidents occurring at any of these locations are likely to cause the CAAS to alarm.

In a given calculational run to confirm CAAS coverage within a cascade building, the MCNP, using a single source location, calculates the response of only a few detector locations. Moreover, the MCNP run-time increases as the number of locations for which detector responses are calculated increases. Thus, it is not possible to determine areal coverage of a CAAS detector with a single MCNP calculation. Each MCNP calculation requires a great deal of computational time to satisfy criteria for statistical acceptance. Some calculations take several weeks to complete. To reduce the time and costs of demonstrating CAAS coverage within a cascade building, several source locations, estimated on the basis of presumed maximum detector-source distance and/or shielding, were chosen to represent the worst-cases for evaluation.

Source location 333-1 in Building X-333 generated a detector response of 4.6 DRU's in the detector located at column 58-U on the cell floor of the building. No detectors on the ground floor responded to either source location 333-1 or source location 333-2. In addition, source location 333-2 did not generate a detector response greater than 1 DRU in any of the detectors on the ground or cell floors, suggesting that the area surrounding column Mb-65 may not be covered for the minimum accident-of-concern. The analysis was discontinued prior to satisfying the normal acceptance criteria because of the long execution time and the low response of the detector. Thus, a criticality accident at this source location is unlikely to cause the CAAS to alarm. The shielding provided by the concrete support columns in the building, the waste storage locations, and the surge drum room substructure is likely to be the cause of the detectors' failure to alarm.

Figure 11 is a plot of the results of analyses in the three cascade buildings as a function of the source-to-detector distance. This plot may be useful in estimating areas of coverage in the cascade buildings. The quantity and type of shielding material varies from location to location, which accounts for the large vertical spread in data points. This plot contains results only for source-detector pairs evaluated within the cascade buildings and is not applicable to other buildings that have different shielding materials and geometries. The plot assumes that increasing shielding is *approximately* proportional to increasing distance, and shows that 1) all sources at a distance of less than 300 feet have a CAAS detector response greater than 1 DRU and 2) all sources greater at a distance than 1,000 feet have a calculated CAAS detector response less than 1 DRU. Sources located 300 to 1,000 feet from a CAAS detector must be evaluated exactly to confirm areal coverage. However, all sources within 300 feet of a detector are not necessarily covered, especially if neutron shielding material is much greater than or much less than the "norm" in the buildings.

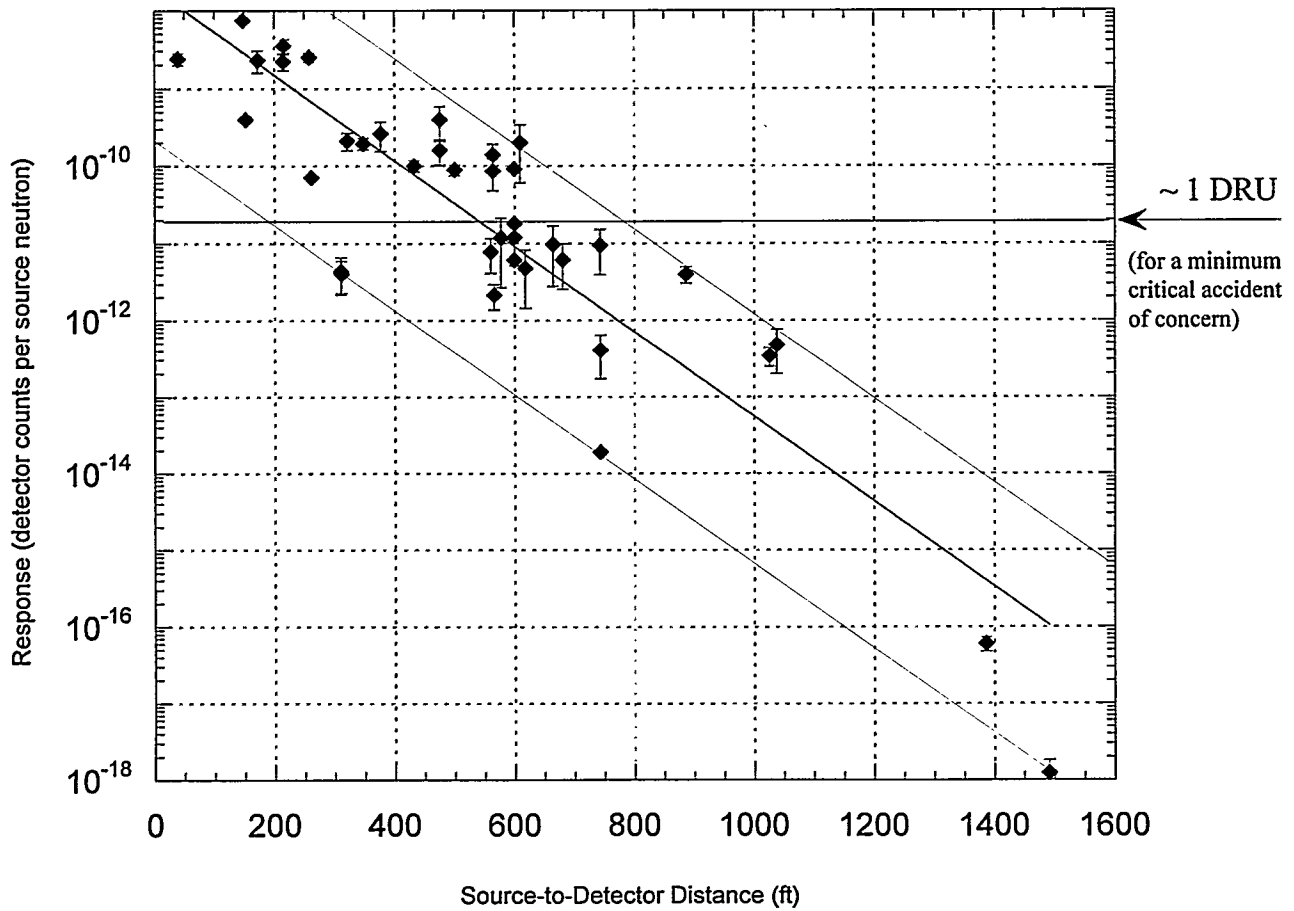


Figure 11. CAAS Detector Response versus Source-to-Detector Distance

## 6.0 CONCLUSIONS

All selected source locations in Buildings X-330 and X-326 were found to have detector responses sufficient to alarm to a minimum accident-of-concern. One source location within Building X-333, location 333-2 at column 64-Mb, did not yield the necessary response at a nearby CAAS detector. Thus, this section of the building may not have CAAS detector coverage.

This report is valid for the configuration of the cascade buildings only at the time when the models were made. Any significant addition, deletion, or rearrangement of neutron shielding material or detectors may invalidate these results.

## 7.0 REFERENCES

- Am86      *American National Standard for Criticality Accident Alarm Systems*, ANSI/ANS-8.3-1986, American Nuclear Society, August 1986.
- Br93      Briesmeister, J.F., Ed., *MCNP - A General Monte Carlo N-Particle Transport Code, Version 4A*, LA-12625, Los Alamos National Laboratory, (1993), available from the Radiation Safety Information Computational Center as CCC-200, Oak Ridge National Laboratory.
- Bu93      Bucholz, J.A., Knight, J.R., Parks, C.V., Petrie, L.M., Turner, J.C., and Westfall, R.M., *Standard Composition Library in SCALE-4.2*, NUREG/CR-0200 revision 4, Volume 3, Section M8, ORNL/NUREG/CSD-2/V3/R4, Oak Ridge National Laboratory, November 1993, available from the Radiation Safety Information Computational Center as CCC-545, Oak Ridge National Laboratory.
- Ca96      *Calibration of Neutron Criticality Monitor Model NCM-600*, Procedure XP4-GP-RI6500 revision 0, Portsmouth Gaseous Diffusion Plant, April, 1996.
- Do95      Dobelbower, M.C., et al, *Verification of Criticality Accident Alarm System Detector Locations for the X-326 Process Cell Floor*, Portsmouth Gaseous Diffusion Plant, POEF-SH-34, August 1995.
- Fi83      Fithian, C., et al, *Data Catalogue of the 1980 SHEBA Experiments*, H&R 224-1, H&R Technical Associates, Inc. for Portsmouth Gaseous Diffusion Plant, May 1983.
- Gr71      *Ground Floor Plan - Unit X-29-1, Unit X-32-1 thru 5*, Drawing X-330 9A, revision 2, Portsmouth Gaseous Diffusion Plant, (1971).
- Gr77      *Ground Floor Plan - Units 3, 4, 5, & 6*, Drawing X-333 8A, revision 2, Portsmouth Gaseous Diffusion Plant, (1977).
- Gr79      *Ground Floor Plan - Units 1, 2, 7, & 8*, Drawing X-333 7A, revision 4, Portsmouth Gaseous Diffusion Plant, (1979)

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- He93 *Henderson Free-In-Air Flux-to-Dose Conversion Factors*, derived from Henderson, B.J., "Conversion of Neutron or Gamma-Ray Flux to Absorbed Dose Rate," XDC-59-8-179, (August 1959), tabulated as a response function with MT No. 9027, "SCALE version 4.2: A Modular Code System for Performing Standardized Computer Analyses for Licensing Evaluation," NUREG/CR-0200, revision 4, (November 1993), available from the Radiation Safety Information Computational Center as CCC-545, Oak Ridge National Laboratory.
- Le95 Lee, B.L., Dobelbower, M.C., and Tayloe Jr., R.W., *Calculated In-Air Leakage Spectra and Power Levels for the ANSI Standard Minimum Accident of Concern*, POEF-SH-31, Portsmouth Gaseous Diffusion Plant, July 1995.
- Ne94a Negron, S.B. and Tayloe, Jr., R.W., *Analysis of the Proposed Relocation of the Neutron Criticality Clusters in the Process Buildings for the Portsmouth Gaseous Diffusion Plant*, Portsmouth Gaseous Diffusion Plant., POEF-SH-12, January 1994.
- Ne94b Negron, S.B., Tayloe Jr., R.W., and Dobelbower, M.C., *Analysis of Criticality Alarm System Response to an Accidental Criticality Outside the Cascade Process Buildings at the Portsmouth Gaseous Diffusion Plant*, Portsmouth Gaseous Diffusion Plant, POEF-SH-19, July 1994.
- No56 *North Half Ground Floor Plan - Unit X-27-1 thru 3 and Units X-25-1 and X-25-2*, Drawing X-326 8A, revision 0, Portsmouth Gaseous Diffusion Plant, (1956).
- Mc94 MCNPDAT: MCNP, Version 4, Standard Neutron Cross Section Data Library Based in Part on ENDF/B-V, contributed by Los Alamos National Laboratory, available from the Radiation Safety Information Computational Center as DLC-105, Oak Ridge National Laboratory.
- Po87 *Portsmouth Gaseous Diffusion Plant Final Safety Analysis Report*, GAT/GDP-1073, Portsmouth Gaseous Diffusion Plant, April 1987.
- Ro96 Robinson, R. A., Battelle letter to Rumble, B. J., Portsmouth Gaseous Diffusion Plant, *Criticality Accident Alarm System Response Function Experimental Measurements*, October 14, 1996.
- So56 *South Half Ground Floor Plan - Unit X-25-3 thru 7, Purge, and Product*, Drawing X-326 9A, revision 0, Portsmouth Gaseous Diffusion Plant, (1956).

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- Va93 Van Riper, K. A., *SABRINA User's Guide*, LA-UR-93-3696, Los Alamos National Laboratory, October 1993. Available from the Radiation Safety Information Computational Center as PSR-242, Oak Ridge National Laboratory.
- We83 Westfall, R.M., and Knight, J.R., *Radiation Levels in a Gaseous Diffusion Plant Assuming a Low-Enriched Criticality Event Corresponding to the ANSI - Standard Minimum Accident of Concern*, ORNL/CSD/INF-82/7, Oak Ridge National Laboratory, January 1983.
- Wo83 Woltz, F.E. and Duncan, J.M., *GDP Criteria for Radial Coverage and Alarm Set Point for Neutron Sensing Radiation Alarm Clusters*, GAT-DM-1535, Portsmouth Gaseous Diffusion Plant, May 1983.

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**APPENDIX A**

**SAMPLE MCNP INPUTS FOR BUILDINGS**

**X-333, X-330, AND X-326**

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Listing A.1

Input for X-333

The model includes both the operating and cell floor for X-333.

```

This is a model of the first floor of the X333
c   Building to determine alarm coverage
c
c
c
c *****
c   cell cards
c *****
c
c
10  10 4.354e-5      180 -230 440 -450 1010 -1030  imp:n=1  $
20  10 4.354e-5      180 -230 460 -470 1010 -1030  imp:n=1  $
30  10 4.354e-5      180 -230 480 -490 1010 -1030  imp:n=1  $
40  10 4.354e-5      180 -230 500 -510 1010 -1030  imp:n=1  $
50  10 4.354e-5      180 -230 520 -530 1010 -1030  imp:n=1  $
60  10 4.354e-5      160 -230 560 -570 1010 -1030  imp:n=1  $
70  10 4.354e-5      160 -230 580 -620 1010 -1030  imp:n=1  $
80  10 4.354e-5      160 -170 630 -640 1010 -1030  imp:n=1  $
90  10 4.354e-5      180 -230 630 -640 1010 -1030  imp:n=1  $
100 10 4.354e-5      160 -170 690 -700 1010 -1030  imp:n=1  $
110 10 4.354e-5      160 -170 710 -760 1010 -1030  imp:n=1  $
120 10 4.354e-5      (180 -230 690 -760 1010 -1030):
      (230 -250 740 -760 1010 -1030) imp:n=1  $
130 10 4.354e-5      240 -250 690 -730 1010 -1030  imp:n=1  $
140 10 4.354e-5      (160 -250 770 -820 1010 -1030):
      (160 -200 820 -860 1010 -1030) imp:n=1  $
c
c   here are the concrete walls
c
150 20 3.9827e-2      150 -160 680 -870 1010 -1030  imp:n=1  $
160 20 3.9827e-2      170 -180 680 -770 1010 -1030  imp:n=1  $
170 20 3.9827e-2      200 -210 820 -870 1010 -1030  imp:n=1  $
180 20 3.9827e-2      230 -240 680 -740 1010 -1030  imp:n=1  $
190 20 3.9827e-2      250 -260 680 -830 1010 -1030  imp:n=1  $
200 20 3.9827e-2      160 -200 860 -870 1010 -1030  imp:n=1  $
205 20 3.9827e-2      210 -250 820 -830 1010 -1030  imp:n=1  $
210 20 3.9827e-2      160 -170 760 -770 1010 -1030  imp:n=1  $
220 20 3.9827e-2      180 -250 760 -770 1010 -1030  imp:n=1  $
230 20 3.9827e-2      160 -170 700 -710 1010 -1030  imp:n=1  $
240 20 3.9827e-2      240 -250 730 -740 1010 -1030  imp:n=1  $
250 20 3.9827e-2      160 -170 680 -690 1010 -1030  imp:n=1  $
260 20 3.9827e-2      180 -230 680 -690 1010 -1030  imp:n=1  $
270 20 3.9827e-2      240 -250 680 -690 1010 -1030  imp:n=1  $
280 20 3.9827e-2      160 -170 640 -650 1010 -1030  imp:n=1  $
290 20 3.9827e-2      180 -230 640 -650 1010 -1030  imp:n=1  $
300 20 3.9827e-2      160 -170 620 -630 1010 -1030  imp:n=1  $
310 20 3.9827e-2      180 -230 620 -630 1010 -1030  imp:n=1  $
320 20 3.9827e-2      160 -230 570 -580 1010 -1030  imp:n=1  $
330 20 3.9827e-2      160 -230 550 -560 1010 -1030  imp:n=1  $
340 20 3.9827e-2      150 -160 550 -650 1010 -1030  imp:n=1  $
345 20 3.9827e-2      170 -180 620 -650 1010 -1030  imp:n=1  $
350 20 3.9827e-2      230 -240 550 -650 1010 -1030  imp:n=1  $
360 20 3.9827e-2      170 -180 430 -540 1010 -1030  imp:n=1  $
370 20 3.9827e-2      230 -240 430 -540 1010 -1030  imp:n=1  $

```

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380	20	3.9827e-2	180	-230	530	-540	1010	-1030	imp:n=1	\$
390	20	3.9827e-2	180	-230	510	-520	1010	-1030	imp:n=1	\$
400	20	3.9827e-2	180	-230	490	-500	1010	-1030	imp:n=1	\$
410	20	3.9827e-2	180	-230	470	-480	1010	-1030	imp:n=1	\$
420	20	3.9827e-2	180	-230	450	-460	1010	-1030	imp:n=1	\$
430	20	3.9827e-2	180	-230	430	-440	1010	-1030	imp:n=1	\$
c										
c		storage areas								
c										
500	40	-0.375	80	-110	590	-600	1010	-1020	imp:n=1	\$ lot A
510	40	-0.375	70	-100	600	-610	1010	-1020	imp:n=1	\$ B
520	40	-0.375	20	-60	590	-600	1010	-1020	imp:n=1	\$ C
530	40	-0.375	25	-40	660	-670	1010	-1020	imp:n=1	\$ D
540	40	-0.375	60	-110	660	-670	1010	-1020	imp:n=1	\$ F
550	40	-0.375	25	-40	720	-750	1010	-1020	imp:n=1	\$ E
560	40	-0.375	40	-60	780	-790	1010	-1020	imp:n=1	\$ G
570	40	-0.375	20	-30	780	-790	1010	-1020	imp:n=1	\$ H
580	40	-0.375	40	-60	810	-840	1010	-1020	imp:n=1	\$ I
590	40	-0.375	70	-90	790	-800	1010	-1020	imp:n=1	\$ J
600	40	-0.375	70	-110	880	-890	1010	-1020	imp:n=1	\$ K
610	40	-0.375	120	-140	880	-890	1010	-1020	imp:n=1	\$ L
620	40	-0.375	130	-140	900	-920	1010	-1020	imp:n=1	\$ M
630	40	-0.375	170	-200	900	-930	1010	-1020	imp:n=1	\$ N
640	40	-0.375	240	-290	900	-910	1010	-1020	imp:n=1	\$ O
650	40	-0.375	240	-270	880	-890	1010	-1020	imp:n=1	\$ P
660	40	-0.375	300	-310	850	-890	1010	-1020	imp:n=1	\$ Q
670	40	-0.375	320	-330	880	-890	1010	-1020	imp:n=1	\$ R
680	40	-0.375	340	-350	880	-890	1010	-1020	imp:n=1	\$ S
690	40	-0.375	280	-290	780	-790	1010	-1020	imp:n=1	\$ T
700	40	-0.375	50	-80	410	-420	1010	-1020	imp:n=1	\$ U
c										
c		walls of building								
c										
705	30	8.7411e-2	15	-360	400	-405	1010	-1052	imp:n=8192	\$ west wall
710	30	8.7411e-2	15	-360	940	-945	1010	-1052	imp:n=1	\$ east wall
c										
720	30	8.7411e-2	10	-15	400	-745	1010	-1052	imp:n=8192	\$ north wall
722	30	8.7411e-2	10	-15	745	-772	1010	-1052	imp:n=4096	\$ north wall
724	30	8.7411e-2	10	-15	772	-775	1010	-1052	imp:n=2048	\$ north wall
726	30	8.7411e-2	10	-15	775	-785	1010	-1052	imp:n=1024	\$ north wall
728	30	8.7411e-2	10	-15	785	-795	1010	-1052	imp:n=512	\$ north wall
730	30	8.7411e-2	10	-15	795	-835	1010	-1052	imp:n=256	\$ north wall
732	30	8.7411e-2	10	-15	835	-845	1010	-1052	imp:n=128	\$ north wall
734	30	8.7411e-2	10	-15	845	-875	1010	-1052	imp:n=64	\$ north wall
736	30	8.7411e-2	10	-15	875	-895	1010	-1052	imp:n=32	\$ north wall
738	30	8.7411e-2	10	-15	895	-905	1010	-1052	imp:n=16	\$ north wall
740	30	8.7411e-2	10	-15	905	-923	1010	-1052	imp:n=8	\$ north wall
742	30	8.7411e-2	10	-15	923	-925	1010	-1052	imp:n=4	\$ north wall
744	30	8.7411e-2	10	-15	925	-932	1010	-1052	imp:n=2	\$ north wall
746	30	8.7411e-2	10	-15	932	-945	1010	-1052	imp:n=1	\$ north wall
c										
750	30	8.7411e-2	360	-365	400	-745	1010	-1052	imp:n=8192	\$ south wall
752	30	8.7411e-2	360	-365	745	-772	1010	-1052	imp:n=4096	\$ south wall
754	30	8.7411e-2	360	-365	772	-775	1010	-1052	imp:n=2048	\$ south wall
756	30	8.7411e-2	360	-365	775	-785	1010	-1052	imp:n=1024	\$ south wall
758	30	8.7411e-2	360	-365	785	-795	1010	-1052	imp:n=512	\$ south wall
760	30	8.7411e-2	360	-365	795	-835	1010	-1052	imp:n=256	\$ south wall
762	30	8.7411e-2	360	-365	835	-845	1010	-1052	imp:n=128	\$ south wall
764	30	8.7411e-2	360	-365	845	-875	1010	-1052	imp:n=64	\$ south wall
766	30	8.7411e-2	360	-365	875	-895	1010	-1052	imp:n=32	\$ south wall
768	30	8.7411e-2	360	-365	895	-905	1010	-1052	imp:n=16	\$ south wall
770	30	8.7411e-2	360	-365	905	-923	1010	-1052	imp:n=6	\$ south wall
772	30	8.7411e-2	360	-365	923	-925	1010	-1052	imp:n=4	\$ south wall
774	30	8.7411e-2	360	-365	925	-932	1010	-1052	imp:n=2	\$ south wall
776	30	8.7411e-2	360	-365	932	-945	1010	-1052	imp:n=1	\$ south wall
c										
780	20	3.9827e-2	15	-360	405	-745	1040	-1050	imp:n=8192	\$ concrete process floor

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```

782 20 3.9827e-2      15 -360 745 -772 1040 -1050  imp:n=4096 $ concrete process floor
784 20 3.9827e-2      15 -360 772 -775 1040 -1050  imp:n=2048 $ concrete process floor
786 20 3.9827e-2      15 -360 775 -785 1040 -1050  imp:n=1024 $ concrete process floor
788 20 3.9827e-2      15 -360 785 -795 1040 -1050  imp:n=512 $ concrete process floor
790 20 3.9827e-2      15 -360 795 -835 1040 -1050  imp:n=256 $ concrete process floor
792 20 3.9827e-2      15 -360 835 -845 1040 -1050  imp:n=128 $ concrete process floor
794 20 3.9827e-2      15 -360 845 -875 1040 -1050  imp:n=64 $ concrete process floor
796 20 3.9827e-2      15 -360 875 -895 1040 -1050  imp:n=32 $ concrete process floor
798 20 3.9827e-2      15 -360 895 -905 1040 -1050  imp:n=16 $ concrete process floor
800 20 3.9827e-2      15 -360 905 -923 1040 -1050  imp:n=8 $ concrete process floor
802 20 3.9827e-2      15 -360 923 -925 1040 -1050  imp:n=4 $ concrete process floor
804 20 3.9827e-2      15 -360 925 -932 1040 -1050  imp:n=2 $ concrete process floor
806 20 3.9827e-2      15 -360 932 -940 1040 -1050  imp:n=1 $ concrete process floor
c
810 20 3.9827e-2      1000 -1010 -1998 imp:n=1 $ concrete floor
820 70 9.0726e-2       10 -365 400 -745 1052 -1055  imp:n=8192 $ roof
822 70 9.0726e-2       10 -365 745 -772 1052 -1055  imp:n=4096 $ roof
824 70 9.0726e-2       10 -365 772 -775 1052 -1055  imp:n=2048 $ roof
826 70 9.0726e-2       10 -365 775 -785 1052 -1055  imp:n=1024 $ roof
828 70 9.0726e-2       10 -365 785 -795 1052 -1055  imp:n=512 $ roof
830 70 9.0726e-2       10 -365 795 -835 1052 -1055  imp:n=256 $ roof
832 70 9.0726e-2       10 -365 835 -845 1052 -1055  imp:n=128 $ roof
834 70 9.0726e-2       10 -365 845 -875 1052 -1055  imp:n=64 $ roof
836 70 9.0726e-2       10 -365 875 -895 1052 -1055  imp:n=32 $ roof
838 70 9.0726e-2       10 -365 895 -905 1052 -1055  imp:n=16 $ roof
840 70 9.0726e-2       10 -365 905 -923 1052 -1055  imp:n=8 $ roof
842 70 9.0726e-2       10 -365 923 -925 1052 -1055  imp:n=4 $ roof
844 70 9.0726e-2       10 -365 925 -932 1052 -1055  imp:n=2 $ roof
846 70 9.0726e-2       10 -365 932 -945 1052 -1055  imp:n=1 $ roof
c
c roofs on offices
c
900 30 8.7411e-2      170 -240 430 -540 1030 -1035  imp:n=1
$ west room roof
910 30 8.7411e-2      150 -240 550 -650 1030 -1035
imp:n=1 $ middle room roof
920 30 8.7411e-2      (150 -260 680 -830 1030 -1035):
(150 -210 830 -870 1030 -1035)
imp:n=1 $ west room roof
c
c air in building
c
1000 0                ((-80:110:-590:600:-1010:1020)
(-70:100:-600:610:-1010:1020)
(-20:60:-590:600:-1010:1020)
(-50:80:-410:420:-1010:1020)
(-150:240:-550:650:-1010:1035)
(-170:240:-430:540:-1010:1035)
(15 -290 405 -660 1010 -1040)) 1110
fill=1 imp:n=1 $ northwest air
1010 0                (-60:110:-660:670:-1010:1020)
(-25:40:-660:670:-1010:1020)
(-25:40:-720:750:-1010:1020)
(-40:60:-780:790:-1010:1020)
(-20:30:-780:790:-1010:1020)
(-40:60:-810:840:-1010:1020)
(-70:90:-790:800:-1010:1020)
(15 -110 660 -880 1010 -1040)
fill=1 imp:n=1 $ air
1012 0                (-70:110:-880:890:-1010:1020)
(-120:140:-880:890:-1010:1020)
(-130:140:-900:920:-1010:1020)
(-170:200:-900:930:-1010:1020)
(-240:290:-900:910:-1010:1020)
(-240:270:-880:890:-1010:1020)
(15 -290 880 -940 1010 -1040)
fill=1 imp:n=1 $ air

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1014 0 ((-280:290:-780:790:-1010:1020)
(-150:260:-680:830:-1010:1035)
(-150:210:-830:870:-1010:1035)
(110 -290 660 -880 1010 -1040)) 1100 1210
fill=1 imp:n=1 $.northeast air
1020 0 (-300:310:-850:890:-1010:1020)
(-320:330:-880:890:-1010:1020)
(-340:350:-880:890:-1010:1020)
(290 -360 660 -940 1010 -1040)
fill=1 imp:n=1 $ southeast air
1030 0 (290 -360 405 -660 1010 -1040) 1120
fill=1 imp:n=1 $ southwest air
c
c repeated structures cells
c
1200 20 3.9827e-2 1520 -1500 1620 -1600 u=2 imp:n=1 $
1210 10 4.354e-5 -1520:1500:-1620:1600 u=2 imp:n=1 $
1220 10 4.354e-5 -1550 1540 -1650 1640 -1700 1730 u=1 lat=1
imp:n=1 fill=0:45 0:65 0:0
2 3035r $ repeated unit cell
c
c
1500 10 4.354e-5 -1100 imp:n=1 $ detector se-1
1510 10 4.354e-5 -1110 imp:n=1 $ detector 33-ls-1
1520 10 4.354e-5 -1120 imp:n=1 $ detector 33-lg
1530 10 4.354e-5 -1130 imp:n=1 $ detector 10-U
1540 10 4.354e-5 -1140 imp:n=1 $ detector 10-Fy
1550 10 4.354e-5 -1150 imp:n=1 $ detector 26-U
1560 10 4.354e-5 -1160 imp:n=1 $ detector 26-Fy
1570 10 4.354e-5 -1170 imp:n=1 $ detector 42-U
1580 10 4.354e-5 -1180 imp:n=1 $ detector 42-Fy
1590 10 4.354e-5 -1190 imp:n=1 $ detector 58-U
1600 10 4.354e-5 -1200 imp:n=1 $ detector 58-G
1610 10 4.354e-5 -1210 imp:n=1 $ detector 56-Mb ground floor
1998 10 4.354e-5 ((-10:365:-400:945) -1998 -1055 1010):
(-1998 1055) imp:n=1 $ air around building
1999 0 (-1000 -1999):(1998 -1999) imp:n=1 $ internal world
2000 0 1999 imp:n=0 $ external world
c
c
2500 10 4.354e-5 15 -360 935 -940 1050 -1051 imp:n=1 $
c
2510 10 4.354e-5 (15 -360 405 -745 1051 -1052)
1130 1140 1150 1160 1170 1180 1190
1200 imp:n=8192 $ air above proc cells
2512 10 4.354e-5 (15 -360 745 -772 1051 -1052)
1130 1140 1150 1160 1170 1180 1190
1200 imp:n=4096 $ air above proc cells
2514 10 4.354e-5 (15 -360 772 -775 1051 -1052)
1130 1140 1150 1160 1170 1180 1190
1200 imp:n=2048 $ air above proc cells
2516 10 4.354e-5 (15 -360 775 -785 1051 -1052)
1130 1140 1150 1160 1170 1180 1190
1200 imp:n=1024 $ air above proc cells
2518 10 4.354e-5 (15 -360 785 -795 1051 -1052)
1130 1140 1150 1160 1170 1180 1190
1200 imp:n=512 $ air above proc cells
2520 10 4.354e-5 (15 -360 795 -835 1051 -1052)
1130 1140 1150 1160 1170 1180 1190
1200 imp:n=256 $ air above proc cells
2522 10 4.354e-5 (15 -360 835 -845 1051 -1052)
1130 1140 1150 1160 1170 1180 1190
1200 imp:n=128 $ air above proc cells
2524 10 4.354e-5 (15 -360 845 -875 1051 -1052)
1130 1140 1150 1160 1170 1180 1190
1200 imp:n=64 $ air above proc cells
2526 10 4.354e-5 (15 -360 875 -895 1051 -1052)
1130 1140 1150 1160 1170 1180 1190

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2528	10	4.354e-5	1200 imp:n=32	\$ air above proc cells
			(15 -360 895 -905 1051 -1052)	
			1130 1140 1150 1160 1170 1180 1190	
2530	10	4.354e-5	1200 imp:n=16	\$ air above proc cells
			(15 -360 905 -923 1051 -1052)	
			1130 1140 1150 1160 1170 1180 1190	
2532	10	4.354e-5	1200 imp:n=8	\$ air above proc cells
			(15 -360 923 -925 1051 -1052)	
			1130 1140 1150 1160 1170 1180 1190	
2534	10	4.354e-5	1200 imp:n=4	\$ air above proc cells
			(15 -360 925 -932 1051 -1052)	
			1130 1140 1150 1160 1170 1180 1190	
2536	10	4.354e-5	1200 imp:n=2	\$ air above proc cells
			(15 -360 932 -940 1051 -1052)	
			1130 1140 1150 1160 1170 1180 1190	
			1200 imp:n=1	\$ air above proc cells
c				
2600	80	1.6021E-3	2000 -2010 2220 -2230 u=7 imp:n=1	\$
2610	80	1.6021E-3	2020 -2030 2220 -2230 u=7 imp:n=1	\$
2620	80	1.6021E-3	2040 -2050 2220 -2230 u=7 imp:n=1	\$
2630	80	1.6021E-3	2060 -2070 2220 -2230 u=7 imp:n=1	\$
2640	80	1.6021E-3	2080 -2090 2220 -2230 u=7 imp:n=1	\$
2650	80	1.6021E-3	2000 -2010 2200 -2210 u=7 imp:n=1	\$
2660	80	1.6021E-3	2020 -2030 2200 -2210 u=7 imp:n=1	\$
2670	80	1.6021E-3	2040 -2050 2200 -2210 u=7 imp:n=1	\$
2680	80	1.6021E-3	2060 -2070 2200 -2210 u=7 imp:n=1	\$
2690	80	1.6021E-3	2080 -2090 2200 -2210 u=7 imp:n=1	\$
2700	10	4.354e-5	((-2000:2010:-2220:2230)	
			(-2020:2030:-2220:2230)	
			(-2000:2010:-2200:2210)	
2710	10	4.354e-5	(-2020:2030:-2200:2210)) -2030 u=7 imp:n=1	\$
			((-2040:2050:-2220:2230)	
			(-2060:2070:-2220:2230)	
			(-2040:2050:-2200:2210)	
			(-2060:2070:-2200:2210)) 2030 -2070	
			u=7 imp:n=1	\$
2720	10	4.354e-5	((-2080:2090:-2220:2230)	
			(-2080:2090:-2200:2210)) 2070 u=7 imp:n=1	\$
c				
2750	0		-2095 12 -2250 402 u=6 lat=1 imp:n=1	
			fill=0:2 0:0 0:0	
			7 2r	\$
c				
2760	0		-362 13 -2240 403 u=5 lat=1 imp:n=1	
			fill=0:0 0:4 0:0	
			6 4r	\$
c				
2770	0		15 -360 405 -745 1050 -1051	
			fill=5 imp:n=8192	\$
2772	0		15 -360 745 -772 1050 -1051	
			fill=5 imp:n=4096	\$
2774	0		15 -360 772 -775 1050 -1051	
			fill=5 imp:n=2048	\$
2776	0		15 -360 775 -785 1050 -1051	
			fill=5 imp:n=1024	\$
2778	0		15 -360 785 -795 1050 -1051	
			fill=5 imp:n=512	\$
2780	0		15 -360 795 -835 1050 -1051	
			fill=5 imp:n=256	\$
2782	0		15 -360 835 -845 1050 -1051	
			fill=5 imp:n=128	\$
2784	0		15 -360 845 -875 1050 -1051	
			fill=5 imp:n=64	\$
2786	0		15 -360 875 -895 1050 -1051	
			fill=5 imp:n=32	\$
2788	0		15 -360 895 -905 1050 -1051	
			fill=5 imp:n=16	\$

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2790	0	15 -360 905 -923 1050 -1051	
		fill=5 imp:n=8	\$
2792	0	15 -360 923 -925 1050 -1051	
		fill=5 imp:n=4	\$
2794	0	15 -360 925 -932 1050 -1051	
		fill=5 imp:n=2	\$
2796	0	15 -360 932 -935 1050 -1051	
		fill=5 imp:n=1	\$
c			
c			
c			
c			
c		*****	
c		surface cards	
c		*****	
c			
10	px	0	\$
12	px	0.189	\$
13	px	0.190	\$
15	px	0.191	\$
20	px	1463	\$
25	px	1920	\$
30	px	3078	\$
40	px	3779	\$
50	px	4328	\$
60	px	5639	\$
70	px	6370	\$
80	px	7010	\$
90	px	7559	\$
100	px	8230	\$
110	px	9510	\$
120	px	11369	\$
130	px	12009	\$
140	px	12710	\$
150	px	13259	\$
160	px	13279	\$
170	px	14021	\$
180	px	14041	\$
200	px	14752	\$
210	px	14772	\$
230	px	15464	\$
240	px	15484	\$
250	px	16286	\$
260	px	16306	\$
270	px	16825	\$
280	px	17435	\$
290	px	18075	\$
300	px	20025	\$
310	px	20665	\$
320	px	21275	\$
330	px	23165	\$
340	px	23805	\$
350	px	25116	\$
360	px	29566	\$
362	px	29566.01	\$
365	px	29566.191	\$
400	py	0	\$
402	py	0.189	\$
403	py	0.190	\$
405	py	0.191	\$
410	py	732	\$
420	py	1402	\$
430	py	6414	\$
440	py	6434	\$

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450	py	7074	\$
460	py	7094	\$
470	py	7734	\$
480	py	7754	\$
490	py	9034	\$
500	py	9054	\$
510	py	10243	\$
520	py	10263	\$
530	py	12103	\$
540	py	12123	\$
c	545	py 17282.16	\$
550	py	19347	\$
560	py	19367	\$
570	py	19885	\$
580	py	19905	\$
590	py	21287	\$
600	py	21897	\$
610	py	22629	\$
620	py	23411	\$
630	py	23431	\$
640	py	23949	\$
650	py	23969	\$
660	py	26591	\$
670	py	27292	\$
680	py	27352	\$
690	py	27372	\$
700	py	27707	\$
710	py	27727	\$
720	py	28146	\$
730	py	28195	\$
740	py	28215	\$
745	py	28529	\$
750	py	28786	\$
760	py	28835	\$
770	py	28855	\$
772	py	29749	\$
775	py	30968	\$
780	py	32047	\$
785	py	32187	\$
790	py	32748	\$
795	py	33406	\$
800	py	33449	\$
810	py	34120	\$
820	py	34311	\$
830	py	34331	\$
835	py	34625	\$
840	py	34790	\$
845	py	35845	\$
850	py	36741	\$
860	py	36891	\$
870	py	36911	\$
875	py	37064	\$
880	py	37381	\$
890	py	37990	\$
895	py	38283	\$
900	py	38935	\$
905	py	39502	\$
910	py	39606	\$
920	py	40276	\$
923	py	40721	\$
925	py	41941	\$
930	py	42227	\$
932	py	43160	\$
935	py	44279	\$
940	py	44379	\$
945	py	44379.191	\$
1000	pz	-3000	\$

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1010	pz	0		\$	
1020	pz	197		\$	top of drums
1030	pz	305		\$	top of rooms
1035	pz	305.09		\$	top of roof on rooms
1040	pz	838.2		\$	top of first floor
1050	pz	868.68		\$	process cell floor
1051	pz	1208.68		\$	top of process cells
1052	pz	2504.6		\$	
1055	pz	2514.6		\$	
1100	s	14752	27241	200	50 \$ detector se-1
1110	s	14752	1351	200	50 \$ detector 33-ls-1
1120	s	28225	12933	200	50 \$ detector 33-lg
1130	s	5639	6414	1368.68	50 \$ detector 10-U
1140	s	23805	6414	1368.68	50 \$ detector 10-Fy
1150	s	5639	17282.16	1368.68	50 \$ detector 26-U
1160	s	23805	17282.16	1368.68	50 \$ detector 26-Fy
1170	s	5639	28146	1368.68	50 \$ detector 42-U
1180	s	23805	28146	1368.68	50 \$ detector 42-Fy
1190	s	5639	38935	1368.68	50 \$ detector 58-U
1200	s	23165	38935	1368.68	50 \$ detector 58-G
1210	s	14000	37000	200	50 \$ detector 56-Mb ground floor

c  
c surfaces for repeating structures first floor

1520	px	-0.1		\$	
1500	px	45.72		\$	
c 1510	px	642.73		\$	
c 1530	px	642.83		\$	
1540	px	-0.01		\$	
1550	px	642.74		\$	
1620	py	-0.1		\$	
1600	py	45.72		\$	
c 1610	py	672.39		\$	
c 1630	py	672.49		\$	
1640	py	-0.01		\$	
1650	py	672.4		\$	
c 1710	pz	-0.1		\$	
1700	pz	900		\$	
c 1720	pz	900.1		\$	
1730	pz	-0.01		\$	
1998	so	80000		\$	
1999	so	10000000		\$	

c  
c surfaces for repeating structures in second floor

2000	px	1244.6		\$	
2010	px	3134.36		\$	
2020	px	3769.36		\$	
2030	px	5659.12		\$	
2040	px	6334.76		\$	
2050	px	8224.52		\$	
2060	px	8859.52		\$	
2070	px	10749.28		\$	
2080	px	11424.92		\$	
2090	px	13314.68		\$	
2095	px	14996.16		\$	
2200	py	731.5		\$	
2210	py	5364.48		\$	
2220	py	6278.88		\$	
2230	py	10911.84		\$	
2240	py	10911.85		\$	
2250	py	10911.86		\$	

c \*\*\*\*\*  
c  
c source term  
c

```

c *****
sdef pos=1.0 44378.0 968.68 erg=d1 vec=5638 -16232 400 dir=d2
c sdef sur=1998 nrm=-1 dir=d1
c sb1 -21 2
scl from h/u=15 5% enrichment normalized to 2881 W
sil h 1.00e-11 1.00e-8 3.00e-8 5.00e-8 1.00e-7 2.25e-7
      3.25e-7 4.00e-7 8.00e-7 1.00e-6 1.13e-6 1.3e-6
      1.77e-6 3.05e-6 1.00e-5 3.00e-5 1.00e-4 5.5e-4
      0.003 0.017 0.1 0.4 0.9 1.4
      1.85 3.0 6.43 20
spl d 0 1.46e+2 8.00e+2 9.71e+2 1.50e+3 1.04e+3
      3.00e+2 1.62e+2 5.54e+2 1.74e+2 8.59e+1 1.04e+2
      2.53e+2 4.73e+2 9.48e+2 1.03e+3 1.18e+3 1.68e+3
      1.82e+3 2.18e+3 2.96e+3 4.36e+3 5.07e+3 3.40e+3
      2.72e+3 5.56e+3 4.90e+3 6.11e+2

c
c
sc2 source bias toward detector U-42
si2 -1 0.94 1
sp2 0 0.97 0.03
sb2 0 0.5 0.5
c *****
c
c material cards
c *****
c
m10 7014.50c 3.570e-5 $ air
     8016.50c 7.840e-6
m20 1001.50c 1.487e-2 $ concrete
     6012.50c 3.814e-3
     8016.50c 4.152e-2
     11023.50c 3.040e-4
     12000.51c 5.870e-4
     13027.50c 7.350e-4
     14000.50c 6.037e-3
     20000.51c 1.159e-2
     26000.50c 1.968e-4
m30 6012.50c 3.921e-3 $ steel
     26000.50c 8.349e-2
m40 6012.50c 6.0 $ wood
     1001.50c 10.0
     8016.50c 5.0
m70 1001.50c 4.288e-2
     6012.50c 1.812e-2
     8016.50c 1.896e-3
     26000.50c 2.783e-2 $ roof
m80 6012.50c 6.230e-5
     9019.50c 8.880e-5
     13027.50c 8.420e-5
     14000.50c 1.666e-5
     17000.50c 8.880e-5
     24000.50c 1.619e-4
     25055.51c 1.703e-5
     26000.50c 5.934e-4
     28000.50c 4.563e-4
     29000.50c 3.273e-5 $ homogenized cell material

c
c
c *****
c
c tally cards
c *****
c
fc4 track length detector se-1
f4:n 1500

```

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fc14 track length detector 33-LS-1
f14:n 1510
fc24 track length detector 1g
f24:n 1520
fc34 track length detector 10-U
f34:n 1530
fc44 track length detector 10-Fy
f44:n 1540
fc54 track length detector 26-U
f54:n 1550
fc64 track length detector 26-Fy
f64:n 1560
fc74 track length detector 42-U
f74:n 1570
fc84 track length detector 42-Fy
f84:n 1580
fc94 track length detector 58-U
f94:n 1590
fc104 track length detector 58-G
f104:n 1600
fc114 track length detector 56-Mb ground floor
f114:n 1610
c fc5 point detector se-1
c f5:n 14752.02 27241.02 200.02 49
c fc15 point detector 33-LS-1
c f15:n 14752.02 1351.02 200.02 49
c f25c point detector 1g
c f25:n 28225.02 12933.02 200.02 49
c e0 1.00e-11 1.00e-8 3.00e-8 5.00e-8 1.00e-7 2.25e-7
c 3.25e-7 4.00e-7 8.00e-7 1.00e-6 1.13e-6 1.3e-6
c 1.77e-6 3.05e-6 1.00e-5 3.00e-5 1.00e-4 5.5e-4
c 0.003 0.017 0.1 0.4 0.9 1.4
c 1.85 3.0 6.43 20
c
c
c Response Function
c *****
c
dE0 1.00E-09 1.00E-08 1.00E-07 5.00E-07
1.00E-06 5.00E-06 1.00E-05 5.00E-05
1.00E-04 5.00E-04 1.00E-03 5.00E-03
1.00E-02 2.00E-02 5.00E-02 1.00E-01
5.00E-01 1 2 5
10 20
c
c
c
c
dF0 0.456683643 0.612833708 1.202405686 1.907520827
2.170074239 2.524934685 2.619466509 2.665319206
2.525689936 2.568979899 2.526120045 2.429598966
2.361915675 2.254370492 2.239813349 2.236561929
1.912907431 1.575113097 1.131268722 0.548312231
0.248252542 0.142345613
c
c
c *****
c
c peripheral cards
c
c *****
c
c ptrac file=asc cell=1500 1510 1520
mode n
c 17 keV cut off
c cut:n j 0.017

```

---

Final Report

```
ctme 10  
c void  
c nps 99000000  
prtmp 3j 4  
c dbcn 31277116122605  
print  
c
```

---

**Final Report**

March 1997

*Examination of Criticality Accident Alarm Coverage on the Operating Floors  
of Buildings X-333, X-330, and X-326 at the  
Portsmouth Gaseous Diffusion Plant*

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Listing A.2

Input for X-330

The model includes both the operating and cell floor for X-330.

Model of the entire X-330 building

```

c
c *****
c   cell cards
c *****
c
10  70  -1.0      10 -15 520 -531 810 -830 imp:n=1 $  battery rm. #1
20  10  4.354e-5  21 -50 441 -460 810 -830 imp:n=1 $
30  10  4.354e-5  21 -30 411 -430 810 -830 imp:n=1 $
50  10  4.354e-5  (21 -31 431 -440 810 -830):
                    (31 -40 411 -440 810 -830) imp:n=1 $
60  10  4.354e-5  41 -50 431 -440 810 -830 imp:n=1 $
70  70  -1.0      53 -54 520 -531 810 -830 imp:n=1 $  battery rm. #2
80  70  -1.0      55 -56 520 -531 810 -830 imp:n=1 $  battery rm. #3
90  10  4.354e-5  61 -80 481 -520 810 -830 imp:n=1 $
95  10  4.354e-5  71 -80 521 -530 810 -830 imp:n=1 $
100 10  4.354e-5  61 -70 471 -480 810 -830 imp:n=1 $
110 10  4.354e-5  71 -80 471 -480 810 -830 imp:n=1 $
120 70  -1.0      85 -88 520 -531 810 -830 imp:n=1 $  battery rm. #4
130 10  4.354e-5  91 -100 501 -510 810 -830 imp:n=1 $
140 70  -1.0      100 -105 520 -531 810 -830 imp:n=1 $  battery rm. #5
142 10  4.354e-5  111 -130 591 -600 810 -830 imp:n=1 $
143 10  4.354e-5  111 -130 571 -590 810 -830 imp:n=1 $
144 10  4.354e-5  111 -130 561 -570 810 -830 imp:n=1 $
145 10  4.354e-5  111 -130 541 -560 810 -830 imp:n=1 $
150 10  4.354e-5  (121 -150 441 -500 810 -830):
                    (121 -130 421 -441 810 -830) imp:n=1 $
170 10  4.354e-5  121 -130 411 -420 810 -830 imp:n=1 $
190 10  4.354e-5  131 -140 411 -440 810 -830 imp:n=1 $
200 10  4.354e-5  141 -150 431 -440 810 -830 imp:n=1 $
210 10  4.354e-5  141 -150 421 -430 810 -830 imp:n=1 $
220 10  4.354e-5  141 -150 411 -420 810 -830 imp:n=1 $
230 70  -1.0      145 -150 520 -531 810 -830 imp:n=1 $  battery rm. #6
240 70  -1.0      153 -154 520 -531 810 -830 imp:n=1 $  battery rm. #7
250 70  -1.0      155 -156 520 -531 810 -830 imp:n=1 $  battery rm. #8
260 10  4.354e-5  161 -170 521 -530 810 -830 imp:n=1 $
270 10  4.354e-5  171 -180 521 -530 810 -830 imp:n=1 $
280 10  4.354e-5  161 -180 481 -520 810 -830 imp:n=1 $
290 10  4.354e-5  161 -170 471 -480 810 -830 imp:n=1 $
300 10  4.354e-5  171 -180 471 -480 810 -830 imp:n=1 $
310 70  -1.0      185 -188 520 -531 810 -830 imp:n=1 $  battery rm. #9
320 10  4.354e-5  191 -200 401 -450 810 -830 imp:n=1 $
330 70  -1.0      195 -200 520 -531 810 -830 imp:n=1 $  battery rm. #10
340 10  4.354e-5  211 -230 480 -490 810 -830 imp:n=1 $
342 10  4.354e-5  211 -230 450 -480 810 -830 imp:n=1 $
344 10  4.354e-5  211 -230 440 -450 810 -830 imp:n=1 $
346 10  4.354e-5  211 -230 421 -440 810 -830 imp:n=1 $
350 70  -1.0      235 -240 520 -531 810 -830 imp:n=1 $  battery rm. #11
360 10  4.354e-5  241 -250 399 -400 810 -830 imp:n=1 $
c
c   these are the concrete walls
c
500 20  3.9827e-2  20 -21 410 -461 810 -830 imp:n=1 $
510 20  3.9827e-2  30 -31 410 -431 810 -830 imp:n=1 $
520 20  3.9827e-2  40 -41 410 -441 810 -830 imp:n=1 $

```

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530	20	3.9827e-2	50	-51	430	-461	810	-830	imp:n=1	\$
540	20	3.9827e-2	21	-50	460	-461	810	-830	imp:n=1	\$
550	20	3.9827e-2	21	-40	440	-441	810	-830	imp:n=1	\$
555	20	3.9827e-2	41	-50	440	-441	810	-830	imp:n=1	\$
560	20	3.9827e-2	21	-30	430	-431	810	-830	imp:n=1	\$
570	20	3.9827e-2	41	-50	430	-431	810	-830	imp:n=1	\$
580	20	3.9827e-2	21	-30	410	-411	810	-830	imp:n=1	\$
590	20	3.9827e-2	31	-40	410	-411	810	-830	imp:n=1	\$
600	20	3.9827e-2	60	-61	470	-521	810	-830	imp:n=1	\$
610	20	3.9827e-2	70	-71	520	-531	810	-830	imp:n=1	\$
620	20	3.9827e-2	70	-71	470	-481	810	-830	imp:n=1	\$
630	20	3.9827e-2	80	-81	470	-531	810	-830	imp:n=1	\$
640	20	3.9827e-2	61	-70	520	-521	810	-830	imp:n=1	\$
645	20	3.9827e-2	71	-80	520	-521	810	-830	imp:n=1	\$
650	20	3.9827e-2	71	-80	530	-531	810	-830	imp:n=1	\$
660	20	3.9827e-2	61	-70	480	-481	810	-830	imp:n=1	\$
670	20	3.9827e-2	71	-80	480	-481	810	-830	imp:n=1	\$
680	20	3.9827e-2	61	-70	470	-471	810	-830	imp:n=1	\$
690	20	3.9827e-2	71	-80	470	-471	810	-830	imp:n=1	\$
700	20	3.9827e-2	90	-91	500	-511	810	-830	imp:n=1	\$
710	20	3.9827e-2	100	-101	500	-511	810	-830	imp:n=1	\$
720	20	3.9827e-2	91	-100	510	-511	810	-830	imp:n=1	\$
730	20	3.9827e-2	91	-100	500	-501	810	-830	imp:n=1	\$
740	20	3.9827e-2	120	-121	410	-501	810	-830	imp:n=1	\$
750	20	3.9827e-2	130	-131	410	-441	810	-830	imp:n=1	\$
760	20	3.9827e-2	140	-141	410	-441	810	-830	imp:n=1	\$
770	20	3.9827e-2	150	-151	410	-501	810	-830	imp:n=1	\$
780	20	3.9827e-2	121	-150	500	-501	810	-830	imp:n=1	\$
790	20	3.9827e-2	131	-140	440	-441	810	-830	imp:n=1	\$
795	20	3.9827e-2	141	-150	440	-441	810	-830	imp:n=1	\$
800	20	3.9827e-2	141	-150	430	-431	810	-830	imp:n=1	\$
810	20	3.9827e-2	121	-130	420	-421	810	-830	imp:n=1	\$
820	20	3.9827e-2	141	-150	420	-421	810	-830	imp:n=1	\$
830	20	3.9827e-2	121	-130	410	-411	810	-830	imp:n=1	\$
840	20	3.9827e-2	131	-140	410	-411	810	-830	imp:n=1	\$
850	20	3.9827e-2	141	-150	410	-411	810	-830	imp:n=1	\$
860	20	3.9827e-2	160	-161	470	-531	810	-830	imp:n=1	\$
870	20	3.9827e-2	170	-171	520	-531	810	-830	imp:n=1	\$
880	20	3.9827e-2	170	-171	470	-481	810	-830	imp:n=1	\$
890	20	3.9827e-2	180	-181	470	-531	810	-830	imp:n=1	\$
900	20	3.9827e-2	161	-170	530	-531	810	-830	imp:n=1	\$
910	20	3.9827e-2	171	-180	530	-531	810	-830	imp:n=1	\$
920	20	3.9827e-2	161	-170	520	-521	810	-830	imp:n=1	\$
930	20	3.9827e-2	171	-180	520	-521	810	-830	imp:n=1	\$
940	20	3.9827e-2	161	-170	480	-481	810	-830	imp:n=1	\$
950	20	3.9827e-2	171	-180	480	-481	810	-830	imp:n=1	\$
960	20	3.9827e-2	161	-170	470	-471	810	-830	imp:n=1	\$
970	20	3.9827e-2	171	-180	470	-471	810	-830	imp:n=1	\$
980	20	3.9827e-2	190	-191	400	-451	810	-830	imp:n=1	\$
990	20	3.9827e-2	200	-201	400	-451	810	-830	imp:n=1	\$
1000	20	3.9827e-2	191	-200	450	-451	810	-830	imp:n=1	\$
1010	20	3.9827e-2	191	-200	400	-401	810	-830	imp:n=1	\$
1020	20	3.9827e-2	210	-211	480	-491	810	-830	imp:n=1	\$
1022	20	3.9827e-2	210	-211	450	-480	810	-830	imp:n=1	\$
1024	20	3.9827e-2	210	-211	440	-450	810	-830	imp:n=1	\$
1026	20	3.9827e-2	210	-211	420	-440	810	-830	imp:n=1	\$
1030	20	3.9827e-2	230	-231	480	-491	810	-830	imp:n=1	\$
1032	20	3.9827e-2	230	-231	450	-480	810	-830	imp:n=1	\$
1034	20	3.9827e-2	230	-231	440	-450	810	-830	imp:n=1	\$
1036	20	3.9827e-2	230	-231	420	-440	810	-830	imp:n=1	\$
1040	20	3.9827e-2	211	-230	490	-491	810	-830	imp:n=1	\$
1050	20	3.9827e-2	211	-230	420	-421	810	-830	imp:n=1	\$
1060	20	3.9827e-2	240	-241	398	-401	810	-830	imp:n=1	\$
1070	20	3.9827e-2	250	-251	398	-401	810	-830	imp:n=1	\$
1080	20	3.9827e-2	241	-250	400	-401	810	-830	imp:n=1	\$
1090	20	3.9827e-2	241	-250	398	-399	810	-830	imp:n=1	\$
1092	20	3.9827e-2	110	-111	540	-601	810	-830	imp:n=1	\$

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1093 20 3.9827e-2 130 -131 540 -601 810 -830 imp:n=1 \$  
 1094 20 3.9827e-2 111 -130 600 -601 810 -830 imp:n=1 \$  
 1095 20 3.9827e-2 111 -130 590 -591 810 -830 imp:n=1 \$  
 1096 20 3.9827e-2 111 -130 570 -571 810 -830 imp:n=1 \$  
 1097 20 3.9827e-2 111 -130 560 -561 810 -830 imp:n=1 \$  
 1098 20 3.9827e-2 111 -130 540 -541 810 -830 imp:n=1 \$

c  
 c  
 c steel walls

c  
 c  
 1100 30 8.7411e-2 1 -2 397 -611 810 -870 imp:n=1 \$  
 1110 30 8.7411e-2 251 -252 1030 -611 810 -870 imp:n=1 \$  
 1111 30 8.7411e-2 251 -252 595 -1030 810 -870 imp:n=1 \$  
 1112 30 8.7411e-2 251 -252 580 -595 810 -870 imp:n=1 \$  
 1113 30 8.7411e-2 251 -252 560 -580 810 -870 imp:n=1 \$  
 1114 30 8.7411e-2 251 -252 1020 -560 810 -870 imp:n=1 \$  
 1115 30 8.7411e-2 251 -252 530 -1020 810 -870 imp:n=1 \$  
 1116 30 8.7411e-2 251 -252 510 -530 810 -870 imp:n=1 \$  
 1117 30 8.7411e-2 251 -252 1000 -510 810 -870 imp:n=1 \$  
 1118 30 8.7411e-2 251 -252 480 -1000 810 -870 imp:n=1 \$  
 1119 30 8.7411e-2 251 -252 450 -480 810 -870 imp:n=1 \$  
 1121 30 8.7411e-2 251 -252 440 -450 810 -870 imp:n=1 \$  
 1122 30 8.7411e-2 251 -252 420 -440 810 -870 imp:n=1 \$  
 1123 30 8.7411e-2 251 -252 397 -420 810 -870 imp:n=1 \$  
 1120 30 8.7411e-2 2 -210 397 -398 810 -870 imp:n=1 \$  
 1125 30 8.7411e-2 210 -251 397 -398 810 -870 imp:n=1 \$  
 1130 30 8.7411e-2 2 -210 610 -611 810 -870 imp:n=1 \$  
 1135 30 8.7411e-2 210 -251 610 -611 810 -870 imp:n=1 \$

c  
 c  
 c sub-structure roofs

c  
 c  
 1300 30 8.7411e-2 (20 -51 430 -461 830 -840):  
 (20 -41 410 -430 830 -840) imp:n=1 \$  
 1310 30 8.7411e-2 (60 -81 470 -521 830 -840):  
 (70 -81 521 -531 830 -840) imp:n=1 \$  
 1320 30 8.7411e-2 90 -101 500 -511 830 -840 imp:n=1 \$  
 1330 30 8.7411e-2 120 -151 410 -501 830 -840 imp:n=1 \$  
 1340 30 8.7411e-2 160 -181 470 -531 830 -840 imp:n=1 \$  
 1350 30 8.7411e-2 190 -201 400 -451 830 -840 imp:n=1 \$  
 1360 30 8.7411e-2 210 -231 480 -491 830 -840 imp:n=1 \$  
 1362 30 8.7411e-2 210 -231 450 -480 830 -840 imp:n=1 \$  
 1364 30 8.7411e-2 210 -231 440 -450 830 -840 imp:n=1 \$  
 1366 30 8.7411e-2 210 -231 420 -440 830 -840 imp:n=1 \$  
 1370 30 8.7411e-2 240 -251 398 -401 830 -840 imp:n=1 \$  
 1380 30 8.7411e-2 110 -131 540 -601 830 -840 imp:n=1 \$

c  
 c  
 c concrete floor and ceiling

c  
 c  
 1400 0 (800 -810 -9998)  
 (-1:252:-397:611) imp:n=1 \$ this is the giant concrete floor  
 1410 20 7.9654e-2 2 -210 398 -610 850 -860 imp:n=1 \$ south proc cell floor  
 1411 20 7.9654e-2 210 -251 1030 -610 850 -860 imp:n=1 \$ north proc cell floor  
 1412 20 7.9654e-2 210 -251 595 -1030 850 -860 imp:n=1 \$ north proc cell floor  
 1413 20 7.9654e-2 210 -251 580 -595 850 -860 imp:n=1 \$ north proc cell floor  
 1414 20 7.9654e-2 210 -251 560 -580 850 -860 imp:n=1 \$ north proc cell floor  
 1415 20 7.9654e-2 210 -251 1020 -560 850 -860 imp:n=1 \$ north proc cell floor  
 1416 20 7.9654e-2 210 -251 530 -1020 850 -860 imp:n=1 \$ north proc cell floor  
 1417 20 7.9654e-2 210 -251 510 -530 850 -860 imp:n=1 \$ north proc cell floor  
 1418 20 7.9654e-2 210 -251 1000 -510 850 -860 imp:n=1 \$ north proc cell floor  
 1419 20 7.9654e-2 210 -251 480 -1000 850 -860 imp:n=1 \$ north proc cell floor  
 1420 20 7.9654e-2 210 -251 450 -480 850 -860 imp:n=1 \$ north proc cell floor  
 1421 20 7.9654e-2 210 -251 440 -450 850 -860 imp:n=1 \$ north proc cell floor

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1422 20 7.9654e-2 210 -251 420 -440 850 -860 imp:n=1 $ north proc cell floor
1423 20 7.9654e-2 210 -251 398 -420 850 -860 imp:n=1 $ north proc cell floor
c
1450 20 7.9654e-2 1 -210 397 -611 800 -810 imp:n=1 $ south roof
1451 20 7.9654e-2 210 -252 1030 -611 800 -810 imp:n=1 $ north roof
1452 20 7.9654e-2 210 -252 595 -1030 800 -810 imp:n=1 $ north roof
1453 20 7.9654e-2 210 -252 580 -595 800 -810 imp:n=1 $ north roof
1454 20 7.9654e-2 210 -252 560 -580 800 -810 imp:n=1 $ north roof
1455 20 7.9654e-2 210 -252 1020 -560 800 -810 imp:n=1 $ north roof
1456 20 7.9654e-2 210 -252 530 -1020 800 -810 imp:n=1 $ north roof
1457 20 7.9654e-2 210 -252 510 -530 800 -810 imp:n=1 $ north roof
1458 20 7.9654e-2 210 -252 1000 -510 800 -810 imp:n=1 $ north roof
1459 20 7.9654e-2 210 -252 480 -1000 800 -810 imp:n=1 $ north roof
1460 20 7.9654e-2 210 -252 450 -480 800 -810 imp:n=1 $ north roof
1461 20 7.9654e-2 210 -252 440 -450 800 -810 imp:n=1 $ north roof
1462 20 7.9654e-2 210 -252 420 -440 800 -810 imp:n=1 $ north roof
1463 20 7.9654e-2 210 -252 397 -420 800 -810 imp:n=1 $ north roof
c
c drum areas
c
1500 40 -0.375 1050 -1060 550 -1030 810 -820 imp:n=1 $ Drum area A
1510 40 -0.375 1070 -190 550 -1030 810 -820 imp:n=1 $ Drum area B
1520 40 -0.375 1080 -220 595 -1030 810 -820 imp:n=1 $ Drum area C
1522 40 -0.375 1080 -220 580 -595 810 -820 imp:n=1 $ Drum area C
1524 40 -0.375 1080 -220 560 -580 810 -820 imp:n=1 $ Drum area C
1526 40 -0.375 1080 -220 1020 -560 810 -820 imp:n=1 $ Drum area C
1530 40 -0.375 1090 -230 595 -1030 810 -820 imp:n=1 $ Drum area D
1532 40 -0.375 1090 -230 580 -595 810 -820 imp:n=1 $ Drum area D
1534 40 -0.375 1090 -230 560 -580 810 -820 imp:n=1 $ Drum area D
1536 40 -0.375 1090 -230 550 -560 810 -820 imp:n=1 $ Drum area D
1540 40 -0.375 220 -1090 510 -520 810 -820 imp:n=1 $ Drum area E
1542 40 -0.375 220 -1090 1000 -510 810 -820 imp:n=1 $ Drum area E
1550 40 -0.375 210 -1080 530 -1010 810 -820 imp:n=1 $ Drum area F
1552 40 -0.375 210 -1080 510 -530 810 -820 imp:n=1 $ Drum area F
1554 40 -0.375 210 -1080 1000 -510 810 -820 imp:n=1 $ Drum area F
1560 40 -0.375 1100 -1110 1030 -1040 810 -820 imp:n=1 $ Drum area G
1561 40 -0.375 1100 -1110 595 -1030 810 -820 imp:n=1 $ Drum area G
1562 40 -0.375 1100 -1110 580 -595 810 -820 imp:n=1 $ Drum area G
1563 40 -0.375 1100 -1110 560 -580 810 -820 imp:n=1 $ Drum area G
1564 40 -0.375 1100 -1110 1020 -560 810 -820 imp:n=1 $ Drum area G
1565 40 -0.375 1100 -1110 530 -1020 810 -820 imp:n=1 $ Drum area G
1566 40 -0.375 1100 -1110 510 -530 810 -820 imp:n=1 $ Drum area G
1567 40 -0.375 1100 -1110 1000 -510 810 -820 imp:n=1 $ Drum area G
1568 40 -0.375 1100 -1110 480 -1000 810 -820 imp:n=1 $ Drum area G
1569 40 -0.375 1100 -1110 450 -480 810 -820 imp:n=1 $ Drum area G
1570 40 -0.375 1100 -1110 440 -450 810 -820 imp:n=1 $ Drum area G
c
1600 0 (-1:-397:252:611:880) -9998 810 imp:n=1 $ air outside building
c
c air in building
c
1700 0 (-10:15:-520:531:830)
(-53:54:-520:531:830)
(-20:41:-410:461:840)
(-41:51:-430:461:840)
(-55:56:-520:531:830)
(-60:81:-470:521:840)
(-70:81:-521:531:840)
(-85:88:-520:531:830)
(2 -90 398 -610 810 -850) 4040 4030 imp:n=1 fill=1 $ air 1
(-90:101:-500:511:840)
(-100:105:-520:531:830)
(-120:151:-410:501:840)
(-145:150:-520:531:830)
(-153:154:-520:531:830)
(-110:131:-540:601:840)
(90 -155 398 -610 810 -850) 4020 imp:n=1 fill=1 $ air 2

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1720 0          (-155:156:-520:531:830)
          (-160:181:-470:531:840)
          (-185:188:-520:531:830)
          (-1050:1060:-550:1030:820)
          (-1070:190:-550:1030:820)
          (-190:201:-400:451:840)
          (-195:200:-520:531:830)
          (155 -210 398 -610 810 -850) 4010 imp:n=1 fill=1 $ air 3
c 1730 10 4.354e-5 (-210:1080:-1000:1010:820)
c          (-1080:220:-1020:1030:820)
c          (-220:1090:-1000:520:820)
c          (-1090:230:-550:1030:820)
c          (-210:231:-420:491:840)
c          (-235:240:-520:531:830)
c          (-1100:1110:-440:1040:820)
c          (-240:401:840)
c          (210 -251 398 -610 810 -850) 4000 imp:n=1 $ air 4
1730 0          (-1100:1110:-440:1040:820)
          (210 -251 1030 -610 810 -850) imp:n=1 fill=1 $ air 4
1731 0          (-1080:220:-1020:1030:820)
          (-1090:230:-550:1030:820)
          (-1100:1110:-440:1040:820)
          (210 -251 595 -1030 810 -850) imp:n=1 fill=1 $ air 4
1732 0          (-1080:220:-1020:1030:820)
          (-1090:230:-550:1030:820)
          (-1100:1110:-440:1040:820)
          (210 -251 580 -595 810 -850) imp:n=1 fill=1 $ air 4
1733 0          (-1080:220:-1020:1030:820)
          (-1090:230:-550:1030:820)
          (-1100:1110:-440:1040:820)
          (210 -251 560 -580 810 -850) imp:n=1 fill=1 $ air 4
1734 0          (-1080:220:-1020:1030:820)
          (-1090:230:-550:1030:820)
          (-1100:1110:-440:1040:820)
          (210 -251 1020 -560 810 -850) imp:n=1 fill=1 $ air 4
1735 0          (-210:1080:-1000:1010:820)
          (-235:240:-520:531:830)
          (-1100:1110:-440:1040:820)
          (210 -251 530 -1020 810 -850) imp:n=1 fill=1 $ air 4
1736 0          (-210:1080:-1000:1010:820)
          (-235:240:-520:531:830)
          (-220:1090:-1000:520:820)
          (-1100:1110:-440:1040:820)
          (210 -251 510 -530 810 -850) imp:n=1 fill=1 $ air 4
1737 0          (-210:1080:-1000:1010:820)
          (-220:1090:-1000:520:820)
          (-1100:1110:-440:1040:820)
          (210 -251 1000 -510 810 -850) imp:n=1 fill=1 $ air 4
1738 0          (-210:231:-420:491:840)
          (-1100:1110:-440:1040:820)
          (210 -251 480 -1000 810 -850) imp:n=1 fill=1 $ air 4
1739 0          (-210:231:-420:491:840)
          (-1100:1110:-440:1040:820)
          (210 -251 450 -480 810 -850) imp:n=1 fill=1 $ air 4
1740 0          (-210:231:-420:491:840)
          (-1100:1110:-440:1040:820)
          (210 -251 440 -450 810 -850) imp:n=1 fill=1 $ air 4
1741 0          (-210:231:-420:491:840)
          (210 -251 420 -440 810 -850) imp:n=1 fill=1 $ air 4
1742 0          (-240:401:840)
          (210 -251 398 -420 810 -850) 4000 imp:n=1 fill=1 $ air 4
c
c
c repeating structures cells
c
1800 30 8.7411e-2 (2000 -2010 2040 -2070):
          (2010 -2020 2050 -2060):

```

---

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```

(2020 -2030 2040 -2070) u=2 imp:n=1 $ I beam
1810 10 4.354e-5 (2010 -2020 2040 -2050):
(2010 -2020 2060 -2070):
(-2000:2030:-2040:2070) u=2 imp:n=1 $ air around I beam
1820 0 -3010 3000 -3030 3020 -3050 3040 .
u=1 lat=1 imp:n=1 fill=0:99 0:40 0:0
2 4099r $ lattice of cells
c
c detector cells
c
1900 10 4.354e-5 -4000 imp:n=1 $ det. col. 87-DD
1910 10 4.354e-5 -4010 imp:n=1 $ det. col. 65-Q
1920 10 4.354e-5 -4020 imp:n=1 $ det. col. 40-AA
1930 10 4.354e-5 -4030 imp:n=1 $ det. col. 30-S
1940 10 4.354e-5 -4040 imp:n=1 $ det. col. 7-AA
c
c internal and external world
c
2000 0 (9998 -9999):(-9998 -800) imp:n=1 $ internal world
2010 0 9999 imp:n=0 $ external world
c
c second story stuff
c
3000 10 4.354e-5 (2 -251 398 -610 5610 -870)
4050 4060 4070 4080 4090 4100
4110 4120 4130 4140 4150
4160 imp:n=1 $ 2ndstory air
3005 10 4.354e-5 (2 -5560 5580 -5590 860 -5610):
(2 -251 5590 -610 860 -5610):
(5570 -251 5580 -5590 860 -5610):
(2 -251 398 -5580 860 -5610) imp:n=1 $airaround
3010 80 9.0726e-2 1 -252 397 -611 870 -880 imp:n=1 $ roof
c
3500 10 4.354e-5 -4050 imp:n=1 $ det col 6-BB
3510 10 4.354e-5 -4060 imp:n=1 $ det col 6-F
3520 10 4.354e-5 -4070 imp:n=1 $ det col 22-BB
3530 10 4.354e-5 -4080 imp:n=1 $ det col 22-F
3540 10 4.354e-5 -4090 imp:n=1 $ det col 38-BB
3550 10 4.354e-5 -4100 imp:n=1 $ det col 38-F
3560 10 4.354e-5 -4110 imp:n=1 $ det col 54-BB
3570 10 4.354e-5 -4120 imp:n=1 $ det col 54-F
3580 10 4.354e-5 -4130 imp:n=1 $ det col 70-BB
3590 10 4.354e-5 -4140 imp:n=1 $ det col 70-F
3600 10 4.354e-5 -4150 imp:n=1 $ det col 86-BB
3610 10 4.354e-5 -4160 imp:n=1 $ det col 86-F
c
c
c repeating structure cells for second floor
c
4000 90 1.6021E-3 5010 -5020 5130 -5140 imp:n=1 u=7 $
4010 90 1.6021E-3 5010 -5020 5110 -5120 imp:n=1 u=7 $
4020 90 1.6021E-3 5030 -5040 5130 -5140 imp:n=1 u=7 $
4030 90 1.6021E-3 5030 -5040 5110 -5120 imp:n=1 u=7 $
4080 10 4.354e-5 (4990 -5060 5090 -5160)
(-5010:5020:-5130:5140)
(-5010:5020:-5110:5120)
(-5030:5040:-5130:5140)
(-5030:5040:-5110:5120) imp:n=1 u=7 $
4100 0 -5050 5000 -5150 5100 -5410 5400
u=6 lat=1 imp:n=1 fill=0:0 0:5 0:0
7 5r
4200 0 -5510 5500 -5530 5520 -5550 5540
u=5 lat=1 imp:n=1 fill=0:11 0:0 0:0
6 4r 3 4r 6 6
c
4300 0 5560 -5570 5580 -5590 860 -5610

```

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```

fill=5 imp:n=1                $ process cells
c
4400 90 1.6021E-3 5210 -5220 5330 -5340 imp:n=1 u=4 $
4410 90 1.6021E-3 5230 -5240 5330 -5340 imp:n=1 u=4 $
4420 90 1.6021E-3 5210 -5220 5310 -5320 imp:n=1 u=4 $
4430 90 1.6021E-3 5230 -5240 5310 -5320 imp:n=1 u=4 $
4440 10 4.354e-5 (-5210:5220:-5330:5340)
                (-5230:5240:-5330:5340)
                (-5210:5220:-5310:5320)
                (-5230:5240:-5310:5320) imp:n=1 u=4 $
4500 0          -5660 5650 -5680 5670 -5700 5690
                u=3 lat=1 imp:n=1 fill=0:0 0:5 0:0
                4 5r

```

```

c
c *****
c surface cards
c *****
c

```

```

1 px 0 $
2 px 0.191 $
10 px 1752 $
15 px 2134 $
20 px 4450 $
21 px 4470 $
30 px 5212 $
31 px 5232 $
40 px 6584 $
41 px 6604 $
50 px 7346 $
51 px 7366 $
53 px 7498 $
54 px 8108 $
55 px 13472 $
56 px 14082 $
60 px 16398 $
61 px 16418 $
70 px 17160 $
71 px 17180 $
80 px 17922 $
81 px 17942 $
85 px 19446 $
88 px 20056 $
90 px 24506 $
91 px 24526 $
100 px 25400 $
101 px 25420 $
105 px 26030 $
110 px 28346 $
111 px 28366 $
120 px 29108 $
121 px 29128 $
130 px 29870 $
131 px 29890 $
140 px 31242 $
141 px 31262 $
145 px 31394 $
150 px 32004 $
151 px 32024 $
153 px 37368 $
154 px 37978 $
155 px 43343 $
156 px 43953 $
160 px 46269 $
161 px 46289 $
170 px 47031 $
171 px 47051 $

```

---

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180	px	47793	\$	
181	px	47813	\$	
185	px	49317	\$	
188	px	49927	\$	
190	px	54376	\$	
191	px	54396	\$	
195	px	55290	\$	
200	px	55900	\$	
201	px	55920	\$	
210	px	58217	\$	
211	px	58237	\$	
220	px	59741	\$	
c	221	px 59761	\$	\$
230	px	61112	\$	
231	px	61132	\$	
235	px	61264	\$	
240	px	61874	\$	
241	px	61894	\$	
250	px	66304	\$	
251	px	66324	\$	
252	px	66324.191	\$	
397	py	0	\$	
398	py	0.191	\$	
399	py	20	\$	
400	py	1280	\$	
401	py	1300	\$	
410	py	2012	\$	
411	py	2032	\$	
420	py	2682	\$	
421	py	2702	\$	
430	py	3353	\$	
431	py	3373	\$	
440	py	4023	\$	
441	py	4043	\$	
450	py	5364	\$	
451	py	5384	\$	
460	py	5700	\$	
461	py	5720	\$	
470	py	6035	\$	
471	py	6055	\$	
480	py	6706	\$	
481	py	6726	\$	
490	py	7376	\$	
491	py	7396	\$	
500	py	8717	\$	
501	py	8737	\$	
510	py	9388	\$	
511	py	9408	\$	
520	py	10058	\$	
521	py	10078	\$	
530	py	10729	\$	
531	py	10749	\$	
540	py	12405	\$	
541	py	12425	\$	
550	py	12741	\$	
c	551	py 12761	\$	\$
560	py	13411	\$	
561	py	13431	\$	
570	py	14082	\$	
571	py	14102	\$	
580	py	14752	\$	
c	581	py 14772	\$	\$
590	py	15423	\$	
591	py	15443	\$	
595	py	16093	\$	
600	py	16764	\$	
601	py	16784	\$	

---

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---

610 py 19507 \$  
 611 py 19507.191 \$  
 800 pz -3000 \$  
 810 pz 0 \$  
 820 pz 197 \$ top of drums  
 830 pz 305 \$ top of rooms  
 840 pz 305.09 \$ top of roof on rooms  
 850 pz 665.48 \$ bottom of proc cell floor  
 860 pz 685.8 \$ top of process cell floor  
 870 pz 2010.57 \$ bottom of roof  
 880 pz 2020.57 \$ top of roof

c  
 c here are drum area surfaces

c  
 1000 py 8046 \$  
 1010 py 11400 \$  
 1020 py 12070 \$  
 1030 py 17435 \$  
 1040 py 18105 \$  
 1050 px 52242 \$  
 1060 px 53004 \$  
 1070 px 53766 \$  
 1080 px 58979 \$  
 1090 px 60351 \$  
 1100 px 64190 \$  
 1110 px 65714 \$

c  
 c repeating structures surfaces

c  
 2000 px -0.01 \$  
 2010 px 0.847 \$  
 2020 px 29.633 \$  
 2030 px 30.48 \$  
 2040 py -0.01 \$  
 2050 py 7.1965 \$  
 2060 py 8.0435 \$  
 2070 py 15.24 \$  
 3000 px -0.001 \$  
 3010 px 745.22 \$  
 3020 py -0.001 \$  
 3030 py 629.26 \$  
 3040 pz -0.01 \$  
 3050 pz 666 \$

c  
 c detector planes

c  
 4000 s 64190 1351 100 50 \$ det. col. 87-DD  
 4010 s 47864 10058 100 50 \$ det. col. 65-Q  
 4020 s 29057 3353 100 50 \$ det. col. 40-AA  
 4030 s 21610 8717 100 50 \$ det. col. 30-S  
 4040 s 4399 3353 100 50 \$ det. col. 7-AA  
 4050 s 3688.1 2682 1185.8 50 \$ det. 6-BB cell floor  
 4060 s 3688.1 16093 1185.8 50 \$ det. 6-F cell floor  
 4070 s 15636.24 2682 1185.8 50 \$ det. 22-BB cell floor  
 4080 s 15636.24 16093 1185.8 50 \$ det. 22-F cell floor  
 4090 s 27584.4 2682 1185.8 50 \$ det. 38-BB cell floor  
 4100 s 27584.4 16093 1185.8 50 \$ det. 38-F cell floor  
 4110 s 39532.56 2682 1185.8 50 \$ det. 54-BB cell floor  
 4120 s 39532.56 16093 1185.8 50 \$ det. 54-F cell floor  
 4130 s 51480.72 2682 1185.8 50 \$ det. 70-BB cell floor  
 4140 s 51480.72 16093 1185.8 50 \$ det. 70-F cell floor  
 4150 s 63428.88 2682 1185.8 50 \$ det. 86-BB cell floor  
 4160 s 63428.88 16093 1185.8 50 \$ det. 86-F cell floor

c  
 c  
 c surfaces for repeating structures on 2nd floor  
 c

---

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---

```

4990 px 609.55 $
5000 px 609.57 $
5010 px 670.6 $
5020 px 2834.6 $
5030 px 3748.6 $
5040 px 5912.6 $
5050 px 6583.63 $
5060 px 6583.65 $
5090 py 2011.63 $
5100 py 2011.65 $
5110 py 2245.68 $
5120 py 3499.68 $
5130 py 3749.68 $
5140 py 5130.68 $
5150 py 5364.71 $
5160 py 5364.74 $
c 5200 px 609.61 $
5210 px 675.6 $
5220 px 2834.61 $
5230 px 3754.6 $
5240 px 5913.6 $
c 5250 px 6583.61 $
c 5300 py 2011.69 $
5310 py 2169.18 $
5320 py 3560.68 $
5330 py 3814.68 $
5340 py 5206.68 $
c 5350 py 5364.69 $
c 5390 pz 685.74 $
5400 pz 685.77 $
5410 pz 1025.84 $
c 5420 pz 1025.87 $
c
5500 px 609.58 $
5510 px 6583.62 $
5520 py 2011.66 $
5530 py 18776.9 $
5540 pz 685.78 $
5550 pz 1025.83 $
c
5560 px 609.59 $
5570 px 66320 $
5580 py 2011.67 $
5590 py 18776.89 $
c 5600 pz 685.79 $
5610 pz 1025.82 $
c
5650 px 609.56 $
5660 px 6583.64 $
5670 py 2011.64 $
5680 py 5364.72 $
5690 pz 685.76 $
5700 pz 1025.85 $
c
c internal & external world planes
c
9998 so 80000 $ internal world
9999 so 1000000 $ external world

c *****
c
c source term
c
c *****
c
c sdef sur=9998 nrm=-1 dir=d1
c sbl -21 2

```

---

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---

```

c
sdef pos=66323 19506 1 erg=d1 vec=-2894.12 -3413 1184.8 dir=d2
sc1 from h/u=15 5% enrichment normalized to 2881 W
sil h 1.00e-11 1.00e-8 3.00e-8 5.00e-8 1.00e-7 2.25e-7
      3.25e-7 4.00e-7 8.00e-7 1.00e-6 1.13e-6 1.3e-6
      1.77e-6 3.05e-6 1.00e-5 3.00e-5 1.00e-4 5.5e-4
      0.003 0.017 0.1 0.4 0.9 1.4
      1.85 3.0 6.43 20
spl d 0 1.46e+2 8.00e+2 9.71e+2 1.50e+3 1.04e+3
      3.00e+2 1.62e+2 5.54e+2 1.74e+2 8.59e+1 1.04e+2
      2.53e+2 4.73e+2 9.48e+2 1.03e+3 1.18e+3 1.68e+3
      1.82e+3 2.18e+3 2.96e+3 4.36e+3 5.07e+3 3.40e+3
      2.72e+3 5.56e+3 4.90e+3 6.11e+2

```

```

c
sc2 these are angles for source
si2 h -1 0.9848 1
sp2 d 0 0.9924 0.0076
sb2 d 0 0.1 0.9

```

```

c
c *****
c

```

material cards

```

c *****
c

```

```

m10 7014.50c 3.570e-5
      8016.50c 7.840e-6 $ air
m20 1001.50c 1.487e-2
      6012.50c 3.814e-3
      8016.50c 4.152e-2
      11023.50c 3.040e-4
      12000.51c 5.870e-4
      13027.50c 7.350e-4
      14000.50c 6.037e-3
      20000.51c 1.159e-2
      26000.50c 1.968e-4 $ concrete
m30 6012.50c 3.921e-3
      26000.50c 8.349e-2 $ steel
m40 6012.50c 6.0
      1001.50c 10.0
      8016.50c 5.0 $ wood
c m60 92238.50c 8.682e-3
c 9019.50c 5.209e-2 $ UF6
m70 1001.50c 2.0
      8016.50c 1.5 $ water
m80 1001.50c 4.288e-2
      6012.50c 1.812e-2
      8016.50c 1.896e-3
      26000.50c 2.783e-2 $ roof
m90 6012.50c 6.230e-5
      9019.50c 8.880e-5
      13027.50c 8.420e-5
      14000.50c 1.666e-5
      17000.50c 8.880e-5
      24000.50c 1.619e-4
      25055.51c 1.703e-5
      26000.50c 5.934e-4
      28000.50c 4.563e-4
      29000.50c 3.273e-5 $ homogenized cell material

```

```

c
c *****
c

```

tally cards

```

c *****
c

```

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```

c
fc4      track det 1. on col 87-DD
f4:n     1900
fc14     track det 2 on col. 65-Q
f14:n    1910
fc24     track det 3 on col. 40-AA
f24:n    1920
fc34     track det 4 on col. 30-S
f34:n    1930
fc44     track det 5 on col. 7-AA
f44:n    1940
fc54     track det 6 on col 6-BB 2 story
f54:n    3500
fc64     track det 6 on col 6-F 2 story
f64:n    3510
fc74     track det 6 on col 22-BB 2 story
f74:n    3520
fc84     track det 6 on col 22-F 2 story
f84:n    3530
fc94     track det 6 on col 38-BB 2 story
f94:n    3540
fc104    track det 6 on col 38-F 2 story
f104:n   3550
fc114    track det 6 on col 54-BB 2 story
f114:n   3560
fc124    track det 6 on col 54-F 2 story
f124:n   3570
fc134    track det 6 on col 70-BB 2 story
f134:n   3580
fc144    track det 6 on col 70-F 2 story
f144:n   3590
fc154    track det 6 on col 86-BB 2 story
f154:n   3600
fc164    track det 6 on col 86-F 2 story
f164:n   3610
c
c
c fc5     point det 1. on col 87-DD
c f5:n    64190 1351 100 49
c
c
c fc15    point det 2 on col. 65-Q
c f15:n   47864 10058 100 50
c f25c    point det 3 on col. 40-AA
c f25:n   29057 3353 100 50
c f35c    point det 4 on col. 30-S
c f35:n   21610 8717 100 50
c f45c    point det 5 on col. 7-AA
c f45:n   4399 3353 100 50
c e0      1.00e-11 1.00e-8 3.00e-8 5.00e-8 1.00e-7 2.25e-7
c         3.25e-7 4.00e-7 8.00e-7 1.00e-6 1.13e-6 1.3e-6
c         1.77e-6 3.05e-6 1.00e-5 3.00e-5 1.00e-4 5.5e-4
c         0.003 0.017 0.1 0.4 0.9 1.4
c         1.85 3.0 6.43 20
c
c em0     0.0 6.03e-17 2.46e-16 3.69e-16 6.52e-16 1.40e-15
c         2.54e-15 3.37e-15 5.39e-15 8.37e-15 9.93e-15 1.13e-14
c         1.42e-14 2.20e-14 5.46e-14 1.70e-13 5.43e-13 2.46e-12
c         1.35e-11 7.20e-11 3.12e-10 1.08e-9 1.79e-9 2.44e-9
c         2.79e-9 3.22e-9 4.18e-9 4.72e-9
c
c
c New Response Function
c *****
c
dE0      1.00E-09 1.00E-08 1.00E-07 5.00E-07
         1.00E-06 5.00E-06 1.00E-05 5.00E-05

```

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1.00E-04	5.00E-04	1.00E-03	5.00E-03
1.00E-02	2.00E-02	5.00E-02	1.00E-01
5.00E-01	1	2	5
10	20		

c  
c  
c  
c  
c

dF0	0.456683643	0.612833708	1.202405686	1.907520827
	2.170074239	2.524934685	2.619466509	2.665319206
	2.525689936	2.568979899	2.526120045	2.429598966
	2.361915675	2.254370492	2.239813349	2.236561929
	1.912907431	1.575113097	1.131268722	0.548312231
	0.248252542	0.142345613		

c  
c  
c  
c  
c  
c

\*\*\*\*\*  
peripheral cards  
\*\*\*\*\*

mode n  
c 17 keV cut off  
c cut:n j 0.017  
c ptrac file=asc max=50000  
ctme 900  
c void  
c nps 90000000  
prtmp 3j 4  
c dbcn 12j 30000000  
print

Listing A.3

Input for X-326

The model includes only the operating floor for X-326.

```

This is a model of the first floor of the x326 process building
c
c *****
c cell cards
c *****
c
c air in rooms
c
5 10 4.354e-5 15 -30 797 -798 820 -840 900 imp:n=1 $
10 10 4.354e-5 62 -80 752 -760 820 -840 imp:n=1 $
20 10 4.354e-5 (62 -80 722 -750 820 -840):
(62 -70 702 -722 820 -840) imp:n=1 $
30 10 4.354e-5 72 -80 702 -720 820 -840 imp:n=1 $
40 10 4.354e-5 202 -210 732 -740 820 -840 imp:n=1 $
50 10 4.354e-5 212 -220 732 -740 820 -840 imp:n=1 $
55 10 4.354e-5 222 -230 732 -740 820 -840 imp:n=1 $
60 10 4.354e-5 202 -240 722 -730 820 -840 imp:n=1 $
70 10 4.354e-5 202 -240 692 -720 820 -840 imp:n=1 $
80 10 4.354e-5 202 -240 682 -690 820 -840 imp:n=1 $
90 10 4.354e-5 272 -290 752 -760 820 -840 imp:n=1 $
100 10 4.354e-5 (272 -290 722 -750 820 -840):
(272 -280 702 -722 820 -840) imp:n=1 $
110 10 4.354e-5 282 -290 702 -720 820 -840 imp:n=1 $
120 10 4.354e-5 (342 -350 782 -790 820 -840 950):
(350 -352 785 -790 820 -840) imp:n=1
125 10 4.354e-5 (352 -360 782 -790 835 -840) imp:n=1 $
126 10 4.354e-5 (352 -360 782 -790 820 -835 1010) imp:n=1 $
130 10 4.354e-5 342 -350 772 -780 820 -840 imp:n=1 $
140 10 4.354e-5 (352 -362 772 -780 820 -840):
(362 -370 772 -790 820 -840) imp:n=1 $
150 10 4.354e-5 402 -430 752 -760 820 -840 imp:n=1 $
160 10 4.354e-5 (402 -430 722 -750 820 -840):
(402 -420 702 -722 820 -840):
(402 -410 692 -702 820 -840) imp:n=1 $
170 10 4.354e-5 422 -430 702 -720 820 -840 imp:n=1 $
180 10 4.354e-5 (472 -490 642 -650 820 -840):
(482 -490 650 -660 820 -840) imp:n=1 $
190 10 4.354e-5 492 -500 642 -670 820 -840 imp:n=1 $
200 10 4.354e-5 472 -480 632 -640 820 -840 imp:n=1 $
210 10 4.354e-5 482 -500 632 -640 820 -840 940 imp:n=1 $
220 10 4.354e-5 462 -470 622 -630 820 -840 imp:n=1 $
230 10 4.354e-5 (462 -470 602 -620 820 -840):
(470 -472 612 -620 820 -840):
(472 -490 612 -630 820 -840) imp:n=1 $
240 10 4.354e-5 (472 -500 602 -610 820 -840):
(492 -500 610 -630 820 -840) imp:n=1 $
c
c battery rooms
c
250 70 -1.0 20 -30 710 -720 820 -850 imp:n=1 $ battery room
260 70 -1.0 40 -50 710 -720 820 -850 imp:n=1 $ battery room
270 70 -1.0 90 -100 710 -720 820 -850 imp:n=1 $ battery room
280 70 -1.0 160 -170 710 -720 820 -850 imp:n=1 $ battery room
290 70 -1.0 180 -190 710 -720 820 -850 imp:n=1 $ battery room
300 70 -1.0 250 -260 710 -720 820 -850 imp:n=1 $ battery room
310 70 -1.0 300 -310 710 -720 820 -850 imp:n=1 $ battery room
320 70 -1.0 320 -330 710 -720 820 -850 imp:n=1 $ battery room

```

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Examination of Criticality Accident Alarm Coverage on the Operating Floors  
of Buildings X-333, X-330, and X-326 at the  
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330	70	-1.0	380	-390	710	-720	820	-850	imp:n=1	\$ battery room
340	70	-1.0	440	-450	710	-720	820	-850	imp:n=1	\$ battery room
c										
c			here are the PCB storage lots							
c										
350	40	-0.375	120	-130	680	-760	820	-830	imp:n=1	\$
360	40	-0.375	(120 -130 765 -783 820 -830):							
			(130 -150 770 -783 820 -830) imp:n=1 \$							
370	40	-0.375	110	-140	790	-795	820	-830	imp:n=1	\$
c										
c			here are the concrete walls							
c										
380	20	3.9827e-2	14	-15	797	-798	820	-840	imp:n=1	\$
385	20	3.9827e-2	14	-32	798	-800	820	-840	imp:n=1	\$
390	20	3.9827e-2	30	-32	797	-798	820	-840	imp:n=1	\$
395	20	3.9827e-2	14	-32	795	-797	820	-840	imp:n=1	\$
400	20	3.9827e-2	60	-82	760	-762	820	-840	imp:n=1	\$
410	20	3.9827e-2	60	-82	750	-752	820	-840	imp:n=1	\$
420	20	3.9827e-2	70	-82	720	-722	820	-840	imp:n=1	\$
430	20	3.9827e-2	60	-82	700	-702	820	-840	imp:n=1	\$
440	20	3.9827e-2	60	-62	702	-750	820	-840	imp:n=1	\$
450	20	3.9827e-2	60	-62	752	-760	820	-840	imp:n=1	\$
460	20	3.9827e-2	80	-82	752	-760	820	-840	imp:n=1	\$
470	20	3.9827e-2	80	-82	722	-750	820	-840	imp:n=1	\$
480	20	3.9827e-2	80	-82	702	-720	820	-840	imp:n=1	\$
490	20	3.9827e-2	70	-72	702	-720	820	-840	imp:n=1	\$
500	20	3.9827e-2	200	-232	740	-742	820	-840	imp:n=1	\$
510	20	3.9827e-2	200	-242	730	-732	820	-840	imp:n=1	\$
520	20	3.9827e-2	200	-242	720	-722	820	-840	imp:n=1	\$
530	20	3.9827e-2	200	-242	690	-692	820	-840	imp:n=1	\$
540	20	3.9827e-2	200	-242	680	-682	820	-840	imp:n=1	\$
550	20	3.9827e-2	200	-202	682	-690	820	-840	imp:n=1	\$
560	20	3.9827e-2	200	-202	692	-720	820	-840	imp:n=1	\$
570	20	3.9827e-2	200	-202	722	-730	820	-840	imp:n=1	\$
580	20	3.9827e-2	200	-202	732	-740	820	-840	imp:n=1	\$
590	20	3.9827e-2	210	-212	732	-740	820	-840	imp:n=1	\$
600	20	3.9827e-2	220	-222	732	-740	820	-840	imp:n=1	\$
610	20	3.9827e-2	230	-232	732	-740	820	-840	imp:n=1	\$
620	20	3.9827e-2	240	-242	722	-730	820	-840	imp:n=1	\$
630	20	3.9827e-2	240	-242	692	-720	820	-840	imp:n=1	\$
640	20	3.9827e-2	240	-242	682	-690	820	-840	imp:n=1	\$
650	20	3.9827e-2	270	-292	760	-762	820	-840	imp:n=1	\$
660	20	3.9827e-2	270	-292	750	-752	820	-840	imp:n=1	\$
670	20	3.9827e-2	280	-292	720	-722	820	-840	imp:n=1	\$
680	20	3.9827e-2	270	-292	700	-702	820	-840	imp:n=1	\$
690	20	3.9827e-2	270	-272	752	-760	820	-840	imp:n=1	\$
700	20	3.9827e-2	290	-292	752	-760	820	-840	imp:n=1	\$
710	20	3.9827e-2	290	-292	722	-750	820	-840	imp:n=1	\$
720	20	3.9827e-2	290	-292	702	-720	820	-840	imp:n=1	\$
730	20	3.9827e-2	280	-282	702	-720	820	-840	imp:n=1	\$
740	20	3.9827e-2	270	-272	702	-750	820	-840	imp:n=1	\$
750	20	3.9827e-2	340	-372	790	-792	820	-840	imp:n=1	\$
760	20	3.9827e-2	340	-362	780	-782	820	-840	imp:n=1	\$
770	20	3.9827e-2	340	-372	770	-772	820	-840	imp:n=1	\$
780	20	3.9827e-2	340	-342	782	-790	820	-840	imp:n=1	\$
790	20	3.9827e-2	350	-352	782	-785	820	-840	imp:n=1	\$
800	20	3.9827e-2	360	-362	782	-790	820	-840	imp:n=1	\$
810	20	3.9827e-2	370	-372	772	-790	820	-840	imp:n=1	\$
820	20	3.9827e-2	350	-352	772	-780	820	-840	imp:n=1	\$
830	20	3.9827e-2	340	-342	772	-780	820	-840	imp:n=1	\$
840	20	3.9827e-2	400	-432	760	-762	820	-840	imp:n=1	\$
850	20	3.9827e-2	400	-432	750	-752	820	-840	imp:n=1	\$
860	20	3.9827e-2	420	-432	720	-722	820	-840	imp:n=1	\$
870	20	3.9827e-2	410	-432	700	-702	820	-840	imp:n=1	\$
880	20	3.9827e-2	400	-412	690	-692	820	-840	imp:n=1	\$
890	20	3.9827e-2	400	-402	752	-760	820	-840	imp:n=1	\$
900	20	3.9827e-2	430	-432	752	-760	820	-840	imp:n=1	\$

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910 20 3.9827e-2 430 -432 722 -750 820 -840 imp:n=1 \$  
 920 20 3.9827e-2 430 -432 702 -720 820 -840 imp:n=1 \$  
 930 20 3.9827e-2 420 -422 702 -720 820 -840 imp:n=1 \$  
 940 20 3.9827e-2 410 -412 692 -700 820 -840 imp:n=1 \$  
 950 20 3.9827e-2 400 -402 692 -750 820 -840 imp:n=1 \$  
 960 20 7.9654e-2 490 -502 670 -672 820 -840 imp:n=1 \$  
 970 20 7.9654e-2 480 -492 660 -662 820 -840 imp:n=1 \$  
 980 20 7.9654e-2 470 -482 650 -652 820 -840 imp:n=1 \$  
 990 20 7.9654e-2 470 -502 640 -642 820 -840 imp:n=1 \$  
 1000 20 7.9654e-2 460 -502 630 -632 820 -840 imp:n=1 \$  
 1010 20 7.9654e-2 460 -472 620 -622 820 -840 imp:n=1 \$  
 1020 20 7.9654e-2 470 -492 610 -612 820 -840 imp:n=1 \$  
 1030 20 7.9654e-2 460 -502 600 -602 820 -840 imp:n=1 \$  
 1040 20 7.9654e-2 490 -492 662 -670 820 -840 imp:n=1 \$  
 1050 20 7.9654e-2 500 -502 642 -670 820 -840 imp:n=1 \$  
 1060 20 7.9654e-2 500 -502 632 -640 820 -840 imp:n=1 \$  
 1070 20 7.9654e-2 500 -502 602 -630 820 -840 imp:n=1 \$  
 1080 20 7.9654e-2 460 -462 602 -620 820 -840 imp:n=1 \$  
 1090 20 7.9654e-2 460 -462 622 -630 820 -840 imp:n=1 \$  
 1100 20 7.9654e-2 470 -472 632 -640 820 -840 imp:n=1 \$  
 1110 20 7.9654e-2 470 -472 642 -650 820 -840 imp:n=1 \$  
 1120 20 7.9654e-2 480 -482 652 -660 820 -840 imp:n=1 \$  
 1130 20 7.9654e-2 490 -492 642 -660 820 -840 imp:n=1 \$  
 1140 20 7.9654e-2 480 -482 632 -640 820 -840 imp:n=1 \$  
 1150 20 7.9654e-2 470 -472 622 -630 820 -840 imp:n=1 \$  
 1160 20 7.9654e-2 490 -492 612 -630 820 -840 imp:n=1 \$  
 1170 20 7.9654e-2 470 -472 602 -610 820 -840 imp:n=1 \$

c

c here are the room roofs

c

1200 30 8.7411e-2 60 -82 700 -762 840 -850 imp:n=1 \$  
 1205 30 8.7411e-2 14 -32 795 -800 840 -850 imp:n=1 \$  
 1210 30 8.7411e-2 (200 -232 732 -742 840 -850):  
 (200 -242 680 -732 840 -850) imp:n=1 \$  
 1220 30 8.7411e-2 270 -292 700 -762 840 -850 imp:n=1 \$  
 1230 30 8.7411e-2 340 -372 770 -792 840 -850 imp:n=1 \$  
 1240 30 8.7411e-2 (400 -432 700 -762 840 -850):  
 (400 -412 690 -700 840 -850) imp:n=1 \$  
 1250 30 8.7411e-2 (490 -502 662 -672 840 -850):  
 (480 -502 652 -662 840 -850):  
 (470 -502 632 -652 840 -850):  
 (460 -502 600 -632 840 -850) imp:n=1 \$

c

c sheet metal walls

c

1300 30 8.7411e-2 10 -504 598 -600 820 -870 imp:n=1 \$  
 1310 30 8.7411e-2 10 -12 600 -800 820 -870 imp:n=1 \$  
 1320 30 8.7411e-2 10 -504 800 -802 820 -870 imp:n=1 \$  
 1330 30 8.7411e-2 502 -504 600 -800 820 -870 imp:n=1 \$

c

c air inside building

c

1350 0 ((12 -110 600 -800 820 -860)  
 (-20:30:-710:720:-820:850)  
 (-40:50:-710:720:-820:850)  
 (-90:100:-710:720:-820:850)  
 (-60:82:-700:762:-820:850)  
 (-14:32:-795:800:-820:850)) 910  
 fill=1 imp:n=1 \$ air 1  
 1360 0 (110 -190 600 -800 820 -860)  
 (-120:130:-680:760:-820:830)  
 (-120:130:-765:783:-820:830)  
 (-130:150:-770:783:-820:830)  
 (-110:140:-790:795:-820:830)  
 (-160:170:-710:720:-820:850)  
 (-180:190:-710:720:-820:850)  
 fill=1 imp:n=1 \$ air 2

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```

1370 0      ((190 -310 600 -800 820 -860)
(-200:242:-680:732:-820:850)
(-200:232:-732:742:-820:850)
(-270:292:-700:762:-820:850)
(-250:260:-710:720:-820:850)
(-300:310:-710:720:-820:850)) 920
fill=1 imp:n=1 $ air 3
1380 0      ((310 -440 600 -800 820 -860)
(-320:330:-710:720:-820:850)
(-380:390:-710:720:-820:850)
(-340:372:-770:792:-820:850)
(-400:432:-700:762:-820:850)
(-400:412:-690:700:-820:850)) 930
fill=1 imp:n=1 $ air 4
1390 0      (440 -502 600 -800 820 -860)
(-440:450:-710:720:-820:850)
(-490:502:-662:672:-820:850)
(-480:502:-652:662:-820:850)
(-470:502:-632:652:-820:850)
(-460:502:-600:632:-820:850)
fill=1 imp:n=1 $ air 5

c
c here is californium thing
1392 30 8.7411e-2 -345 344 -788 787 -820 815 imp:n=1 $ steel lid
1394 50 -0.93 -345 344 -788 787 -815 814 imp:n=1 $ paraffin layer
1396 10 4.354e-5 -345 344 -788 787 -814 813 imp:n=1 $ air in pit
3000 0      820 -823 -1000 imp:n=1 $ the can
3010 80 -0.92 820 -823 1000 -1010 imp:n=1 $ poly around can
3020 80 -0.92 823 -825 -1010 imp:n=1 $ top of can
3030 80 -0.92 825 -835 -1010 imp:n=1 $ array area

c
1400 20 7.9654e-2 12 -502 600 -800 860 -870 imp:n=1 $ concrete roof
1500 10 4.354e-5 ((-10:504:-598:802:870) 820) -1998 imp:n=1 $ air around building
1600 10 4.354e-5 -900 imp:n=1 $ det. 5-A
1610 10 4.354e-5 -910 imp:n=1 $ det. 23-H
1620 10 4.354e-5 -920 imp:n=1 $ det. 63-H
1630 10 4.354e-5 -930 imp:n=1 $ det. 93-H
1640 10 4.354e-5 -940 imp:n=1 $ det. 101-W
1650 10 4.354e-5 -950 imp:n=1 $ det. NDA lab

c
1700 20 7.9654e-2 (813 -820 -1998)
(-787:788:-344:345) imp:n=1 $ concrete layer 1
1710 20 7.9654e-2 810 -813 -1998 imp:n=1 $ concrete ground L2

c
c repeating structures cells
c
1800 30 8.7411e-2 (2000 -2010 2040 -2070):
(2010 -2020 2050 -2060):
(2020 -2030 2040 -2070) u=2 imp:n=1 $ I beam
1810 10 4.354e-5 (2010 -2020 2040 -2050):
(2010 -2020 2060 -2070):
(-2000:2030:-2040:2070) u=2 imp:n=1 $ air around I beam
1820 0      -3010 3000 -3030 3020 -3050 3040
u=1 lat=1 imp:n=1 fill=0:104 0:24 0:0
2 2624r $ lattice of cells

c
c
2000 0      (-1998 -810):(1998 -1999) imp:n=1 $ internal world
2010 0      1999 imp:n=0 $ external world

c
c *****
c surface cards
c *****
c
10 px 0 $
12 px 0.191 $

```

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14	px	2012	\$
15	px	2032	\$
20	px	2713	\$
30	px	3414	\$
32	px	3434	\$
40	px	9601	\$
50	px	10302	\$
60	px	13076	\$
62	px	13096	\$
70	px	14387	\$
72	px	14407	\$
80	px	15088	\$
82	px	15108	\$
90	px	16490	\$
100	px	17191	\$
110	px	19263	\$
120	px	20665	\$
130	px	21275	\$
140	px	21796	\$
150	px	22677	\$
160	px	23378	\$
170	px	24079	\$
180	px	30267	\$
190	px	30968	\$
200	px	33741	\$
202	px	33761	\$
210	px	33985	\$
212	px	34005	\$
220	px	34442	\$
222	px	34462	\$
230	px	35052	\$
232	px	35072	\$
240	px	35753	\$
242	px	35773	\$
250	px	37155	\$
260	px	37856	\$
270	px	40630	\$
272	px	40650	\$
280	px	41940	\$
282	px	41960	\$
290	px	42642	\$
292	px	42662	\$
300	px	44044	\$
310	px	44745	\$
320	px	50932	\$
330	px	51633	\$
340	px	53706	\$
342	px	53726	\$
c	344	px 54036	\$
344	px	54481	\$
c	345	px 54097	\$
345	px	54541.935	\$
350	px	54407	\$
352	px	54427	\$
360	px	55108	\$
362	px	55128	\$
370	px	55717	\$
372	px	55737	\$
380	px	57821	\$
390	px	58522	\$
400	px	61295	\$
402	px	61315	\$
410	px	61998	\$
412	px	62018	\$
420	px	62606	\$
422	px	62626	\$
430	px	63304	\$

---

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---

432	px	63324	\$
440	px	64709	\$
450	px	65410	\$
460	px	67483	\$
462	px	67503	\$
470	px	68184	\$
472	px	68204	\$
480	px	68489	\$
482	px	68509	\$
490	px	68885	\$
492	px	68905	\$
500	px	69474	\$
502	px	69494	\$
504	px	69494.191	\$
598	py	-0.191	\$
600	py	0	\$
602	py	20	\$
610	py	244	\$
612	py	264	\$
620	py	488	\$
622	py	508	\$
630	py	732	\$
632	py	752	\$
640	py	2195	\$
642	py	2215	\$
650	py	2926	\$
652	py	2946	\$
660	py	3658	\$
662	py	3678	\$
670	py	4023	\$
672	py	4043	\$
680	py	4389	\$
682	py	4409	\$
690	py	5852	\$
692	py	5872	\$
700	py	6584	\$
702	py	6604	\$
710	py	6949	\$
720	py	7315	\$
722	py	7335	\$
730	py	8047	\$
732	py	8067	\$
740	py	8778	\$
742	py	8798	\$
750	py	10241	\$
752	py	10261	\$
760	py	10973	\$
762	py	10993	\$
765	py	12435	\$
770	py	13167	\$
772	py	13187	\$
780	py	13533	\$
782	py	13553	\$
783	py	13899	\$
785	py	14265	\$
c 787	py	14061	\$
787	py	13607	\$
c 788	py	14122	\$
788	py	13668	\$
790	py	14630	\$
792	py	14650	\$
795	py	15362	\$
797	py	15382	\$
798	py	16073	\$
800	py	16093	\$
802	py	16093.191	\$
810	pz	-3000	\$ bottom of earth

---

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---

```

813 pz -30.48 $ bottom of pit
814 pz -7.62 $ bottom of poly layer
815 pz -2.54 $ bottom of steel lid
820 pz 0 $ floor
823 pz 84.455 $ top of barrel in Cf shuffler
825 pz 150 $ top of assay area in Cf shuffler
830 pz 197 $ top of drums
835 pz 300 $ top of storage cube in Cf shuffler
840 pz 305 $ top of rooms
850 pz 305.09 $ top of roof on rooms
860 pz 610 $ top of first floor
870 pz 686 $ process cell floor
900 s 2713.1 16022.1 100 50 $ det. col.5-A
910 s 15088.1 11044.1 100 50 $ det. col 23-H
920 s 42642.1 11044.1 100 50 $ det. col 63-H
930 s 63304.1 11044.1 100 50 $ det. col 93-H
940 s 68885.1 1463.1 100 50 $ det. col 101-W
950 s 53777 14579 100 50 $ det. in NDA lab
1000 c/z 54511.455 13637.455 28.575 $ inner cylinder in Cf shuffler
1010 c/z 54511.455 13637.455 69.215 $ outer cylinder in Cf shuffler
1998 so 800000 $
1999 so 1000000 $

```

```

c
c repeating structures surfaces
c

```

```

2000 px -0.01 $
2010 px 0.847 $
2020 px 29.633 $
2030 px 30.48 $
2040 py -0.01 $
2050 py 7.1965 $
2060 py 8.0435 $
2070 py 15.24 $
3000 px -0.001 $
3010 px 688.06 $
3020 py -0.001 $
3030 py 764.77 $
3040 pz -0.01 $
3050 pz 611 $

```

```

c
c
c *****
c

```

```

c source term
c
c *****
c

```

```

c sdef sur=1998 nrm=-1 dir=d1
c sbl -21 2
c

```

```

sdef pos=54511.48 13637.48 -30.1 erg=d1
scl from h/u=120 100% enrichment normalized to 1281 W
sil h 1.00e-11 1.00e-8 3.00e-8 5.00e-8 1.00e-7 2.25e-7
      3.25e-7 4.00e-7 8.00e-7 1.00e-6 1.13e-6 1.3e-6
      1.77e-6 3.05e-6 1.00e-5 3.00e-5 1.00e-4 5.5e-4
      0.003 0.017 0.1 0.4 0.9 1.4
      1.85 3.0 6.43 20
spl d 0 1.04e+2 5.67e+2 7.14e+2 1.28e+3 1.29e+3
      4.84e+2 2.74e+2 9.66e+2 3.17e+2 1.68e+2 1.92e+2
      4.79e+2 7.91e+2 1.79e+3 1.71e+3 2.09e+3 3.21e+3
      3.52e+3 3.99e+3 5.83e+3 8.89e+3 1.03e+4 7.25e+3
      5.88e+3 1.13e+4 1.02e+4 1.28e+3

```

```

c
c *****
c
c material cards

```

```

c
c *****
c
m10 7014.50c 3.570e-5
      8016.50c 7.840e-6 $ air
m20 1001.50c 1.487e-2
      6012.50c 3.814e-3
      8016.50c 4.152e-2
      11023.50c 3.040e-4
      12000.51c 5.870e-4
      13027.50c 7.350e-4
      14000.50c 6.037e-3
      20000.51c 1.159e-2
      26000.50c 1.968e-4 $ concrete
m30 6012.50c 3.921e-3
      26000.50c 8.349e-2 $ steel
m40 6012.50c 6.0
      1001.50c 10.0
      8016.50c 5.0 $ wood
m50 6012.50c 25
      1001.50c 52 $ paraffin
m70 1001.50c 2.0
      8016.50c 1.0 $ water
m80 8016.50c 1.0
      1001.50c 2.0 $ polyethylene

c
c *****
c
c tally cards
c
c *****
c
fc4 track det 1. on col 5-A
f4:n 1600
fc14 track det 2 on col. 23-H
f14:n 1610
fc24 track det 3 on col. 63-H
f24:n 1620
fc34 track det 4 on col. 93-H
f34:n 1630
fc44 track det 5 on col. 101-W
f44:n 1640
fc54 track det 5 in NDA lab
f54:n 1650
c e0 1.00e-11 1.00e-8 3.00e-8 5.00e-8 1.00e-7 2.25e-7
c 3.25e-7 4.00e-7 8.00e-7 1.00e-6 1.13e-6 1.3e-6
c 1.77e-6 3.05e-6 1.00e-5 3.00e-5 1.00e-4 5.5e-4
c 0.003 0.017 0.1 0.4 0.9 1.4
c 1.85 3.0 6.43 20
c
c New Response Function
c *****
c
dE0 1.00E-09 1.00E-08 1.00E-07 5.00E-07
      1.00E-06 5.00E-06 1.00E-05 5.00E-05
      1.00E-04 5.00E-04 1.00E-03 5.00E-03
      1.00E-02 2.00E-02 5.00E-02 1.00E-01
      5.00E-01 1 2 5
      10 20
c
c
c
c
dF0 0.456683643 0.612833708 1.202405686 1.907520827
      2.170074239 2.524934685 2.619466509 2.665319206

```

**Final Report**

March 1997

*Examination of Criticality Accident Alarm Coverage on the Operating Floors  
of Buildings X-333, X-330, and X-326 at the  
Portsmouth Gaseous Diffusion Plant*

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2.525689936	2.568979899	2.526120045	2.429598966
2.361915675	2.254370492	2.239813349	2.236561929
1.912907431	1.575113097	1.131268722	0.548312231
0.248252542	0.142345613		

```
c
c *****
c
c peripheral cards
c *****
c
c mode n
c 17 keV cut off
c cut:n j 0.017
c tme 1800
c ptrac file=asc max=100000
c void
c nps 50000000
c prdmp 3j 4
c dbcn 31277116122605
c print
```