**ANALYSIS OF CRITICALITY ACCIDENT ALARM SYSTEM
COVERAGE OF THE X-744G, X-744H, X-342/344A and
X-343 FACILITIES AT THE PORTSMOUTH GASEOUS
DIFFUSION PLANT**

1995

by

**M. Christian Dobelbower
Jeffrey E. Woollard
Billy L. Lee, Jr.
BATTELLE**

Under Contract 400183

to

LOCKHEED MARTIN UTILITY SERVICES, INC.

PORTSMOUTH GASEOUS DIFFUSION PLANT

P.O. Box 628 Piketon, Ohio 45661

Under Contract USECHQ-93-C-0001

to the

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EXECUTIVE SUMMARY

Additional services for the uranium enrichment cascade process, such as UF_6 feed, sampling, and material storage are provided by several ancillary Uranium Material Handling (UMH) facilities at the PORTS site. These facilities include the X-343 Feed Vaporization and Sampling Facility, the X-744G Bulk Non-Uranium Enrichment Service Activity (UESA) Storage Building, the X-744H Waste Separation and Storage Facility, the X-344A Toll Enrichment Services Facility and the X-342A Feed Vaporization and Fluorine Generation Facility. As uranium operations are performed within these facilities, the potential for a criticality accident exists. In the event of a criticality accident within a process facility at PORTS, a Criticality Accident Alarm System (CAAS) is in place to detect the criticality accident and sound an alarm. In this report, an analysis was performed to provide verification that the existing CAAS at PORTS provides complete criticality accident coverage in the X-343, X-744G, X-744H, X-344A and X-342A facilities. The analysis has determined that all of the above-mentioned facilities have complete CAAS coverage.

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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 managed and operated by Lockheed Martin Utility Services (LMUS). At these plants, uranium (U), in the form of uranium hexafluoride (UF_6), is enriched via a gaseous diffusion process from its naturally occurring isotopic concentration of about 0.7% U^{235} , up to about 5% U^{235} with a plant maximum of 10% U^{235} . The diffusion cascade process equipment is housed in buildings X-333, X-330, and X-326. Additional services for the cascade process, such as UF_6 feed, sample and material storage are provided by several ancillary Uranium Material Handling (UMH) and Waste Management facilities at the PORTS site. These facilities include the X-343 Feed Vaporization and Sampling Facility, the X-744G Bulk Non-UESA Storage Building, the X-744H Waste Separation and Storage Facility, the X-344A Toll Enrichment Services Facility and the X-342A Feed Vaporization and Fluorine Generation Facility.¹

As uranium operations are performed within the process facilities at PORTS, the potential for a criticality accident exists. In the event of a criticality accident within a facility at PORTS, a Criticality Accident Alarm System (CAAS) is in place to detect the criticality accident and sound an alarm. According to ANSI standard ANS 8.3-1986² "Criticality Accident Alarm System", the CAAS "shall be designed to detect immediately the minimum accident of concern." In order to meet this requirement, CAAS detectors are located at various positions throughout all of the cascade process buildings and in some of the support services buildings at PORTS. In this report, an analysis was performed to provide verification that the existing CAAS at PORTS provides complete criticality accident coverage in the X-343, X-744G, X-744H, X-344A and X-342A facilities.

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2.0 FACILITY DESCRIPTIONS

UMH and Waste Management facilities which provide support services for the U²³⁵ enrichment cascade process at PORTS include the X-343 Feed Vaporization and Sampling Facility, the X-744G Bulk Non-UESA Storage Building, the X-744H Waste Separation and Storage Facility, the X-344A Toll Enrichment Services Facility, and the X-342A Feed Vaporization and Fluorine Generation Facility. These facilities, and the operations performed at each, are described briefly in the sections that follow.

2.1 The X-343 Feed Vaporization and Sampling Facility

The X-343 Feed Vaporization and Sampling Facility (the X-343 facility) is located approximately 250 ft east of the X-333 process building and serves as the receiving point for inbound UF₆, both natural assay (0.711% U²³⁵) and Paducah product (about 1.9% assay U²³⁵) feed material. This feed material is delivered to PORTS in large cylinders (10 and 14 ton). Once received at the X-343 facility, the feed material is sampled and fed into the enrichment cascade. This facility also serves as the shipping point for the empty cylinders and as a UF₆ sampling location.¹

The X-343 facility has a total floor area of about 11,200 sq ft, and is divided into an office area and an operations area. The operations area, located in the east portion of the building, is equipped with seven steam-heated autoclaves. All seven autoclaves are designed for feed or vapor phase sampling operations and are connected to the U²³⁵ enrichment cascade feed headers. Three of the seven autoclaves, the Feed and Sample autoclaves, have 7-ft diameters and are equipped with cylinder rollers to allow the cylinder valve to be moved for liquid phase sampling. The remaining four autoclaves have 6-ft diameters and are not equipped for cylinder rotation. Feed material cylinders are placed in the autoclaves and heated. The UF₆ feed material changes from a solid, to a liquid phase and is then sampled

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as a liquid or fed into the enrichment cascade as a gas. Manipulation of feed material cylinders (both empty and full) is performed by an overhead crane.¹ The office area, located in the west portion of the building, provides office space for the various operations personnel at the facility. The X-343 facility contains one CAAS detector. This detector is located on the east side of the concrete block wall which separates the office area from the operation area.^{3,4}

2.2 The X-744G Bulk Non-UESA Storage Building

The X-744G Bulk Non-UESA (Uranium Enrichment Service Activity) Storage Building (the X-744G facility) is located approximately 500 ft southeast of the X-333 process building. This facility is used for the storage of category 3B material (less than 350 g of U²³⁵ enriched to 20% or more), which includes contaminated solutions, contaminated cascade trapping materials, contaminated solid scrap, uranium oxides, and various other uranium-contaminated compounds. The facility also houses an aluminum smelter, which is no longer used.¹

Contaminated material stored in the X-744G facility is kept in a variety of different containers. These containers include various 5-in. diameter metal cans and 55-gallon metal and plastic drums. Some of the storage containers are kept on storage racks, while others are located in floor racks inside the facility. The X-744G facility contains two CAAS detectors.^{3,5}

2.3 The X-744H Waste Separation and Storage Facility

The X-744H Waste Separation and Storage Facility, generically called Warehouse-18, is a large barrack-like structure located approximately 300 ft west of the X-744G facility. The X-744H facility has a total floor area of approximately 58,000 sq ft. The facility is

divided into two sections with differing operations being performed in each section. The first section of the X-744H facility is located on the north end of the building and is used for the sorting and batching of solid contaminated burnables. Solid contaminated burnables are received at the facility in 55-gal drums. The burnables are sorted and placed into B-10 boxes for subsequent disposal. This section of the building is also used for temporary storage of the contaminated burnables. The southern section of the X-744H facility is used as a general storage facility and does not house uranium operations. For the scope of this report, it was assumed that the south end of the X-744H facility contains only crates, boxes and storage shelves.

2.4 The X-344A/342A Complex

The X-344A/342A complex is located approximately 450 ft north of the X-330 process building. This building houses the X-344A Toll Enrichment Services Facility and the X-342A Feed Vaporization Facility. These facilities, and the services provided by each, are briefly discussed in the following sections.

2.4.1 The X-344A Toll Enrichment Services Facility

The X-344A Toll Enrichment Services Facility (the X-344A facility) occupies the west side of the X-344A/342A building. This facility serves as the processing and shipping point for low assay (U^{235} enrichments of 5% or less) product UF_6 . Typically, material is withdrawn from the cascade process into large (10-ton) cylinders. The material is then transported to the X-344A facility where it is sampled and transferred into smaller, customer-owned (2.5 ton) cylinders for shipping.¹

The X-344A facility is a two-story structure. It has approximately 40,000 sq ft of ground floor area, 18,700 sq ft of second floor area, and 4300 sq ft of basement floor area.

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The facility consists of an office area, two high bay areas (a north high bay and a south high bay), and a storage vault. The north high bay contains four 8-ft diameter autoclaves for sampling and transfer of UF_6 . These autoclaves are equipped with cylinder rolling and tilting devices to facilitate sampling and transfer operations. Shipping and receiving activities are performed in either the north or south high bay using any of the four overhead bridge cranes.¹ The office area, located on the west end of the building, provides office space for operations personnel. The X-344A facility contains two CAAS detectors.^{3,6}

2.4.2 The X-342A Feed Vaporization Facility

The X-342A Feed Vaporization Facility (the X-342A facility) occupies the east portion of the X-344A/342A building. This facility was formerly the primary location for UF_6 feed sampling and cascade feed vaporization. Presently, the facility is used for the production of fluorine, which is used in the cascade process, and for sampling UF_6 prior to shipment.¹

The X-342A building consists of an office area, several process areas and a vaporizer bay. The vaporizer bay contains two 7-ft diameter Feed and Sample autoclaves. These autoclaves are identical in design and operation to the three 7-ft diameter Feed and Sample autoclaves in the X-343 facility.¹ Directly beneath the autoclaves is a sump which receives autoclave condensate. The sump has two pumps which discharge through an oil interceptor to a storm drain. There are no CAAS detectors in the X-342A facility. However, as noted above, the X-342A facility is housed in the same building as the X-344A facility.

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3.0 ANALYSIS

To determine CAAS coverage in these facilities, a model of each facility was developed. In this model, CAAS detectors were modeled at positions corresponding to the currently existing CAAS detectors. Next, neutron sources, representing criticality accidents, were modeled at various locations throughout the facilities and a detector response was calculated for each detector location. Finally, the response of the detectors was used to determine CAAS coverage. If a criticality accident at a given source location resulted in a calculated detector response that was larger than the PORTS CAAS setpoint of 5 mrad/hr, then a criticality accident at that location would be detected and the CAAS coverage is determined to be adequate. If, however, the detector response was smaller than the PORTS CAAS setpoint, then a criticality accident at that source location may go undetected and the existing CAAS coverage is deemed deficient.

Currently, two CAAS detectors in the X-744G facility and one in the X-343 facility provide CAAS coverage within those facilities. Also, two CAAS detectors in the X-344A/342A building provide CAAS coverage within that facility. The X-744H facility, however, does not contain a CAAS detector. Therefore, if a criticality accident occurs in this facility, a detector in one of the neighboring facilities must be able to detect the criticality accident and sound an alarm. Neighboring facilities which contain CAAS detectors which are close enough to reasonably detect a criticality accident in the X-744H facility include the X-343 and X-744G facilities and the X-333 process building. These facilities and their CAAS detector locations are shown in Figure 1. The nearest CAAS detector in the X-333 process building is located in the southwest corner of the building, on the process cell floor (the 2nd floor).³ As a result, the detector in the X-333 process building will be shielded from a criticality accident in the one-story X-744H facility by the concrete process cell floor. This CAAS detector may not respond to a criticality event in the X-744H facility. A criticality accident in the X-744H facility will more likely be detected by CAAS detectors

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Figure 1. Layout of X-343, X-744G, X-744H, and X-333 Facilities and the Locations of the CAAS Detectors in Each Facility

in the X-343 or X-744G facilities. Therefore, to determine CAAS coverage in the X-744H facility, the X-343, X-744G and X-744H facilities have been modeled in a single model (the X-343/X-744G/X-744H model) for the analysis. The X-333 process building has not been included in this model. This model was also used to verify CAAS coverage in the X-343 and X-744G facilities.

Similarly, the X-342A facility does not contain a CAAS detector. A criticality accident occurring in this facility must be detected by the CAAS detectors located in the X-344A facility. These facilities, however, are in the same building and were therefore modeled together (the X-344A/342A model) for the analysis. The X-344A/342A model was used to determine CAAS coverage in the X-344A and X-342A facilities. These two facilities were modeled and analyzed separately from the X-343/X-744G/X-744H model.

The analysis was performed using the Monte Carlo N-Particle transport code, MCNP.⁸ The development of the MCNP models and the analysis of the results were performed in five steps. First, a suitable geometry approximating the facilities was developed. Second, an accurate source term describing an appropriate criticality accident was determined. Third, the CAAS detectors were modeled and flux tallies were implemented in a manner that provided an accurate representation of the neutron flux spectrum at the detector locations. Fourth, variance reduction techniques were employed such that the problem could be solved in a timely manner while still generating accurate results. Finally, a neutron flux to dose conversion was applied to the tally results to determine the CAAS detector response. These five steps are described in detail in the sections that follow.

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3.1 Facility Models

As mentioned previously, the X-343, X-744G and X-744H buildings were each individually modeled and then combined to form the X-343/X-744G/X-744H model used in the MCNP analysis. The X-344A/342A model was developed and analyzed separately. Each model will be briefly discussed in the sections that follow.

3.1.1 The X-343/X-744G/X-744H Model

The X-343/X-744G/X-744H model consists of individual facility models of the X-343, X-744G and X-744H facilities. The three individual facility models were combined on a 30-m thick concrete ground and surrounded by a large hemisphere of air with a radius of 8 km. The location and orientation of each facility model with respect to each of the others in the X-343/X-744G/X-744H model is exactly the same as it is at PORTS. Each individual facility model is briefly discussed in the sections below.

3.1.1.1 The X-343 Facility Model

The X-343 facility model is shown in Figure 2. The facility model consists of an office area and an autoclave bay. The office area, located on the west side of the building, was modeled as 127 ft long by 24 ft wide by 13 ft tall.⁹ Concrete block walls separate the rooms in the office area. The autoclave bay is also separated from the office area by a concrete block wall. The autoclave bay was modeled as a large bay, 157 ft long by 100 ft wide by 43 ft high.^{4,10} The autoclave bay model contains 7 autoclaves. A SABRINA⁹ representation of the X-343 facility model, including the arrangement of the autoclaves, is shown in Figure 3.

Figure 2. The X-343 Facility Model

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Figure 3. SABRINA Representation of the X-343 Facility Model

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Two different diameter autoclaves were modeled. Autoclaves 1 through 4 have 6-ft diameters while autoclaves 5 through 7 have a 7-ft diameters.¹ The autoclaves were modeled as two concentric cylinders. The inner cylinder has a 4-ft diameter and was modeled as partial density (66%) solid UF_6 to represent a cylinder in the autoclave. The outer cylinder was modeled as a 1-in. thick steel shell with a diameter of 6 or 7 ft depending on the autoclave modeled. A SABRINA representation of the autoclave model is shown in Figure 4. The autoclave cylinders are located in 3.5-ft deep trenches in the concrete floor of the building (see Figure 4). These trenches end in a below grade hallway on the east end of the building. This hallway runs the length of the building. Also included in the autoclave bay model are two scale pits and a sump pit/oil interceptor. The two scale pits were modeled as rectangular pits in the concrete floor, approximately 12 ft across by 6.5 ft wide by 3.5 ft deep. Their locations are shown in Figure 2. The sump pit/oil interceptor was modeled as a rectangular pit in the concrete floor approximately 1.5 ft across by 2 ft wide by 4 ft deep, and is located in the southwest corner of the basement hallway. The sump pit/oil interceptor is also shown in Figure 2. Finally, all concrete block walls were modeled as half density concrete with the appropriate thickness.

3.1.1.2 The X-744G Facility Model

The X-744G facility model is shown in Figure 5. This facility was modeled as 520 ft long by 220 ft wide.¹ The inside of the building model consists of an office area, a sampling area, a loading dock and 4 storage bay areas. All of the walls in the building model were modeled as 14 gauge steel sheet metal with the exception of the concrete block firewall in the northeast corner of the northeast storage bay. The concrete block firewall was modeled as half density concrete and has dimensions of 4 in thick by 40 ft long by 18 ft high.^{5,11}

The roof of the facility was modeled as 20-gauge steel sheet metal at a height of 18 ft, with the exception of the northwest storage bay area. The roof over the northwest storage

Figure 4. SABRINA Representation of the Autoclave Model

Figure 5. The X-744G Facility Model

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bay consists of three sections at heights of 30 ft and 35 ft¹¹ as shown in Figure 5. A SABRINA representation of the X-744G facility model is shown in Figure 6.

3.1.1.3 The X-744H Facility Model

The X-744H facility model is shown in Figure 7. This facility was modeled as a single story building 590 ft long by 100 ft wide.¹² The roof was modeled using 2 half-cylinder shells running the length of the building. The height of the building model varies as a result of the cylindrical roof. All exterior walls were modeled as 14 gauge steel sheet metal. The roof was modeled as 20 gauge steel sheet metal. The inside of the facility model was divided into two areas, a waste separation area and a storage area. The waste separation area was modeled as the north end of the building (the first 75 ft of the facility) and contained a large array of 55-gallon drums on 4 ft centers. The 55-gal drums were modeled to contain partial density (50%) wood to approximate paper, personal protective equipment, and other burnables. A SABRINA representation of this part of the facility model is shown in Figure 8. The storage area was modeled as the remainder of the facility. In this area, four long shelving units, 515 ft long by 4 ft across by 6 ft tall were modeled. The location of the shelving units is shown in Figures 7 and 8.

3.1.2 The X-344A/342A Model

Since the X-344A and X-342A facilities are housed within a single structure, one single model, the X-344A/342A model, was developed to represent both facilities. This model is shown in Figure 9. The entire structure was modeled as a single story structure 500 ft long by 210 ft wide by 20 ft tall.^{6,13,14} The north and west portions of the model represent the X-344A facility and the southeast corner of the model represents the X-342A facility.

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Figure 6. SABRINA Representation of the X-744G Facility Model

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Figure 7. X-744H Facility Model

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Figure 8. A SABRINA Representation of the North End of the X-744H Facility Model

Figure 9. The X-344A/342A Facility Model

The X-344A portion of the facility model contains an office area, several process areas, a storage area, a cylinder loading/unloading area and an autoclave bay. The autoclave bay area was modeled to contain four 8-ft diameter autoclaves. The autoclaves were modeled in a manner identical to that used for the autoclaves in the X-343 facility and described in section 3.1.1.1. The autoclave models were located such that the center of the autoclave models are 11 ft above the facility floor. The arrangement of the autoclaves is shown in Figure 9.

The X-342A portion of the facility model contains an office area and an autoclave bay. The autoclave bay area was modeled to contain two 7-ft-diameter autoclaves. Again, the autoclaves were modeled in a manner identical to that used for the autoclaves in the X-343 facility and described in Section 3.1.1.1. The autoclave models were located such that the bottom of the autoclave models are 1 cm above the facility floor. The arrangement of the autoclave models is also shown in Figure 9. A scale pit and several drainage trenches were included in the autoclave bay model. The scale pit was modeled as a rectangular pit in the concrete floor 14 ft across by 7 ft wide by 3 ft deep. Pipe trenches were all modeled as 2-ft deep. Also included in the autoclave bay model was a small, below grade access room. The access room was modeled as a rectangular pit in the concrete floor, 20 ft across by 10 ft wide by 8 ft deep. The access room is connected to the drainage trench network. A cylindrical sump pit/oil interceptor pit, 5 ft deep, was modeled in the floor of the access room. The sump pit/oil interceptor pit has a diameter of 3 ft. Most of the access room and pipe trench network is covered with a 3-in. layer of concrete. The locations of the scale pit, access room, oil interceptor pit and drainage trenches are shown in Figure 10.

Finally, all concrete walls in the X-344A and X-342A facilities were included in the facility model. Concrete block walls were modeled as half-density concrete with the appropriate thickness. The facility was modeled on a 30 m thick concrete ground and surrounded by a large hemisphere of air with a radius of 8 km. A SABRINA representation of the X-344A/342A facility, without the roof, is shown in Figure 11.

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Figure 10. Locations of the Sump Pit and Pipe Trenches

3.1.3 Material Compositions

For consistency with previous calculations of criticality alarm response in the PORTS buildings,¹⁵ the number densities of air, concrete, and steel used in this analysis were taken from Westfall et al.¹⁶ These number densities, along with those for the wood modeled in the X-744G facility model are given in Table 1.

Table 1. Material Compositions

Material	Element	Number Density (Atom barn-1 cm-1)
Air	Nitrogen	3.570E-05
	Oxygen	7.840E-06
Concrete	Hydrogen	1.487E-02
	Carbon	3.814E-03
	Oxygen	4.152E-02
	Sodium	3.040E-04
	Magnesium	5.870E-04
	Aluminum	7.350E-04
	Silicon	6.037E-03
	Calcium	1.159E-02
	Iron	1.968E-04
Steel	Carbon	3.921E-03
	Iron	8.349E-02
Wood (Oak) ¹⁷	Hydrogen	1.394E-02
	Carbon	8.364E-03
	Oxygen	6.970E-03

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Figure 11. SABRINA Representation of the X-344A/342A Facility

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3.2 Source Term

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

3.2.1 Source Locations

Source locations were chosen that would maximize the distance and/or shielding between the source and the detector. Criticality accidents modeled at these source locations result in the smallest absorbed dose rates at the detectors. Therefore, any other source location would result in a smaller distance or smaller thickness of shielding between the source and detector and will be bounded by the cases analyzed. Several different source locations in each model were used in this analysis. These source locations are presented in Tables 2 and 3 for the X-343/X-744G/X-744H and X-344A/342A models, respectively. These source locations in each facility are also shown in the respective facility model figures.

Table 2. Criticality Accident Source Locations in X-343/X-744G/X-744H Model

Source #	Building	Description	U ²³⁵ Enrichment (%)	Power Level (W)
S1	X-343	Bottom center of north scale pit	5	2881
S2	X-343	Southwest corner of sump pit	5	2881
S3	X-343	Center of autoclave #7	5	2881
S4	X-744G	Behind concrete firewall on the north wall of building	100	1281
S5	X-744H	In center of 55 gal. drums in storage area	100	1281
S6	X-744H	Behind westernmost shelving unit on south end of building	100	1281

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Table 3. Criticality Accident Source Locations in X-344A/342A Model

Source #	Building	Description	U^{235} Enrichment (%)	Power Level (W)
S1	X-344A	Center of southernmost autoclave	5	2881
S2	X-342A	Center of right autoclave	5	2881
S3	X-342A	Center of scale pit	5	2881
S4	X-342A	Center of sump pit	5	2881
S5	X-344A	In northeast corner of lunch room	5	2881

3.2.2 Source Power Level and Energy Spectrum

The criticality sources used in this analysis were those that result in the minimum critical accident of concern as defined in ANSI/ANS 8.3-1986.² Since criticality accidents that may occur in different locations in the plant will most likely result from material enriched to different levels, the source used in the analysis varied with its location in the plant. As calculated in POEF-SH-31,¹⁸ source power levels and neutron energy spectra for the minimum critical accident of concern vary for sources with different ^{235}U enrichments. For each source location, the source term was modeled to have the maximum credible ^{235}U enrichment for material that is, or at one time may have been, present in that location.

All power levels and source neutron energy spectra were taken from POEF-SH-31. The power level for each criticality accident source used in the analysis is shown in Table 2 and Table 3. Source neutron energy spectra for the different criticality accident sources modeled are tabulated in Table 4. All sources were modeled as isotropic point sources.

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Table 4. Source Terms for 5% and 100% ^{235}U Enriched Sources

Upper Energy Limit (MeV)	Source Neutron Energy Spectra	
	5% ^{235}U Enriched	100% ^{235}U Enriched
2.00E+01	6.11E+2	1.28E+03
6.43E+00	4.90E+3	1.02E+04
3.00E+00	5.56E+3	1.13E+04
1.85E+00	2.72E+3	5.88E+03
1.40E+00	3.40E+3	7.25E+03
9.00E-01	5.07E+3	1.03E+04
4.00E-01	4.36E+3	8.89E+03
1.00E-01	2.96E+3	5.83E+03
1.70E-02	2.18E+3	3.99E+03
3.00E-03	1.82E+3	3.52E+03
5.50E-04	1.68E+3	3.21E+03
1.00E-04	1.18E+3	2.09E+03
3.00E-05	1.03E+3	1.71E+03
1.00E-05	9.48E+2	1.79E+03
3.05E-06	4.73E+2	7.91E+02
1.77E-06	2.53E+2	4.79E+02
1.30E-06	1.04E+2	1.92E+02
1.13E-06	8.59E+1	1.68E+02
1.00E-06	1.74E+2	3.17E+02
8.00E-07	5.54E+2	9.66E+02
4.00E-07	1.62E+2	2.74E+02
3.25E-07	3.00E+2	4.84E+02
2.25E-07	1.04E+3	1.29E+03

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Upper Energy Limit (MeV)	Source Neutron Energy Spectra	
	5% ²³⁵ U Enriched	100% ²³⁵ U Enriched
1.00E-07	1.50E+3	1.28E+03
5.00E-08	9.71E+2	7.14E+02
3.00E-08	8.00E+2	5.67E+02
1.00E-08	1.46E+2	1.04E+02
1.00E-11	0.00E+0	0.00E+00

3.3 Flux Tallies

The CAAS detectors used at the PORTS site are set to alarm at an absorbed dose rate in tissue of 5 mrad/hr.⁷ Values of the neutron flux in air, calculated by MCNP, will be converted to absorbed dose rates through the use of an appropriate flux to absorbed dose rate conversion factor (see section 3.5). Therefore, the detectors modeled in MCNP must tally the neutron flux spectra in air. The MCNP detectors were modeled as spheres with a 1-m diameter at locations corresponding to the currently installed CAAS detectors.³ The neutron fluence per source particle at the various detectors was tallied using a next event estimator (point detector) at the center of the detector spheres.

3.4 Variance Reduction

Two methods of variance reduction were implemented in this analysis to reduce computational time. The first was the use of point detectors to tally the neutron fluence per source particle, the second was the implementation of a particle cutoff based on neutron energy. The use of point detectors allows every neutron interaction to result in a contribution to the tallies. This serves to help reduce the overall variance in the flux tally by

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increasing the number of source particles that score, and at the same time reduces the time required to obtain an accurate flux value. A particle cutoff was implemented in the analysis that terminated a neutron's random walk when that neutron's energy fell below 17KeV. The 17KeV cutoff was chosen because neutrons with energy below 17KeV do not significantly contribute to the total detector response (as a result of the detector response function applied). Therefore, to reduce computation time, neutrons with energies below this threshold were eliminated from the calculation. This allows MCNP to spend its time tracking only neutrons that will make a significant contribution to the detector response.

3.5 Flux to Absorbed Dose Rate Conversion

MCNP was used to calculate the neutron fluence per source neutron at the modeled detector locations. In order to calculate the absorbed dose rate in the detectors, the neutron fluence per source neutron was first converted to neutron flux. Then, a neutron flux to neutron absorbed dose rate conversion factor was applied to calculate the neutron absorbed dose rate in the detector.

To convert the neutron fluence per source particle to neutron flux, the neutron production rate (power level) of the source must be known. The source neutron production rate was determined according to the following equation:

$$N\left(\frac{\text{neutrons}}{\text{sec}}\right) = \phi_p\left(\frac{\#}{\text{cm}^2\text{secwatt}}\right) * P(W) * A(\text{cm}^2)$$

where

N = the source neutron production rate (n/s)

ϕ_p = the neutron flux per unit power (#/cm²/s/W)

P = power for the minimum critical accident of concern (W)

A = the surface area of a sphere with radius 2 meters (cm^2)

Using the appropriate values for ϕ_p and P from POEF-SH-31, the neutron source rates for each source term were calculated. The neutron source rates for the two different criticality accident sources modeled are shown in Table 5.

Table 5. Criticality Accident Source Neutron Production Rates

U^{235} Enrichment (%)	Power Level (W)	Neutron Production Rate (n/s)
5	2881	6.517×10^{13}
100	1281	5.121×10^{13}

Next, a neutron flux to neutron absorbed dose rate conversion factor was applied to the neutron flux to calculate the neutron absorbed dose rate. In this analysis, the neutron absorbed dose rate was calculated on a per energy bin basis. The absorbed dose rate at the detector was calculated using the following equation:

$$D \left(\frac{\text{mrad}}{\text{hr}} \right) = \sum_{i=1}^{27} N_i \left(\frac{\text{n}}{\text{s}} \right) * \phi_{i,\text{mcnp}} \left(\frac{\frac{\#}{\text{cm}^2}}{\text{n}} \right) * k_i \left(\frac{\frac{\text{rad}}{\text{n}}}{\text{cm}^2} \right) * \left(\frac{3600 \text{sec}}{\text{hr}} \right) * \left(\frac{1000 \text{mrad}}{\text{rad}} \right)$$

where

D = neutron absorbed dose rate at detector (mrad/hr)

ϕ_{mcnp} = the neutron fluence per source particle at detector ($\#/\text{cm}^2/\text{n}$)

N = source neutron production rate (n/s)

k = neutron flux to neutron absorbed dose rate conversion factor ($\text{rad}/\text{n}/\text{cm}^2$)

i = energy bin index

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In this analysis, the Henderson Free in Air Tissue kerma factors,¹⁹ as shown in Table 6, were used.

Table 6. Henderson Free-in-Air Tissue Kerma Factors

Upper Energy Boundary (MeV)	Henderson Free in Air Tissue Kerma Factor (rads/(n/cm ²))
1.00E-11	0.00E+00
1.00E-08	6.03E-17
3.00E-08	2.46E-16
5.00E-08	3.69E-16
1.00E-07	6.52E-16
2.25E-07	1.40E-15
3.25E-07	2.54E-15
4.00E-07	3.37E-15
8.00E-07	5.39E-15
1.00E-06	8.37E-15
1.13E-06	9.93E-15
1.30E-06	1.13E-14
1.77E-06	1.42E-14
3.05E-06	2.20E-14
1.00E-05	5.46E-14
3.00E-05	1.70E-13
1.00E-04	5.43E-13
5.50E-04	2.36E-12
3.00E-03	1.35E-11
1.70E-02	7.20E-11
1.00E-01	3.12E-10
4.00E-01	1.08E-09
9.00E-01	1.79E-09
1.40E+00	2.44E-09

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Upper Energy Boundary (MeV)	Henderson Free in Air Tissue Kerma Factor (rads/(n/cm ²))
1.85E+00	2.79E-09
3.00E+00	3.22E-09
6.43E+00	4.18E-09
2.00E+01	4.72E-09

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4.0 RESULTS

These facilities were analyzed in two separate models, the X-343/X-744G/X-744H model and the X-344A/342A model. Sample MCNP input files for both models are included in Appendix A. In the analysis for each model, a source was placed at various source locations and the fluence per source neutron value for each individual detector in the model was then calculated. These values were then converted to absorbed dose rates using the methodology presented in section 3.5. Spreadsheets of these calculations are included in Appendix B.

For a given source location, the distance and/or amount of shielding between the source and a detector varies with the detector location. As a result, in the MCNP analysis, one detector may arrive at a statistically significant fluence per source neutron value (fractional uncertainty $< 5\%$) more rapidly than the others. This is usually, but not always, the detector closest to the source. This will be further discussed in section 5.0.

Detector responses for each source location are presented in Tables 7 and 8 for the X-343/X-744G/X-744H and X-344A/342A models, respectively. Only one detector response is given for each source location. The value tabulated is for the detector that yielded the highest response which is still statistically significant. In most cases this value is from the detector nearest the source. The location of the detector whose response is tabulated is also identified in the tables.

Table 7. Detector Responses for the X-343/X-744G/X-744H Model

Source Location (Building)	Detector	Detector Response (mrad/hr)	Standard Deviation (mrad/hr)
S1 (X-343)	X-343	1587	10
S2 (X-343)	X-343	29	1
S3 (X-343)	X-343	170	7
S4 (X-744G)	X-744G East	1711	7
S5 (X-744H)	X-744G West	15.1	0.5
S6 (X-744H)	X-744G West	13.2	0.3

Table 8. Detector Responses for the X-344A/342A Model

Source Location (Building)	Detector	Detector Response (mrad/hr)	Standard Deviation (mrad/hr)
S1 (X-344A)	X-344A West	34.4	0.5
S2 (X-342A)	X-344A East	8.1	0.9
S3 (X-342A)	X-344A East	192	8
S4 (X-342A)	X-344A East	20.9	1.7
S5 (X-344A)	X-344A East	124	16

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5.0 DISCUSSION

In the analysis of CAAS coverage in these facilities, source locations were chosen which would minimize detector response and which were also credible criticality accident locations. Due to the conservative nature of the selected source locations, all other locations within the range of selected source locations will result in a higher detector response and will, therefore, be bounded by these source locations.

The analysis determines coverage or non-coverage of a location by comparing calculated detector responses to the PORTS CAAS alarm setpoint of 5 mrad/hr. MCNP was run using point detectors to tally the neutron fluence per source particle. The problem was run until the tally for one of the detectors had a fractional uncertainty of less than 5%. At this point the response of this detector was calculated as outlined in section 3.5. If the calculated detector response was greater than or equal to 5 mrad/hr, the area was then considered to be covered by the CAAS and the problem was terminated. Otherwise the problem was continued until the fractional uncertainty of all of the detector tallies were less than or equal to 5%. Responses for all detectors were then calculated and the largest detector response was used to determine coverage or non-coverage. Using this method, the UMH facilities X-343, X-744G, X-744H, X-344A and X-342A are completely covered for the source points chosen.

The CAAS not only provides criticality accident coverage inside the UMH facilities at PORTS, it also provides some criticality accident coverage for the roads surrounding the UMH facilities. Since a criticality accident in the X-744H facility (S5 and S6) will be detected by the west CAAS detector in the X-744G facility, a criticality accident in the road between the X-744H and X-744G facilities will also be detected. Therefore, the roads between the two facilities are covered. Based on this analysis, all roads around the X-744G facility, within a radius approximately equal to the distance between the X-744H and X-744G

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facilities, should also be covered. This conclusion assumes that there is no significant shielding material anywhere around the X-744G facility and within this radius. If any significant shielding does exist, the radius of coverage around the X-744G facility provided by the CAAS detectors may be less.

In addition, a previous analysis²⁰ done to determine CAAS coverage of cylinder storage lots at PORTS can be used to show CAAS coverage of the roads surrounding the X-343 and X-344A/342A facilities. In this analysis, CAAS coverage was shown to extend to the first row of UF₆ cylinders in storage lot X-745D, located northeast of the X-343 facility. Therefore, CAAS coverage is provided around the X-343 facility within a radius equal to the distance between X-343 and X-745D. In this report, CAAS coverage provided by detectors in the X-344A/342A facility was also shown to extend to the first rows of UF₆ storage cylinders in storage lots X-745F and X-745B (north and south of the X-344A/342A facility, respectively). Again, this would indicate that CAAS coverage is provided to roads within the immediate proximity of the X-344A/342A facility. Finally, it must be remembered that in this report, no shielding was modeled between the facilities and the storage lots. Any additional shielding around the facilities will only serve to reduce CAAS coverage of roads surrounding the facilities.

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6.0 CONCLUSION

The CAAS detectors at PORTS are set to alarm at an absorbed dose rate of 5 mrad/hr. As can be seen from the absorbed dose rate values presented in Tables 7 and 8, the CAAS provides complete coverage of the X-343, X-744G, X-744H, X-344A and X-342A facilities. Additionally, this analysis, coupled with an analysis performed in a previous report, can be used to show CAAS coverage of roads immediately surrounding these facilities.

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APPENDIX A

**SAMPLE MCNP INPUTS FOR THE X-343/X-744G/X-744H
AND X-344A/342A MODELS**

This is a model of the 744g, 744h, and 343 buildings to determine alarm coverage

C
C
C
C
C
C
C
C
C
C
C

cell cards for x744g

10	1	4.354e-5	(21 -50 201 -270 410 -420):		
			(270 -280 21 -40 410 -420):		
			(21 -40 201 -265 420 -425):		
			(201 -265 40 -45 420 -425):		
			(201 -265 45 -50 420 -425):		
			(41 -45 201 -265 425 -430)	imp:n=1	\$ bay area (N.W corner)
20	1	4.354e-5	(281 -300 21 -30 410 -420):		
			(310 -320 21 -30 410 -420):		
			(30 -41 281 -320 410 -420):		
			(41 -50 271 -320 410 -420)	imp:n=1	\$ bay in N.E corner
30	1	4.354e-5	(211 -220 51 -100 410 -420):		
			(51 -70 220 -231 410 -420):		
			(91 -100 220 -231 410 -420):		
			(51 -100 231 -240 410 -420):		
			(240 -250 61 -81 410 -420):		
			(81 -100 240 -260 410 -420)		
			imp:n=1		\$ sw bay area
40	1	4.354e-5	71 -90 221 -230 410 -420	imp:n=1	\$ sampling area
50	1	4.354e-5	51 -60 241 -260 410 -420	imp:n=1	\$ toxic gas and fume area
60	1	4.354e-5	61 -80 251 -260 410 -420	imp:n=1	\$ office
70	1	4.354e-5	51 -100 261 -270 410 -420	imp:n=1	\$ junk storage area
80	1	4.354e-5	51 -100 271 -290 410 -420	imp:n=1	\$ lots of corroding cylinders
90	2	3.9827e-2	21 -30 300 -310 410 -420	imp:n=1	\$ concrete fire wall

C
C
C

here are the sheet metal walls for x744g

100	3	8.7411e-2	20 -21 200 -266 410 -425	imp:n=1	\$ north wall
101	3	8.7411e-2	20 -21 266 -321 410 -420	imp:n=1	\$ north wall
110	3	8.7411e-2	40 -41 270 -281 410 -420	imp:n=1	\$
115	3	8.7411e-2	45 -46 200 -266 425 -430	imp:n=1	\$
116	3	8.7411e-2	40 -41 200 -266 425 -430	imp:n=1	\$
120	3	8.7411e-2	50 -51 266 -321 410 -420	imp:n=1	\$
121	3	8.7411e-2	50 -51 200 -266 410 -425	imp:n=1	\$
130	3	8.7411e-2	60 -61 240 -261 410 -420	imp:n=1	\$
140	3	8.7411e-2	70 -71 220 -231 410 -420	imp:n=1	\$
150	3	8.7411e-2	80 -81 250 -261 410 -420	imp:n=1	\$
160	3	8.7411e-2	90 -91 220 -231 410 -420	imp:n=1	\$
170	3	8.7411e-2	100 -101 210 -291 410 -420	imp:n=1	\$
180	3	8.7411e-2	200 -201 21 -50 410 -425	imp:n=1	\$
181	3	8.7411e-2	41 -45 200 -201 425 -430	imp:n=1	\$
190	3	8.7411e-2	210 -211 51 -100 410 -420	imp:n=1	\$
200	3	8.7411e-2	220 -221 71 -90 410 -420	imp:n=1	\$
210	3	8.7411e-2	230 -231 71 -90 410 -420	imp:n=1	\$
220	3	8.7411e-2	240 -241 51 -60 410 -420	imp:n=1	\$
230	3	8.7411e-2	250 -251 61 -80 410 -420	imp:n=1	\$
240	3	8.7411e-2	260 -261 81 -100 410 -420	imp:n=1	\$
242	3	8.7411e-2	260 -261 61 -80 410 -420	imp:n=1	\$
244	3	8.7411e-2	260 -261 51 -60 410 -420	imp:n=1	\$
250	3	8.7411e-2	270 -271 41 -50 410 -420	imp:n=1	\$
254	3	8.7411e-2	21 -40 265 -266 420 -425	imp:n=1	
255	3	8.7411e-2	41 -45 265 -266 425 -430	imp:n=1	
256	3	8.7411e-2	46 -50 265 -266 420 -425	imp:n=1	
257	3	8.7411e-2	40 -46 265 -266 420 -425	imp:n=1	
260	3	8.7411e-2	270 -271 51 -100 410 -420	imp:n=1	\$
270	3	8.7411e-2	280 -281 21 -40 410 -420	imp:n=1	\$
280	3	8.7411e-2	290 -291 51 -100 410 -420	imp:n=1	\$
290	3	8.7411e-2	320 -321 21 -50 410 -420	imp:n=1	\$
320	1	4.354e-5	10 -20 200 -321 410 -420	imp:n=1	\$ air in loading dock
330	1	4.354e-5	51 -101 200 -210 410 -432	imp:n=1	\$ air in S.W corner
340	1	4.354e-5	51 -101 291 -321 410 -432	imp:n=1	\$ air in S.E corner
345	1	4.354e-5	(200 -321 10 -20 422 -432):		
			(266 -321 20 -51 422 -432):		
			(51 -101 210 -291 422 -432):		
			(200 -266 20 -40 427 -432):		
			(200 -266 46 -51 427 -432)	imp:n=1	\$ air above building
400	1	4.354e-5	200 -266 20 -40 425 -426	imp:n=1	\$ insul on north med. bay
401	3	8.7411e-2	200 -266 20 -40 426 -427	imp:n=1	\$ steel of roof on north med. bay
410	1	4.354e-5	200 -266 40 -46 430 -431	imp:n=1	\$ insul high bay roof
411	3	8.7411e-2	200 -266 40 -46 431 -432	imp:n=1	\$ steel high bay roof
420	3	8.7411e-2	200 -266 46 -51 425 -426	imp:n=1	\$ insul on south med. bay

```

421 3 8.7411e-2      200 -266 46  -51 426 -427 imp:n=1      $ steel roof on south med. bay
430 1 4.354e-5      (200 -321 10  -20 420 -421):
      (266 -321 20  -51 420 -421):
      (210 -291 51 -101 420 -421) imp:n=1      $ lower insulation
431 3 8.7411e-2      (200 -321 10  -20 421 -422):
      (266 -321 20  -51 421 -422):
      (210 -291 51 -101 421 -422) imp:n=1      $ steel on low roof

```

```

C
C
C *****

```

cell cards for x744h

```

C *****
500 3 8.7411e-2      550 -560 500 -540 410 -700 imp:n=1      $ west wall
510 3 8.7411e-2      660 -670 500 -540 410 -700 imp:n=1      $ east wall
520 3 8.7411e-2      560 -660 500 -510 410 -700 imp:n=1      $ north wall
525 3 8.7411e-2      500 -510 700 -710 imp:n=1      $ north wall west cylinder
526 3 8.7411e-2      500 -510 715 -660 -720 700 imp:n=1      $ north wall east cylinder
530 3 8.7411e-2      530 -540 560 -660 410 -700 imp:n=1      $ south wall
535 3 8.7411e-2      530 -540 560 700 -710 imp:n=1      $ south wall west cylinder
536 3 8.7411e-2      530 -540 715 -660 -720 700 imp:n=1      $ south wall east cylinder
540 1 4.354e-5      510 -520 560 -660 680 -700 imp:n=1      $ air above drum area
545 1 4.354e-5      510 -520 700 -710 imp:n=1      $ air above drums west
546 1 4.354e-5      510 -520 715 -660 700 -720 imp:n=1      $ air above drums east
550 5 -0.375      520 -530 570 -580 410 -690 imp:n=1      $ shelving
560 5 -0.375      520 -530 590 -600 410 -690 imp:n=1      $ shelving
570 5 -0.375      520 -530 620 -630 410 -690 imp:n=1      $ shelving
580 5 -0.375      520 -530 640 -650 410 -690 imp:n=1      $ shelving
590 1 4.354e-5      (520 -530 560 -570 410 -690):
      (520 -530 580 -590 410 -690):
      (520 -530 600 -620 410 -690):
      (520 -530 630 -640 410 -690):
      (520 -530 650 -660 410 -690):
      (520 -530 560 -660 690 -700):
      (520 -530 700 -710):
      (520 -530 715 -660 700 -720) imp:n=1      $ air around shelves
600 3 8.7411e-2      500 -540 550 700 710 -715 imp:n=1      $ roof
610 3 8.7411e-2      500 -540 715 -670 720 -725 700 imp:n=1      $ roof
650 5 -0.375      -762 u=2      imp:n=1      $
652 1 4.354e-5      762 u=2      imp:n=1      $
654 0      -752 750 -756 754 -760 758 imp:n=1 lat=1
      u=1 fill=0:18 0:24 0:0
      2 474r
656 0      510 -520 560 -660 410 -680 fill=1 imp:n=1      $ unit cell repeated

```

```

C
C
C *****

```

cell cards for x343

```

C *****
1010 1 4.354e-5      1280 -1364 1400 -1490 410 -1660 imp:n=1      $ air piece outside bldg
1015 1 4.354e-5      1010 -1280 1400 -1490 1640 -1660 imp:n=1      $ air above offices
1020 1 4.354e-5      1410 -1450 1011 -1020 410 -1630 imp:n=1      $ supervisor area
1030 1 4.354e-5      1460 -1490 1011 -1020 410 -1630 imp:n=1      $ conference room
1040 1 4.354e-5      1410 -1450 1030 -1040 410 -1630 imp:n=1      $ sectrtary
1050 1 4.354e-5      1460 -1490 1030 -1040 410 -1630 imp:n=1      $ foremens office
1060 1 4.354e-5      1410 -1490 1050 -1060 410 -1630 imp:n=1      $ entrance hall
1070 1 4.354e-5      1410 -1490 1070 -1080 410 -1630 imp:n=1      $ controll room
1080 1 4.354e-5      (1420 -1450 1090 -1130 410 -1630):
      (1120 -1130 1450 -1460 410 -1630):
      (1090 -1150 1460 -1470 410 -1630):
      (1090 -1100 1470 -1490 410 -1630):
      (1110 -1150 1470 -1490 410 -1630) imp:n=1      $ men's rest room
1090 1 4.354e-5      1420 -1430 1140 -1150 410 -1630 imp:n=1      $ mens shower
1100 1 4.354e-5      1140 -1150 1440 -1450 410 -1630 imp:n=1      $ mens dry area
1110 1 4.354e-5      1410 -1490 1160 -1170 410 -1630 imp:n=1      $ acess area
1120 1 4.354e-5      1420 -1430 1180 -1190 410 -1630 imp:n=1      $ womens shower
1130 1 4.354e-5      1440 -1450 1180 -1190 410 -1630 imp:n=1      $ womens dry area
1140 1 4.354e-5      (1420 -1450 1200 -1220 410 -1630):
      (1200 -1210 1450 -1460 410 -1630):
      (1180 -1220 1460 -1470 410 -1630):
      (1210 -1220 1470 -1480 410 -1630):
      (1200 -1220 1480 -1490 410 -1630) imp:n=1      $ women rest room
1150 1 4.354e-5      1480 -1490 1180 -1190 410 -1630 imp:n=1      $ janitors room

```

1160	1	4.354e-5	1230 -1240 1410 -1490 410 -1630	imp:n=1	\$ maintenance
1170	1	4.354e-5	1250 -1260 1410 -1490 410 -1630	imp:n=1	\$ electrical
1180	1	4.354e-5	(1011 -1362 1500 -1511 410 -1650):		
			(1270 -1362 1495 -1500 410 -1630):		
			(1280 -1362 1495 -1500 1630 -1640):		
			(1270 -1362 1495 -1500 1640 -1650):		
			(1495 -1500 1011 -1270 1640 -1650)	imp:n=1	\$ air in bay area
1190	1	4.354e-5	1011 -1362 1511 -1520 410 -1650		
			1700 1710 1720 1730 1740		
			1750 1760	imp:n=1	\$ air over cyls
1200	1	4.354e-5	1520 -1530 1011 -1362 410 -1650	imp:n=1	\$ air in autoclave area
1202	1	4.354e-5	1610 -410 1305 -1306 1513 -1516	imp:n=1	\$ north pit
1204	1	4.354e-5	1610 -410 1325 -1326 1513 -1516	imp:n=1	\$ south pit
1205	1	4.354e-5	1605 -410 1010 -1364 1520 -1540	imp:n=1	\$ lower hallway
1206	1	4.354e-5	1601 -1605 1361 -1364 1520 -1525	imp:n=1	\$ air in sump
1210	3	8.7411e-2	1010 -1011 1400 -1495 410 -1630	imp:n=1	\$ walls
1220	2	3.9827e-2	1020 -1030 1410 -1500 410 -1630	imp:n=1	\$
1230	2	3.9827e-2	1040 -1050 1410 -1500 410 -1630	imp:n=1	\$
1240	2	3.9827e-2	1060 -1070 1410 -1500 410 -1630	imp:n=1	\$
1250	2	3.9827e-2	1080 -1090 1410 -1500 410 -1630	imp:n=1	\$
1260	2	3.9827e-2	1100 -1110 1470 -1500 410 -1630	imp:n=1	\$
1270	2	3.9827e-2	1130 -1140 1410 -1460 410 -1630	imp:n=1	\$
1280	2	3.9827e-2	1150 -1160 1410 -1500 410 -1630	imp:n=1	\$
1290	2	3.9827e-2	1170 -1180 1410 -1500 410 -1630	imp:n=1	\$
1300	2	3.9827e-2	1190 -1200 1410 -1460 410 -1630	imp:n=1	\$
1310	2	3.9827e-2	1190 -1200 1470 -1500 410 -1630	imp:n=1	\$
1320	2	3.9827e-2	1220 -1230 1410 -1500 410 -1630	imp:n=1	\$
1330	2	3.9827e-2	1240 -1250 1410 -1500 410 -1630	imp:n=1	\$
1340	2	3.9827e-2	1260 -1270 1410 -1500 410 -1630	imp:n=1	\$
1350	3	8.7411e-2	1270 -1280 1400 -1495 410 -1630	imp:n=1	\$
1360	3	8.7411e-2	1011 -1270 1400 -1410 410 -1630	imp:n=1	\$
1370	2	3.9827e-2	1011 -1020 1450 -1460 410 -1630	imp:n=1	\$
1380	2	3.9827e-2	1011 -1020 1490 -1500 410 -1630	imp:n=1	\$
1400	2	3.9827e-2	1450 -1460 1030 -1040 410 -1630	imp:n=1	\$
1410	2	3.9827e-2	1030 -1040 1490 -1500 410 -1630	imp:n=1	\$
1430	2	3.9827e-2	1050 -1060 1490 -1500 410 -1630	imp:n=1	\$
1450	2	3.9827e-2	1070 -1080 1490 -1500 410 -1630	imp:n=1	\$
1460	2	3.9827e-2	1090 -1130 1410 -1420 410 -1630	imp:n=1	\$
1470	2	3.9827e-2	1090 -1120 1450 -1460 410 -1630	imp:n=1	\$
1480	2	3.9827e-2	1090 -1100 1490 -1500 410 -1630	imp:n=1	\$
1490	2	3.9827e-2	1140 -1150 1410 -1420 410 -1630	imp:n=1	\$
1500	2	3.9827e-2	1140 -1150 1430 -1440 410 -1630	imp:n=1	\$
1510	2	3.9827e-2	1140 -1150 1450 -1460 410 -1630	imp:n=1	\$
1520	2	3.9827e-2	1110 -1150 1490 -1500 410 -1630	imp:n=1	\$
1540	2	3.9827e-2	1160 -1170 1490 -1500 410 -1630	imp:n=1	\$
1550	2	3.9827e-2	1180 -1190 1410 -1420 410 -1630	imp:n=1	\$
1560	2	3.9827e-2	1180 -1190 1430 -1440 410 -1630	imp:n=1	\$
1570	2	3.9827e-2	1180 -1190 1450 -1460 410 -1630	imp:n=1	\$
1580	2	3.9827e-2	1180 -1190 1470 -1480 410 -1630	imp:n=1	\$
1590	2	3.9827e-2	1180 -1190 1490 -1500 410 -1630	imp:n=1	\$
1600	2	3.9827e-2	1200 -1220 1410 -1420 410 -1630	imp:n=1	\$
1610	2	3.9827e-2	1210 -1220 1450 -1460 410 -1630	imp:n=1	\$
1620	2	3.9827e-2	1200 -1210 1470 -1480 410 -1630	imp:n=1	\$
1630	2	3.9827e-2	1200 -1220 1490 -1500 410 -1630	imp:n=1	\$
1640	2	3.9827e-2	1230 -1240 1490 -1500 410 -1630	imp:n=1	\$
1650	2	3.9827e-2	1250 -1260 1490 -1500 410 -1630	imp:n=1	\$
1660	3	8.7411e-2	1280 -1362 1490 -1495 410 -1630	imp:n=1	\$
1670	3	8.7411e-2	1362 -1364 1490 -1540 410 -1650	imp:n=1	\$
1680	3	8.7411e-2	1011 -1362 1530 -1540 410 -1650	imp:n=1	\$
1690	3	8.7411e-2	(1010 -1011 1495 -1540 410 -1630):		
			(1010 -1011 1500 -1540 1630 -1640):		
			(1010 -1011 1495 -1540 1640 -1650)	imp:n=1	\$
1692	3	8.7411e-2	1280 -1362 1490 -1495 1630 -1650	imp:n=1	\$ above 660
1694	3	8.7411e-2	1010 -1280 1490 -1495 1640 -1650	imp:n=1	\$ panel above offices
1696	3	8.7411e-2	1010 -1364 1490 -1540 1650 -1660	imp:n=1	\$ upper roof
1698	3	8.7411e-2	1010 -1280 1400 -1500 1630 -1640	imp:n=1	\$ lower roof

c

now for the cylinders

c

1700	6	4.052e-2	1511 -1520 -1702	imp:n=1	\$ uf6
1701	1	4.354e-5	1511 -1520 1702 -1701	imp:n=1	\$ air
1702	3	8.7411e-2	1511 -1520 1701 -1700	imp:n=1	\$ steel
1710	6	4.052e-2	1511 -1520 -1712	imp:n=1	\$ all are uranium, air, steel
1711	1	4.354e-5	1511 -1520 1712 -1711	imp:n=1	\$
1712	3	8.7411e-2	1511 -1520 1711 -1710	imp:n=1	\$
1720	6	4.052e-2	1511 -1520 -1722	imp:n=1	\$
1721	1	4.354e-5	1511 -1520 1722 -1721	imp:n=1	\$
1722	3	8.7411e-2	1511 -1520 1721 -1720	imp:n=1	\$
1730	6	4.052e-2	1511 -1520 -1732	imp:n=1	\$
1731	1	4.354e-5	1511 -1520 1732 -1731	imp:n=1	\$
1732	3	8.7411e-2	1511 -1520 1731 -1730	imp:n=1	\$

```

1740 6 4.052e-2 1511 -1520 -1742 imp:n=1 $
1741 1 4.354e-5 1511 -1520 1742 -1741 imp:n=1 $
1742 3 8.7411e-2 1511 -1520 1741 -1740 imp:n=1 $
1750 6 4.052e-2 1511 -1520 -1752 imp:n=1 $
1751 1 4.354e-5 1511 -1520 1752 -1751 imp:n=1 $
1752 3 8.7411e-2 1511 -1520 1751 -1750 imp:n=1 $
1760 6 4.052e-2 1511 -1520 -1762 imp:n=1 $
1761 1 4.354e-5 1511 -1520 1762 -1761 imp:n=1 $
1762 3 8.7411e-2 1511 -1520 1761 -1760 imp:n=1 $
c
c concrete floor (only for bldg x343)
c
1770 2 7.9654e-2 (400 -1610 1010 -1364 1400 -1520):
(1610 -410 1010 -1364 1400 -1510):
(400 -1605 1010 -1361 1520 -1540):
(400 -1601 1361 -1364 1520 -1540):
(1601 -1605 1361 -1364 1525 -1540):
(1610 -410 1010 -1290 1510 -1520):
(1610 -410 1300 -1305 1510 -1520):
(1610 -410 1305 -1306 1510 -1513):
(1610 -410 1305 -1306 1516 -1520):
(1610 -410 1306 -1310 1510 -1520) imp:n=1 $
1771 2 7.9654e-2 (1610 -410 1320 -1325 1510 -1520) imp:n=1 $
1772 2 7.9654e-2 (1610 -410 1325 -1326 1510 -1513) imp:n=1 $
1773 2 7.9654e-2 (1610 -410 1325 -1326 1516 -1520) imp:n=1 $
1774 2 7.9654e-2 (1610 -410 1326 -1330 1510 -1520) imp:n=1 $
1775 2 7.9654e-2 (1610 -410 1340 -1350 1510 -1520) imp:n=1 $
1776 2 7.9654e-2 (1610 -410 1360 -1364 1510 -1520) imp:n=1 $
c
c air under cyl's
c
1780 1 4.354e-5 (1610 -410 1511 -1520 1290 -1300 1700 1710):
(1610 -410 1290 -1300 1510 -1511) imp:n=1 $
1790 1 4.354e-5 (1610 -410 1511 -1520 1310 -1320 1720 1730):
(1610 -410 1510 -1511 1310 -1320) imp:n=1 $
1800 1 4.354e-5 (1610 -410 1511 -1520 1330 -1340 1740 1750):
(1610 -410 1510 -1511 1330 -1340) imp:n=1 $
1810 1 4.354e-5 (1610 -410 1511 -1520 1350 -1360 1760):
(1610 -410 1510 -1511 1350 -1360) imp:n=1 $
c
c
c *****
c
c common cells cards for all buildings
c
c *****
c
c ground and air cards
c
310 2 7.9654e-2 400 -410 -998 (1364:-1010:1540:-1400)
imp:n=1 $ concrete ground
c
350 1 4.354e-5 (-10:101:-200:321:432)
((-500:540:-550:670) -700):
(700 715 725):(700 -715 -550):
(700 -715 -500):(700 -725 -500):
(700 -715 540):(700 -725 540))
(1364:-1010:1540:-1400:1660)
410 -998 imp:n=1 $ air around buildings
c
c
c internal and external world
c
c
c
990 0 (400 998 -999):
(-400 -999) imp:n=1 $ internal world
999 0 999 imp:n=0 $ external world
c
c *****
c
c surface cards for x744g
c
c *****
c
c
10 px 27432 $ north end of loading dock
20 px 28651 $ north face of building
21 px 28651.191 $ north face of building

```


[illegible]


```

690 pz 182.88 $
700 pz 459.74 $
710 c/x -5341.62 -820.42 1485.9 $
715 c/x -5341.62 -820.42 1485.991 $
720 c/x -3832.86 -820.42 1485.9 $
725 c/x -3832.86 -820.42 1485.991 $
750 px 25907.99 $ unit cell boundary
752 px 26029.92 $
754 py -6096.01 $
756 py -5974.08 $
758 pz -0.01 $
760 pz 88.31 $
762 c/z 25968.96 -6035.04 28.575 $ barrel
c
c
c
c *****
c
c surfaces for x343
c
c *****
c
c
1010 px 0.0 $
1011 px 0.191 $
1020 px 479.84 $
1030 px 511.17 $
1040 px 856.61 $
1050 px 869.95 $
1060 px 1036.32 $
1070 px 1049.65 $
1080 px 1831.97 $
1090 px 1832.64 $
1100 px 1985.04 $
1110 px 2005.36 $
1120 px 2061.23 $
1130 px 2183.15 $
1140 px 2203.47 $
1150 px 2355.87 $
1160 px 2376.19 $
1170 px 2437.15 $
1180 px 2457.47 $
1190 px 2609.87 $
1200 px 2630.19 $
1210 px 2782.59 $
1220 px 2874.03 $
1230 px 2894.35 $
1240 px 3183.91 $
1250 px 3204.23 $
1260 px 3850.68 $
1270 px 3870.809 $
1280 px 3871.00 $
1290 px 457.2 $ these are for bays under clyinders
1300 px 1066.8 $
1305 px 1158.2 $ scale pit
1306 px 1524.0 $ scale pit
1310 px 1676.4 $
1320 px 2286.00 $
1325 px 2377.4 $ scale pit
1326 px 2743.2 $ scale pit
1330 px 2895.6 $
1340 px 3505.2 $
1350 px 3916.68 $
1360 px 4160.52 $
1361 px 4739.6 $ side of sump
1362 px 4785.169 $
1364 px 4785.36 $
1400 py 0.0 $
1410 py 0.191 $
1420 py 20.32 $
1430 py 172.72 $
1440 py 193.04 $
1450 py 345.44 $
1460 py 365.76 $
1470 py 518.16 $
1480 py 538.48 $
1490 py 723.00 $
1495 py 723.191 $
1500 py 743.58 $
1510 py 1480.19 $ these are for pits under cylinders
1511 py 2136.19 $ these are for cyl ends

```

```

1513 py 2090.4 $ scale pit
1516 py 2288.5 $ scale pit
1520 py 2745.74 $
1525 py 2806.7 $ side of sump
1530 py 3035.109 $
1540 py 3035.3 $
c 1600 pz -3000.00 $
1601 pz -381.0 $ bottom of sump
1605 pz -259.08 $ bottom of back hallway
1610 pz -106.68 $ pit bottom
c 1620 pz 0.0 $
1630 pz 396.24 $
1640 pz 396.331 $
1650 pz 1306.20 $
1660 pz 1306.291 $
1702 c/y 563.88 22.86 60.96 $ cyl 1 uranium
1701 c/y 563.88 22.86 88.90 $ cyl 1 inner steel
1700 c/y 563.88 22.86 91.44 $ cyl 1 outter steel
1712 c/y 960.12 22.86 60.96 $ cyl 2 uranium
1711 c/y 960.12 22.86 88.90 $ cyl 2 inner steel
1710 c/y 960.12 22.86 91.44 $ cyl 2 outter steel
1722 c/y 1783.08 22.86 60.96 $ cyl 3 uranium
1721 c/y 1783.08 22.86 88.90 $ cyl 3 inner steel
1720 c/y 1783.08 22.86 91.44 $ cyl 3 outter steel
1732 c/y 2179.32 22.86 60.96 $ cyl 4 uranium
1731 c/y 2179.32 22.86 88.90 $ cyl 4 inner steel
1730 c/y 2179.32 22.86 91.44 $ cyl 4 outter steel
1742 c/y 3002.28 52.55 60.96 $ cyl 5 uranium
1741 c/y 3002.28 52.55 104.14 $ cyl 5 inner steel
1740 c/y 3002.28 52.55 106.68 $ cyl 5 outter steel
1752 c/y 3398.52 52.55 60.96 $ cyl 6 uranium
1751 c/y 3398.52 52.55 104.14 $ cyl 6 inner steel
1750 c/y 3398.52 52.55 106.68 $ cyl 6 outter steel
1762 c/y 4038.6 52.55 60.96 $ cyl 7 uranium
1761 c/y 4038.6 52.55 104.14 $ cyl 7 inner steel
1760 c/y 4038.6 52.55 106.68 $ cyl 7 outter steel

```

```

c
c
c *****

```

```

c common surface cards for all buildings

```

```

c *****

```

```

998 s 27432 6858 0 500000 $ enclosing sphere
999 s 27432 6858 0 600000 $ enclosing sphere

```

```

c
c
c *****

```

```

c source term

```

```

c *****

```

```

sdef pos=4785 2746 -380.9 erg=d1

```

```

c sdef sur=999 nrm=-1 dir=d1

```

```

c sbl -21 2

```

```

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
c *****

```

```

c material cards

```

```

c *****

```

```

m1 7014.50c 3.570e-5 $ air

```

```

8016.50c 7.840e-6

```

```

m2 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
m3 6012.50c 3.921e-3 $ steel
26000.50c 8.349e-2
m5 6012.50c 6.0 $ wood
1001.50c 10.0
8016.50c 5.0
m6 92238.50c 8.682e-3 $ UF6
9019.50c 5.209e-2
c
c
c *****
c
c tally cards
c
c *****
c
c
fc5 x343 building detector
f5:n 2591 745 300 1.0
fc15 x744G east building detector
f15:n 31092 19660 300 1.0
f25c x744g west building detector
f25:n 32918 12344 300 1.0
e0 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
c
c
c *****
c
c peripheral cards
c
c *****
c
mode n
c 17 keV cut off
c cut:n j 0.017
ctme 1
c void
nps 50000000
prtmp 3j 4
c dbcn 31277116122605
print
c
c

```

0000000000

cell cards for x344

ROOMS

CC

c horizontal walls

c

c

500	20	3.9827e-2	10	-150	610	-620	1220	-1230	imp:n=1	\$
600	20	3.9827e-2	10	-195	630	-640	1220	-1230	imp:n=1	\$
610	20	3.9827e-2	110	-195	650	-660	1220	-1230	imp:n=1	\$
620	20	3.9827e-2	10	-80	670	-680	1220	-1230	imp:n=1	\$
630	20	3.9827e-2	110	-170	690	-700	1220	-1230	imp:n=1	\$
640	20	3.9827e-2	10	-80	710	-720	1220	-1230	imp:n=1	\$
650	20	3.9827e-2	10	-80	730	-740	1220	-1230	imp:n=1	\$
660	20	3.9827e-2	110	-190	750	-760	1220	-1230	imp:n=1	\$
670	20	3.9827e-2	10	-40	770	-780	1220	-1230	imp:n=1	\$
680	20	3.9827e-2	90	-120	790	-800	1220	-1230	imp:n=1	\$
690	20	3.9827e-2	50	-80	810	-820	1220	-1230	imp:n=1	\$
700	20	3.9827e-2	110	-190	830	-840	1220	-1230	imp:n=1	\$
800	20	3.9827e-2	10	-60	850	-860	1220	-1230	imp:n=1	\$
900	20	3.9827e-2	10	-60	870	-880	1220	-1230	imp:n=1	\$
910	20	3.9827e-2	110	-500	870	-880	1220	-1230	imp:n=1	\$
920	20	3.9827e-2	260	-530	900	-910	1220	-1230	imp:n=1	\$
930	20	3.9827e-2	470	-530	930	-940	1220	-1230	imp:n=1	\$
940	20	3.9827e-2	410	-440	930	-940	1220	-1230	imp:n=1	\$
950	20	3.9827e-2	260	-420	630	-640	1220	-1230	imp:n=1	\$
960	20	3.9827e-2	430	-530	630	-640	1220	-1230	imp:n=1	\$
970	20	3.9827e-2	510	-530	950	-960	1220	-1230	imp:n=1	\$
980	20	3.9827e-2	260	-530	970	-980	1220	-1230	imp:n=1	\$
990	20	3.9827e-2	220	-500	690	-700	1220	-1230	imp:n=1	\$
1000	20	3.9827e-2	240	-280	990	-1000	1220	-1230	imp:n=1	\$
1010	20	3.9827e-2	290	-440	1010	-1020	1220	-1230	imp:n=1	\$
1020	20	3.9827e-2	310	-440	1030	-1040	1220	-1230	imp:n=1	\$
1030	20	3.9827e-2	220	-500	1050	-1060	1220	-1230	imp:n=1	\$
1040	20	3.9827e-2	200	-500	750	-760	1220	-1230	imp:n=1	\$
1050	20	3.9827e-2	470	-500	1070	-1080	1220	-1230	imp:n=1	\$
1060	20	3.9827e-2	330	-460	1090	-1100	1220	-1230	imp:n=1	\$

c

c

c vertical walls

c

c

1200	20	3.9827e-2	10	-20	860	-870	1220	-1230	imp:n=1	\$
1210	20	3.9827e-2	30	-40	740	-770	1220	-1230	imp:n=1	\$
1220	20	3.9827e-2	50	-60	740	-810	1220	-1230	imp:n=1	\$
1230	20	3.9827e-2	50	-60	820	-850	1220	-1230	imp:n=1	\$
1240	20	3.9827e-2	50	-60	860	-870	1220	-1230	imp:n=1	\$
1250	20	3.9827e-2	70	-80	820	-880	1220	-1230	imp:n=1	\$
1260	20	3.9827e-2	70	-80	740	-810	1220	-1230	imp:n=1	\$
1270	20	3.9827e-2	70	-80	720	-730	1220	-1230	imp:n=1	\$
1280	20	3.9827e-2	70	-80	680	-710	1220	-1230	imp:n=1	\$
1290	20	3.9827e-2	70	-80	640	-670	1220	-1230	imp:n=1	\$
1300	20	3.9827e-2	90	-100	640	-790	1220	-1230	imp:n=1	\$
1310	20	3.9827e-2	110	-120	840	-870	1220	-1230	imp:n=1	\$
1320	20	3.9827e-2	110	-120	800	-830	1220	-1230	imp:n=1	\$
1330	20	3.9827e-2	110	-120	760	-790	1220	-1230	imp:n=1	\$
1340	20	3.9827e-2	110	-120	700	-750	1220	-1230	imp:n=1	\$
1350	20	3.9827e-2	110	-120	660	-690	1220	-1230	imp:n=1	\$
1360	20	3.9827e-2	110	-120	640	-650	1220	-1230	imp:n=1	\$
1370	20	3.9827e-2	130	-140	660	-690	1220	-1230	imp:n=1	\$
1380	20	3.9827e-2	160	-170	660	-690	1220	-1230	imp:n=1	\$
1390	20	3.9827e-2	160	-170	840	-870	1220	-1230	imp:n=1	\$
1400	20	3.9827e-2	180	-190	840	-870	1220	-1230	imp:n=1	\$
1410	20	3.9827e-2	180	-190	1060	-750	1220	-1230	imp:n=1	\$
1420	20	3.9827e-2	200	-210	760	-870	1220	-1230	imp:n=1	\$
1430	20	3.9827e-2	220	-230	700	-1050	1220	-1230	imp:n=1	\$
1440	20	3.9827e-2	240	-250	1000	-1050	1220	-1230	imp:n=1	\$
1450	20	3.9827e-2	240	-250	700	-990	1220	-1230	imp:n=1	\$
1460	20	3.9827e-2	260	-270	760	-870	1220	-1230	imp:n=1	\$
1470	20	3.9827e-2	260	-270	640	-970	1220	-1230	imp:n=1	\$
1480	20	3.9827e-2	260	-270	910	-630	1220	-1230	imp:n=1	\$
1490	20	3.9827e-2	290	-300	700	-1010	1220	-1230	imp:n=1	\$
1500	20	3.9827e-2	310	-320	1040	-1050	1220	-1230	imp:n=1	\$
1510	20	3.9827e-2	330	-340	1100	-870	1220	-1230	imp:n=1	\$
1520	20	3.9827e-2	330	-340	760	-1090	1220	-1230	imp:n=1	\$
1530	20	3.9827e-2	350	-360	700	-1010	1220	-1230	imp:n=1	\$
1540	20	3.9827e-2	370	-380	700	-1010	1220	-1230	imp:n=1	\$
1550	20	3.9827e-2	390	-400	1040	-1050	1220	-1230	imp:n=1	\$
1560	20	3.9827e-2	410	-420	640	-970	1220	-1230	imp:n=1	\$
1570	20	3.9827e-2	410	-420	940	-630	1220	-1230	imp:n=1	\$
1580	20	3.9827e-2	430	-440	1040	-1050	1220	-1230	imp:n=1	\$
1590	20	3.9827e-2	430	-440	1020	-1030	1220	-1230	imp:n=1	\$
1600	20	3.9827e-2	430	-440	700	-1010	1220	-1230	imp:n=1	\$
1610	20	3.9827e-2	430	-440	640	-970	1220	-1230	imp:n=1	\$
1620	20	3.9827e-2	430	-440	910	-930	1220	-1230	imp:n=1	\$

```

1630 20 3.9827e-2 470 -480 640 -970 1220 -1230 imp:n=1 $
1640 20 3.9827e-2 470 -480 910 -930 1220 -1230 imp:n=1 $
1650 20 3.9827e-2 450 -460 760 -1090 1220 -1230 imp:n=1 $
1660 20 3.9827e-2 470 -480 760 -1070 1220 -1230 imp:n=1 $
1670 20 3.9827e-2 490 -500 1080 -870 1220 -1230 imp:n=1 $
1680 20 3.9827e-2 490 -500 760 -1070 1220 -1230 imp:n=1 $
1690 20 3.9827e-2 490 -500 1060 -750 1220 -1230 imp:n=1 $
1700 20 3.9827e-2 490 -500 700 -1050 1220 -1230 imp:n=1 $
1710 20 3.9827e-2 490 -500 980 -690 1220 -1230 imp:n=1 $
1720 20 3.9827e-2 510 -520 960 -970 1220 -1230 imp:n=1 $
1730 20 3.9827e-2 510 -520 640 -950 1220 -1230 imp:n=1 $
c
c
c air around building and concrete
c
c
2000 10 4.354e-5 (151 -196 921 -631 1220 -1231):
(151 -216 891 -921 1220 -1231):
(151 -541 601 -891 1220 -1231) imp:n=1 $
2010 10 4.354e-5 (501 -541 981 -881 1220 -1231):
(531 -541 911 -981 1220 -1231) imp:n=1 $
2020 20 3.9827e-2 (5200 -1220 -9998)
(-4100:4101:-4102:4103)
(-4005:4006:-5110:5120)
(-5020:4004:-5110:5120)
(-5000:5015:-5125:5130) imp:n=1 $ 3" concrete floor
2022 20 3.9827e-2 (5210 -5200 -9998)
(-5010:430:5150:-5140)
(-5030:5040:5140:-5120)
(-5000:5020:5130:-5100)
(-5020:5060:5120:-5110)
(-4100:4101:-4102:4103) imp:n=1 $ layer 1
2024 20 3.9827e-2 (5220 -5210 -9998)
(-5000:5020:5130:-5100) imp:n=1 $ layer 2
2026 20 3.9827e-2 5230 -5220 -9998 5500 imp:n=1 $ layer 3
2028 20 3.9827e-2 1200 -5230 -9998 imp:n=1 $ layer 4
2030 10 4.354e-5 (-9:541:-601:881:1231) 1220 -9998 imp:n=1 $ giant air
c
c
c internal and external world
c
c
2040 0 (-1200 -9998):(9998 -9999) imp:n=1 $
2050 0 9999 imp:n=0 $
c
c
c steel walls
c
3000 30 8.7411e-2 9 -501 880 -881 1220 -1230 imp:n=1 $
3010 30 8.7411e-2 500 -501 981 -880 1220 -1230 imp:n=1 $
3020 30 8.7411e-2 500 -531 980 -981 1220 -1230 imp:n=1 $
3030 30 8.7411e-2 530 -531 911 -980 1220 -1230 imp:n=1 $
3040 30 8.7411e-2 530 -541 910 -911 1220 -1230 imp:n=1 $
3050 30 8.7411e-2 540 -541 890 -910 1220 -1230 imp:n=1 $
3060 30 8.7411e-2 216 -541 891 -890 1220 -1230 imp:n=1 $
3070 30 8.7411e-2 216 -215 890 -921 1220 -1230 imp:n=1 $
3080 30 8.7411e-2 196 -215 921 -920 1220 -1230 imp:n=1 $
3090 30 8.7411e-2 196 -195 920 -631 1220 -1230 imp:n=1 $
3100 30 8.7411e-2 150 -195 631 -630 1220 -1230 imp:n=1 $
3110 30 8.7411e-2 150 -151 600 -631 1220 -1230 imp:n=1 $
3120 30 8.7411e-2 9 -151 601 -600 1220 -1230 imp:n=1 $
3130 30 8.7411e-2 9 -10 600 -880 1220 -1230 imp:n=1 $
3140 30 8.7411e-2 (9 -151 601 -881 1230 -1231):
(151 -196 631 -881 1230 -1231):
(196 -216 921 -881 1230 -1231):
(216 -501 891 -881 1230 -1231):
(501 -531 891 -981 1230 -1231):
(531 -541 891 -911 1230 -1231) imp:n=1 $
c
c
c here come the cylinders
c
c
4000 60 4.052e-2 4001 -4002 -4007 imp:n=1 $ uf6 c1
4010 10 4.354e-5 4001 -4002 4007 -4008 imp:n=1 $ air c1
4020 30 8.7411e-2 4001 -4002 4008 -4009 imp:n=1 $ steel c1
4030 60 4.052e-2 4001 -4002 -4010 imp:n=1 $ uf6 c2
4040 10 4.354e-5 4001 -4002 4010 -4011 imp:n=1 $ air c2
4050 30 8.7411e-2 4001 -4002 4011 -4012 imp:n=1 $ steel c2
4060 60 4.052e-2 4001 -4002 -4013 imp:n=1 $ uf6 c3
4070 10 4.354e-5 4001 -4002 4013 -4014 imp:n=1 $ air c3

```

```

4080 30 8.7411e-2 4001 -4002 4014 -4015 imp:n=1 $ steel c3
4090 60 4.052e-2 4001 -4002 -4016 imp:n=1 $ uf6 c4
4100 10 4.354e-5 4001 -4002 4016 -4017 imp:n=1 $ air c4
4110 30 8.7411e-2 4001 -4002 4017 -4018 imp:n=1 $ steel c4
4120 60 4.052e-2 4003 -4004 -4019 imp:n=1 $ uf6 c5
4130 10 4.354e-5 4003 -4004 4019 -4020 imp:n=1 $ air c5
4140 30 8.7411e-2 4003 -4004 4020 -4021 imp:n=1 $ steel c5
4150 60 4.052e-2 4005 -4006 -4019 imp:n=1 $ uf6 c6
4160 10 4.354e-5 4005 -4006 4019 -4020 imp:n=1 $ air c6
4170 30 8.7411e-2 4005 -4006 4020 -4021 imp:n=1 $ steel c6
c
c
c below grade air
c
6000 10 4.354e-5 5020 -4004 5110 -5120 5200 -1220 imp:n=1 $ air under autoclave
6010 10 4.354e-5 4005 -4006 5110 -5120 5200 -1220 imp:n=1 $ air under other autoclave
6020 10 4.354e-5 (5010 -430 5140 -5150 5210 -5200):
(5030 -5040 5120 -5140 5210 -5200):
(5020 -5060 5110 -5120 5210 -5200) imp:n=1 $ air in pipe trenches
(5000 -5020 5100 -5130 5220 -5200):
(5000 -5015 5125 -5130 5200 -1220):
imp:n=1 $ air in sump room
(-5500 5230 -5220)
c
c
c detector cells
c
c
6500 10 4.354e-5 -6000 imp:n=1 $ east detector
6510 10 4.354e-5 -6010 imp:n=1 $ west detector
c
c
c *****
c
c surface cards for x344
c
c *****
c
c
9 px 1736.81 $
10 px 1737 $
20 px 1757 $
30 px 2448 $
40 px 2468 $
50 px 2631 $
60 px 2651 $
70 px 3371 $
80 px 3391 $
90 px 3615 $
100 px 3645 $
110 px 6736 $
120 px 6756 $
130 px 7061 $
140 px 7076 $
150 px 7346 $
151 px 7346.19 $
160 px 7838 $
170 px 7853 $
180 px 8554 $
190 px 8585 $
195 px 9133 $
196 px 9132.81 $
200 px 9195 $
210 px 9215 $
215 px 10352 $
216 px 10351.81 $
220 px 10454 $
230 px 10474 $
240 px 10916 $
250 px 10936 $
260 px 10992 $
270 px 11012 $
280 px 11373 $
290 px 11480 $
300 px 11500 $
310 px 11556 $
320 px 11576 $
330 px 11713 $
340 px 11733 $
350 px 11877 $
360 px 11897 $
370 px 11958 $

```

380	px	11978	\$
390	px	12130	\$
400	px	12150	\$
410	px	12211	\$
420	px	12226	\$
430	px	12374	\$
440	px	12394	\$
450	px	12495	\$
460	px	12515	\$
470	px	12729	\$
480	px	12745	\$
490	px	13309	\$
500	px	13329	\$
501	px	13329.19	\$
510	px	13583	\$
520	px	13599	\$
530	px	14071	\$
531	px	14071.19	\$
540	px	15290	\$
541	px	15290.19	\$
600	py	0	\$
601	py	-0.19	\$
610	py	1524	\$
620	py	1554	\$
630	py	3048	\$
631	py	3047.81	\$
640	py	3078	\$
650	py	3383	\$
660	py	3398	\$
670	py	3890	\$
680	py	3910	\$
690	py	4048	\$
700	py	4063	\$
710	py	4459	\$
720	py	4479	\$
730	py	4735	\$
740	py	4755	\$
750	py	5095	\$
760	py	5110	\$
770	py	5202	\$
780	py	5222	\$
790	py	5349	\$
800	py	5379	\$
810	py	5609	\$
820	py	5629	\$
830	py	5791	\$
840	py	5821	\$
850	py	6080	\$
860	py	6100	\$
870	py	6411	\$
880	py	6431	\$
881	py	6431.19	\$
890	py	884	\$
891	py	883.81	\$
900	py	2149	\$
910	py	2164	\$
911	py	2164.19	\$
920	py	2682	\$
921	py	2681.81	\$
930	py	2875	\$
940	py	2896	\$
950	py	3352	\$
960	py	3368	\$
970	py	3673	\$
980	py	3688	\$
981	py	3688.19	\$
990	py	4185	\$
1000	py	4205	\$
1010	py	4339	\$
1020	py	4359	\$
1030	py	4496	\$
1040	py	4516	\$
1050	py	4862	\$
1060	py	4882	\$
1070	py	5446	\$
1080	py	5466	\$
1090	py	5649	\$
1100	py	5669	\$
1200	pz	-1000	\$
c	1210	pz	-100 \$
1220	pz	0	\$

1230	pz	609.6	\$		
1231	pz	609.689	\$		
4001	px	4755	\$		
4002	px	5365	\$		
4003	px	11831	\$		
4004	px	12440	\$		
4005	px	12684	\$		
4006	px	13294	\$		
4007	c/x	2822	335.28	60.96	\$
4008	c/x	2822	335.28	119.38	\$
4009	c/x	2822	335.28	121.92	\$
4010	c/x	2474	335.28	60.96	\$
4011	c/x	2474	335.28	119.38	\$
4012	c/x	2474	335.28	121.92	\$
4013	c/x	2127	335.28	60.96	\$
4014	c/x	2127	335.28	119.38	\$
4015	c/x	2127	335.28	121.92	\$
4016	c/x	1780	335.28	60.96	\$
4017	c/x	1780	335.28	119.38	\$
4018	c/x	1780	335.28	121.92	\$
4019	c/x	1882.3	124.46	60.96	\$
4020	c/x	1882.3	124.46	104.14	\$
4021	c/x	1882.3	124.46	106.68	\$
4022	c/x	1882.3	124.46	60.96	\$
4023	c/x	1882.3	124.46	104.14	\$
4024	c/x	1882.3	124.46	106.68	\$
4100	px	14165	\$		
4101	px	14592	\$		
4102	py	1311	\$		
4103	py	1524	\$		
5000	px	11195	\$		
5010	px	11216	\$		
5015	px	11378	\$		
5020	px	11801	\$		
5030	px	11993	\$		
5040	px	12069	\$		
5060	px	14802	\$		
5100	py	1730	\$		
5110	py	1836	\$		
5120	py	1928	\$		
5125	py	1944	\$		
5130	py	2035	\$		
5140	py	2316	\$		
5150	py	2393	\$		
5200	pz	-7.62	\$		
5210	pz	-60.96	\$		
5220	pz	-243.84	\$		
5230	pz	-396.24	\$		
5500	c/z	11271	1806	46	\$ sump cyl
6000	s	11785	3997	243.84	50 \$ east detector sphere
6010	s	3993	3825	243.84	50 \$ west detector sphere
9998	so	500000	\$		
9999	so	600000	\$		

```

C
C *****
C
C          source term
C
C *****
C      sdef sur=9999 nrm=-1 dir=d1
C      sbl -21 2
C      sdef pos=11271 1806 -396 erg=d1
C      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 *****
C
C          material cards
C
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
m50  6012.50c  6.0      $ wood
      1001.50c  10.0
      8016.50c  5.0
m60  92238.50c 8.682e-3  $ UF6
      9019.50c  5.209e-2

```

```

c
c
c *****
c
c      tally cards
c
c *****
c
c

```

```

fc4      east detector 19Cg
f4:n      6500
fc14     west detector 7Da
f14:n      6510
fc5      east detector 19Cg
f5:n      11785 3997 243.84 1.0
fc15     west detector 7Da
f15:n      3993 3825 243.84 1.0
e0      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

```

```

c
c
c *****
c
c      peripheral cards
c
c *****
c

```

```

mode      n
ctme      4100
c          void
prdump    3j 4
print
c
c

```

APPENDIX B

ABSORBED DOSE RATE CALCULATION SPREADSHEETS

Detector Response for the X-744G, X-744H and X-343 Complex						
The source is located in the bottom center of the north scale pit in X-343 (S1)						
	Upper Energy Boundary (MeV)	Henderson Free in Air Tissue Kerma Factor (rads/(n/cm^2))	X-744G East Detector Neutron Fluence/sp	Relative Error	Absorbed Dose Rate (rads/s)	Error
Source Rate (n/s)	1.00E-11		0.00E+00	0		
6.52E+13	1.00E-08	6.03E-17	0.00E+00	0	0	0
5% U-235	3.00E-08	2.46E-16	0.00E+00	0	0	0
P = 2881 W	5.00E-08	3.69E-16	0.00E+00	0	0	0
	1.00E-07	6.52E-16	0.00E+00	0	0	0
	2.25E-07	1.40E-15	0.00E+00	0	0	0
	3.25E-07	2.54E-15	0.00E+00	0	0	0
	4.00E-07	3.37E-15	0.00E+00	0	0	0
	8.00E-07	5.39E-15	0.00E+00	0	0	0
	1.00E-06	8.37E-15	0.00E+00	0	0	0
	1.13E-06	9.93E-15	0.00E+00	0	0	0
	1.30E-06	1.13E-14	0.00E+00	0	0	0
	1.77E-06	1.42E-14	0.00E+00	0	0	0
	3.05E-06	2.20E-14	0.00E+00	0	0	0
	1.00E-05	5.46E-14	0.00E+00	0	0	0
	3.00E-05	1.70E-13	0.00E+00	0	0	0
	1.00E-04	5.43E-13	0.00E+00	0	0	0
	5.50E-04	2.46E-12	0.00E+00	0	0	0
	3.00E-03	1.35E-11	0.00E+00	0	0	0
	1.70E-02	7.20E-11	0.00E+00	0	0	0
	1.00E-01	3.12E-10	4.34E-12	0.0524	8.83446E-08	4.63E-09
	4.00E-01	1.08E-09	4.88E-12	0.0429	3.43295E-07	1.47E-08
	9.00E-01	1.79E-09	3.56E-12	0.0294	4.15525E-07	1.22E-08
	1.40E+00	2.44E-09	1.57E-12	0.0577	2.50267E-07	1.44E-08
	1.85E+00	2.79E-09	7.48E-13	0.0544	1.35914E-07	7.39E-09
	3.00E+00	3.22E-09	8.93E-13	0.0624	1.87446E-07	1.17E-08
	6.43E+00	4.18E-09	3.86E-13	0.0585	1.05092E-07	6.15E-09
	2.00E+01	4.72E-09	2.89E-14	0.0861	8.89066E-09	7.65E-10
				Total AD (rad/s) =	1.53477E-06	2.87E-08
				Total AD (mrad/hr) =	5.525186097	0.103462

[illegible]

Detector Response for the X-744G, X-744H and X-343 Complex						
The source is located in the southwest corner of the sump pit in the southeast corner of X-343 (S2)						
	Upper Energy Boundary (MeV)	Henderson Free in Air Tissue Kerma Factor (rads/(n/cm^2))	X-744G East Detector Neutron Fluence/sp	Relative Error	Absorbed Dose Rate (rads/s)	Error
Source Rate (n/s)	1.00E-11		0.00E+00	0		
6.52E+13	1.00E-08	6.03E-17	0.00E+00	0	0	0
5% U-235	3.00E-08	2.46E-16	0.00E+00	0	0	0
P = 2881 W	5.00E-08	3.69E-16	0.00E+00	0	0	0
	1.00E-07	6.52E-16	0.00E+00	0	0	0
	2.25E-07	1.40E-15	0.00E+00	0	0	0
	3.25E-07	2.54E-15	0.00E+00	0	0	0
	4.00E-07	3.37E-15	0.00E+00	0	0	0
	8.00E-07	5.39E-15	0.00E+00	0	0	0
	1.00E-06	8.37E-15	0.00E+00	0	0	0
	1.13E-06	9.93E-15	0.00E+00	0	0	0
	1.30E-06	1.13E-14	0.00E+00	0	0	0
	1.77E-06	1.42E-14	0.00E+00	0	0	0
	3.05E-06	2.20E-14	0.00E+00	0	0	0
	1.00E-05	5.46E-14	0.00E+00	0	0	0
	3.00E-05	1.70E-13	0.00E+00	0	0	0
	1.00E-04	5.43E-13	0.00E+00	0	0	0
	5.50E-04	2.46E-12	0.00E+00	0	0	0
	3.00E-03	1.35E-11	0.00E+00	0	0	0
	1.70E-02	7.20E-11	0.00E+00	0	0	0
	1.00E-01	3.12E-10	2.65E-13	0.0669	5.39757E-09	3.61E-10
	4.00E-01	1.08E-09	3.39E-13	0.0967	2.38465E-08	2.31E-09
	9.00E-01	1.79E-09	2.30E-13	0.051	2.67858E-08	1.37E-09
	1.40E+00	2.44E-09	9.67E-14	0.05	1.53758E-08	7.69E-10
	1.85E+00	2.79E-09	5.64E-14	0.1738	1.0261E-08	1.78E-09
	3.00E+00	3.22E-09	7.39E-14	0.1187	1.55095E-08	1.84E-09
	6.43E+00	4.18E-09	3.07E-14	0.191	8.35584E-09	1.6E-09
	2.00E+01	4.72E-09	1.75E-15	0.1122	5.37326E-10	6.03E-11
				Total AD (rad/s) =	1.06069E-07	4.13E-09
				Total AD (mrad/hr) =	0.381849456	0.014854

X-744G West Detector				X-343 Detector			
Neutron Fluence/sp	Relative Error	Absorbed Dose Rate (rads/s)	Error	Neutron Fluence/sp	Relative Error	Absorbed Dose Rate (rads/s)	Error
0.00E+00	0			0.00E+00	0		
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
4.37E-13	0.1562	8.88306E-09	1.39E-09	2.86E-11	0.0465	5.80573E-07	2.7E-08
3.94E-13	0.0868	2.7752E-08	2.41E-09	2.58E-11	0.0221	1.81882E-06	4.02E-08
2.59E-13	0.1383	3.02556E-08	4.18E-09	1.57E-11	0.0254	1.82668E-06	4.64E-08
9.07E-14	0.0623	1.44274E-08	8.99E-10	8.11E-12	0.123	1.29033E-06	1.59E-07
3.57E-14	0.0706	6.49762E-09	4.59E-10	4.00E-12	0.0471	7.27863E-07	3.43E-08
6.54E-14	0.1698	1.37164E-08	2.33E-09	5.31E-12	0.0402	1.11473E-06	4.48E-08
2.05E-14	0.1368	5.59316E-09	7.65E-10	2.77E-12	0.0905	7.54131E-07	6.82E-08
1.48E-15	0.1816	4.55221E-10	8.27E-11	1.18E-13	0.0485	3.63789E-08	1.76E-09
	Total AD (rad/s) =	1.07581E-07	5.68E-09		Total AD (rad/s) =	8.14951E-06	1.94E-07
	Total AD (mrad/hr) =	0.387289981	0.020451		Total AD (mrad/hr) =	29.33824229	0.697422

Detector Response for the X-744G, X-744H and X-343 Complex						
The source is located in the center of Autoclave # 7 in the X-343 facility (S3)						
	Upper Energy Boundary (MeV)	Henderson Free in Air Tissue Kerma Factor (rads/(n/cm^2))	X-744G East Detector Neutron Fluence/sp	Relative Error	Absorbed Dose Rate (rads/s)	Error
Source Rate (n/s)	1.00E-11		0.00E+00	0		
6.52E+13	1.00E-08	6.03E-17	0.00E+00	0	0	0
5% U-235	3.00E-08	2.46E-16	0.00E+00	0	0	0
P = 2881 W	5.00E-08	3.69E-16	0.00E+00	0	0	0
	1.00E-07	6.52E-16	0.00E+00	0	0	0
	2.25E-07	1.40E-15	0.00E+00	0	0	0
	3.25E-07	2.54E-15	0.00E+00	0	0	0
	4.00E-07	3.37E-15	0.00E+00	0	0	0
	8.00E-07	5.39E-15	0.00E+00	0	0	0
	1.00E-06	8.37E-15	0.00E+00	0	0	0
	1.13E-06	9.93E-15	0.00E+00	0	0	0
	1.30E-06	1.13E-14	0.00E+00	0	0	0
	1.77E-06	1.42E-14	0.00E+00	0	0	0
	3.05E-06	2.20E-14	0.00E+00	0	0	0
	1.00E-05	5.46E-14	0.00E+00	0	0	0
	3.00E-05	1.70E-13	0.00E+00	0	0	0
	1.00E-04	5.43E-13	0.00E+00	0	0	0
	5.50E-04	2.46E-12	0.00E+00	0	0	0
	3.00E-03	1.35E-11	0.00E+00	0	0	0
	1.70E-02	7.20E-11	0.00E+00	0	0	0
	1.00E-01	3.12E-10	3.79E-13	0.1241	7.69911E-09	9.55E-10
	4.00E-01	1.08E-09	3.24E-13	0.1535	2.28318E-08	3.5E-09
	9.00E-01	1.79E-09	1.97E-13	0.0392	2.30078E-08	9.02E-10
	1.40E+00	2.44E-09	7.26E-14	0.0388	1.15441E-08	4.48E-10
	1.85E+00	2.79E-09	3.33E-14	0.0602	6.05688E-09	3.65E-10
	3.00E+00	3.22E-09	5.35E-14	0.042	1.12254E-08	4.71E-10
	6.43E+00	4.18E-09	3.39E-14	0.037	9.2397E-09	3.42E-10
	2.00E+01	4.72E-09	7.17E-15	0.1345	2.20589E-09	2.97E-10
				Total AD (rad/s) =	9.38097E-08	3.84E-09
				Total AD (mrad/hr) =	0.337715034	0.013835

X-744G West Detector Neutron Fluence/sp	Relative Error	Absorbed Dose Rate (rads/s)	Error	X-343 Detector Neutron Fluence/sp	Relative Error	Absorbed Dose Rate (rads/s)	Error
0.00E+00	0			0.00E+00	0		
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
3.60E-13	0.0909	7.31184E-09	6.65E-10	3.82E-10	0.0495	7.76818E-06	3.85E-07
4.17E-13	0.0932	2.93241E-08	2.73E-09	1.14E-10	0.0331	8.02739E-06	2.66E-07
2.65E-13	0.0827	3.09672E-08	2.56E-09	1.02E-10	0.0354	1.18637E-05	4.2E-07
9.62E-14	0.1023	1.52945E-08	1.56E-09	3.38E-11	0.0337	5.37527E-06	1.81E-07
3.92E-14	0.156	7.12693E-09	1.11E-09	1.66E-11	0.0942	3.01728E-06	2.84E-07
6.13E-14	0.0609	1.28618E-08	7.83E-10	2.15E-11	0.1186	4.50572E-06	5.34E-07
4.98E-14	0.0692	1.35747E-08	9.39E-10	2.20E-11	0.272	5.98775E-06	1.63E-06
9.94E-15	0.0837	3.05617E-09	2.56E-10	2.53E-12	0.1753	7.79055E-07	1.37E-07
	Total AD (rad/s) =	1.19517E-07	4.44E-09		Total AD (rad/s) =	4.73244E-05	1.86E-06
	Total AD (mrad/hr) =	0.430261679	0.015985		Total AD (mrad/hr) =	170.3677928	6.701425

Detector Response for the X-744G, X-744H and X-343 Complex						
The source is located just north of the concrete firewall in the northwest corner of X744G (S4)						
	Upper Energy Boundary (MeV)	Henderson Free in Air Tissue Kerma Factor (rads/(n/cm ²))	X-744G East Detector Neutron Fluence/sp	Relative Error	Absorbed Dose Rate (rads/s)	Error
Source Rate (n/s)	1.00E-11		0.00E+00	0		
5.47E+13	1.00E-08	6.03E-17	0.00E+00	0	0	0
100% U-235	3.00E-08	2.46E-16	0.00E+00	0	0	0
P = 1281 W	5.00E-08	3.69E-16	0.00E+00	0	0	0
	1.00E-07	6.52E-16	0.00E+00	0	0	0
	2.25E-07	1.40E-15	0.00E+00	0	0	0
	3.25E-07	2.54E-15	0.00E+00	0	0	0
	4.00E-07	3.37E-15	0.00E+00	0	0	0
	8.00E-07	5.39E-15	0.00E+00	0	0	0
	1.00E-06	8.37E-15	0.00E+00	0	0	0
	1.13E-06	9.93E-15	0.00E+00	0	0	0
	1.30E-06	1.13E-14	0.00E+00	0	0	0
	1.77E-06	1.42E-14	0.00E+00	0	0	0
	3.05E-06	2.20E-14	0.00E+00	0	0	0
	1.00E-05	5.46E-14	0.00E+00	0	0	0
	3.00E-05	1.70E-13	0.00E+00	0	0	0
	1.00E-04	5.43E-13	0.00E+00	0	0	0
	5.50E-04	2.46E-12	0.00E+00	0	0	0
	3.00E-03	1.35E-11	0.00E+00	0	0	0
	1.70E-02	7.20E-11	0.00E+00	0	0	0
	1.00E-01	3.12E-10	7.39E-10	0.0142	1.26092E-05	1.79E-07
	4.00E-01	1.08E-09	8.45E-10	0.0101	4.99182E-05	5.04E-07
	9.00E-01	1.79E-09	7.32E-10	0.0139	7.16078E-05	9.95E-07
	1.40E+00	2.44E-09	4.13E-10	0.0204	5.51514E-05	1.13E-06
	1.85E+00	2.79E-09	3.18E-10	0.0102	4.84538E-05	4.94E-07
	3.00E+00	3.22E-09	6.28E-10	0.005	0.000110505	5.53E-07
	6.43E+00	4.18E-09	4.87E-10	0.0086	0.000111215	9.56E-07
	2.00E+01	4.72E-09	6.12E-11	0.0129	1.5804E-05	2.04E-07
				Total AD (rad/s) =	0.000475264	2.01E-06
				Total AD (mrad/hr) =	1710.951995	7.243695

X-744G West Detector Neutron Fluence/sp	Relative Error	Absorbed Dose Rate (rads/s)	Error	X-343 Detector Neutron Fluence/sp	Relative Error	Absorbed Dose Rate (rads/s)	Error
0.00E+00	0			0.00E+00	0		
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
0.00E+00	0	0	0	0.00E+00	0	0	0
9.22E-11	0.031	1.57237E-06	4.87E-08	4.24E-12	0.0667	7.22676E-08	4.82E-09
1.05E-10	0.0624	6.21753E-06	3.88E-07	1.48E-11	0.6194	8.71413E-07	5.4E-07
7.17E-11	0.034	7.01533E-06	2.39E-07	2.30E-11	0.6846	2.25196E-06	1.54E-06
3.32E-11	0.0245	4.4244E-06	1.08E-07	3.74E-12	0.1324	4.99041E-07	6.61E-08
1.97E-11	0.0349	3.00966E-06	1.05E-07	1.88E-12	0.1072	2.86482E-07	3.07E-08
3.05E-11	0.0235	5.37474E-06	1.26E-07	3.26E-12	0.0368	5.73868E-07	2.11E-08
1.99E-11	0.0595	4.54598E-06	2.7E-07	2.28E-12	0.0562	5.20936E-07	2.93E-08
2.33E-12	0.0715	6.0248E-07	4.31E-08	2.52E-13	0.0765	6.49998E-08	4.97E-09
Total AD (rad/s) =		3.27625E-05	5.69E-07	Total AD (rad/s) =		5.14096E-06	1.64E-06
Total AD (mrad/hr) =		117.9449409	2.047721	Total AD (mrad/hr) =		18.5074704	5.887736

Detector Response for the X-744G, X-744H and X-343 Complex The source is located in the center of the room containing the drums in X744H (S5)						
	Upper Energy Boundary (MeV)	Henderson Free in Air Tissue Kerma Factor (rads/(n/cm^2))	X-744G East Detector Neutron Fluence/sp	Relative Error	Absorbed Dose Rate (rads/s)	Error
Source Rate (n/s)	1.00E-11		0.00E+00	0		
5.47E+13	1.00E-08	6.03E-17	5.71E-13	0.3409	1.88168E-15	6.41E-16
100% U-235	3.00E-08	2.46E-16	4.56E-12	0.2628	6.13679E-14	1.61E-14
P = 1281 W	5.00E-08	3.69E-16	3.23E-12	0.1208	6.51634E-14	7.87E-15
	1.00E-07	6.52E-16	6.43E-12	0.1826	2.29238E-13	4.19E-14
	2.25E-07	1.40E-15	3.94E-12	0.1674	3.01704E-13	5.05E-14
	3.25E-07	2.54E-15	1.16E-12	0.233	1.61464E-13	3.76E-14
	4.00E-07	3.37E-15	5.70E-13	0.2358	1.04986E-13	2.48E-14
	8.00E-07	5.39E-15	1.52E-12	0.1239	4.47358E-13	5.54E-14
	1.00E-06	8.37E-15	4.29E-13	0.1371	1.96342E-13	2.69E-14
	1.13E-06	9.93E-15	5.39E-13	0.3201	2.92452E-13	9.36E-14
	1.30E-06	1.13E-14	3.07E-13	0.167	1.89833E-13	3.17E-14
	1.77E-06	1.42E-14	6.24E-13	0.1589	4.84048E-13	7.69E-14
	3.05E-06	2.20E-14	1.31E-12	0.1039	1.57672E-12	1.64E-13
	1.00E-05	5.46E-14	2.93E-12	0.1302	8.75844E-12	1.14E-12
	3.00E-05	1.70E-13	3.54E-12	0.1858	3.29359E-11	6.12E-12
	1.00E-04	5.43E-13	3.70E-12	0.1477	1.09784E-10	1.62E-11
	5.50E-04	2.46E-12	4.91E-12	0.169	6.60375E-10	1.12E-10
	3.00E-03	1.35E-11	4.94E-12	0.1192	3.64796E-09	4.35E-10
	1.70E-02	7.20E-11	5.03E-12	0.1218	1.98179E-08	2.41E-09
	1.00E-01	3.12E-10	7.56E-12	0.1161	1.28953E-07	1.5E-08
	4.00E-01	1.08E-09	6.72E-12	0.0622	3.96649E-07	2.47E-08
	9.00E-01	1.79E-09	5.10E-12	0.0492	4.99024E-07	2.46E-08
	1.40E+00	2.44E-09	2.35E-12	0.0497	3.13923E-07	1.56E-08
	1.85E+00	2.79E-09	1.12E-12	0.0715	1.71097E-07	1.22E-08
	3.00E+00	3.22E-09	1.57E-12	0.0687	2.76778E-07	1.9E-08
	6.43E+00	4.18E-09	8.71E-13	0.0634	1.99153E-07	1.26E-08
	2.00E+01	4.72E-09	9.80E-14	0.0519	2.52982E-08	1.31E-09
				Total AD (rad/s) =	2.03516E-06	4.86E-08
				Total AD (mrad/hr) =	7.326563954	0.174793

X-744G West Detector				X-343 Detector			
Neutron Fluence/sp	Relative Error	Absorbed Dose Rate (rads/s)	Error	Neutron Fluence/sp	Relative Error	Absorbed Dose Rate (rads/s)	Error
2.65E-20	1			0.00E+00	0		
2.48E-12	0.5244	8.17221E-15	4.29E-15	4.96E-13	0.5923	1.63513E-15	9.68E-16
8.62E-12	0.0929	1.15928E-13	1.08E-14	2.73E-12	0.4486	3.67289E-14	1.65E-14
8.38E-12	0.0818	1.6897E-13	1.38E-14	4.13E-12	0.757	8.3308E-14	6.31E-14
1.34E-11	0.0784	4.76026E-13	3.73E-14	4.76E-12	0.5066	1.69673E-13	8.6E-14
8.63E-12	0.0992	6.60378E-13	6.55E-14	8.32E-13	0.4774	6.3696E-14	3.04E-14
2.63E-12	0.252	3.65748E-13	9.22E-14	3.21E-13	0.8444	4.46342E-14	3.77E-14
1.11E-12	0.1479	2.04462E-13	3.02E-14	5.81E-14	0.4024	1.07086E-14	4.31E-15
3.44E-12	0.0884	1.01269E-12	8.95E-14	5.57E-13	0.6802	1.64163E-13	1.12E-13
1.39E-12	0.198	6.36189E-13	1.26E-13	9.00E-14	0.3975	4.11932E-14	1.64E-14
7.11E-13	0.1781	3.85814E-13	6.87E-14	1.95E-14	0.2411	1.0574E-14	2.55E-15
1.18E-12	0.2509	7.26894E-13	1.82E-13	6.29E-14	0.5889	3.88311E-14	2.29E-14
2.45E-12	0.1746	1.8999E-12	3.32E-13	1.11E-13	0.4193	8.59201E-14	3.6E-14
3.42E-12	0.158	4.11128E-12	6.5E-13	3.94E-13	0.4755	4.73677E-13	2.25E-13
8.11E-12	0.1257	2.42051E-11	3.04E-12	1.41E-12	0.6426	4.21509E-12	2.71E-12
8.64E-12	0.1212	8.02691E-11	9.73E-12	4.45E-13	0.2769	4.13979E-12	1.15E-12
8.23E-12	0.098	2.4432E-10	2.39E-11	3.53E-13	0.1416	1.04819E-11	1.48E-12
1.19E-11	0.1009	1.60617E-09	1.62E-10	9.96E-13	0.5256	1.33905E-10	7.04E-11
1.16E-11	0.1052	8.547E-09	8.99E-10	8.94E-13	0.5074	6.59843E-10	3.35E-10
1.07E-11	0.0723	4.22591E-08	3.06E-09	8.38E-13	0.1912	3.29864E-09	6.31E-10
1.43E-11	0.1265	2.44385E-07	3.09E-08	1.48E-12	0.322	2.51934E-08	8.11E-09
1.38E-11	0.0466	8.15321E-07	3.8E-08	9.04E-13	0.1081	5.33701E-08	5.77E-09
1.34E-11	0.0922	1.31083E-06	1.21E-07	8.04E-13	0.1287	7.86603E-08	1.01E-08
4.71E-12	0.0637	6.28291E-07	4E-08	3.53E-13	0.0936	4.70842E-08	4.41E-09
2.06E-12	0.0458	3.1403E-07	1.44E-08	1.70E-13	0.0701	2.58755E-08	1.81E-09
2.61E-12	0.0537	4.59435E-07	2.47E-08	2.66E-13	0.0466	4.67423E-08	2.18E-09
1.46E-12	0.0344	3.31659E-07	1.14E-08	1.27E-13	0.0661	2.89163E-08	1.91E-09
1.62E-13	0.0436	4.18189E-08	1.82E-09	1.53E-14	0.1	3.95313E-09	3.95E-10
	Total AD (rad/s) =	4.19854E-06	1.4E-07		Total AD (rad/s) =	3.13908E-07	1.53E-08
	Total AD (mrad/hr) =	15.11473233	0.503574		Total AD (mrad/hr) =	1.130068008	0.054994

Detector Response for the X-744G, X-744H and X-343 Complex						
The source is located just west of the western most row of shelves on the south end of the X744H building (S6)						
	Upper Energy Boundary (MeV)	Henderson Free in Air Tissue Kerma Factor (rads/(n/cm^2))	X-744G East Detector Neutron Fluence/sp	Relative Error	Absorbed Dose Rate (rads/s)	Error
Source Rate (n/s)	1.00E-11		1.47E-28	1		
5.47E + 13	1.00E-08	6.03E-17	4.19E-13	0.1988	1.38187E-15	2.75E-16
100% U-235	3.00E-08	2.46E-16	2.15E-12	0.1409	2.89491E-14	4.08E-15
P = 1281 W	5.00E-08	3.69E-16	2.71E-12	0.1237	5.46547E-14	6.76E-15
	1.00E-07	6.52E-16	4.94E-12	0.2282	1.76063E-13	4.02E-14
	2.25E-07	1.40E-15	3.26E-12	0.1076	2.49254E-13	2.68E-14
	3.25E-07	2.54E-15	8.35E-13	0.1452	1.15972E-13	1.68E-14
	4.00E-07	3.37E-15	8.00E-13	0.3552	1.47461E-13	5.24E-14
	8.00E-07	5.39E-15	2.05E-12	0.1741	6.0453E-13	1.05E-13
	1.00E-06	8.37E-15	8.30E-13	0.2974	3.7957E-13	1.13E-13
	1.13E-06	9.93E-15	2.60E-13	0.1985	1.41276E-13	2.8E-14
	1.30E-06	1.13E-14	2.14E-13	0.2052	1.3205E-13	2.71E-14
	1.77E-06	1.42E-14	7.90E-13	0.1586	6.13019E-13	9.72E-14
	3.05E-06	2.20E-14	4.02E-12	0.6478	4.83556E-12	3.13E-12
	1.00E-05	5.46E-14	4.01E-12	0.1615	1.19691E-11	1.93E-12
	3.00E-05	1.70E-13	3.35E-12	0.1276	3.11663E-11	3.98E-12
	1.00E-04	5.43E-13	3.19E-12	0.1139	9.47856E-11	1.08E-11
	5.50E-04	2.46E-12	4.06E-12	0.0831	5.46149E-10	4.54E-11
	3.00E-03	1.35E-11	7.35E-12	0.2129	5.42431E-09	1.15E-09
	1.70E-02	7.20E-11	4.56E-12	0.0857	1.79408E-08	1.54E-09
	1.00E-01	3.12E-10	6.01E-12	0.0717	1.0244E-07	7.34E-09
	4.00E-01	1.08E-09	6.09E-12	0.0615	3.59292E-07	2.21E-08
	9.00E-01	1.79E-09	4.91E-12	0.0729	4.80152E-07	3.5E-08
	1.40E+00	2.44E-09	1.76E-12	0.042	2.343E-07	9.84E-09
	1.85E+00	2.79E-09	9.47E-13	0.1589	1.44445E-07	2.3E-08
	3.00E+00	3.22E-09	1.02E-12	0.0445	1.79535E-07	7.99E-09
	6.43E+00	4.18E-09	3.87E-13	0.0391	8.83883E-08	3.46E-09
	2.00E+01	4.72E-09	2.77E-14	0.0813	7.14783E-09	5.81E-10
				Total AD (rad/s) =	1.61976E-06	4.97E-08
				Total AD (mrad/hr) =	5.831122731	0.178948

X-744G West Detector				X-343 Detector			
Neutron Fluence/sp	Relative Error	Absorbed Dose Rate (rads/s)	Error	Neutron Fluence/sp	Relative Error	Absorbed Dose Rate (rads/s)	Error
0.00E+00	0			0.00E+00	0		
1.56E-12	0.3793	5.13894E-15	1.95E-15	4.54E-15	0.3927	1.4971E-17	5.88E-18
7.51E-12	0.1282	1.00984E-13	1.29E-14	4.10E-13	0.7335	5.51008E-15	4.04E-15
8.25E-12	0.1625	1.66385E-13	2.7E-14	5.60E-13	0.7348	1.12869E-14	8.29E-15
1.22E-11	0.1641	4.35911E-13	7.15E-14	1.01E-13	0.3778	3.58901E-15	1.36E-15
7.91E-12	0.1221	6.05562E-13	7.39E-14	1.88E-13	0.4999	1.43682E-14	7.18E-15
1.81E-12	0.1106	2.51808E-13	2.78E-14	1.40E-14	0.2214	1.9445E-15	4.31E-16
1.00E-12	0.1237	1.85045E-13	2.29E-14	6.40E-15	0.1833	1.17857E-15	2.16E-16
4.61E-12	0.2273	1.35743E-12	3.09E-13	3.32E-13	0.5332	9.77274E-14	5.21E-14
1.02E-12	0.1212	4.65317E-13	5.64E-14	5.55E-14	0.8657	2.53769E-14	2.2E-14
4.28E-13	0.1455	2.32462E-13	3.38E-14	4.41E-15	0.2179	2.39666E-15	5.22E-16
9.73E-13	0.2164	6.0085E-13	1.3E-13	8.84E-15	0.4416	5.46269E-15	2.41E-15
2.08E-12	0.1811	1.61561E-12	2.93E-13	1.01E-14	0.1528	7.86344E-15	1.2E-15
4.61E-12	0.228	5.54011E-12	1.26E-12	2.76E-13	0.8684	3.32483E-13	2.89E-13
6.45E-12	0.0947	1.92672E-11	1.82E-12	8.91E-14	0.1695	2.66071E-13	4.51E-14
5.64E-12	0.0825	5.24362E-11	4.33E-12	1.76E-13	0.499	1.63222E-12	8.14E-13
9.50E-12	0.2241	2.81944E-10	6.32E-11	9.50E-14	0.2096	2.82033E-12	5.91E-13
9.44E-12	0.0773	1.26944E-09	9.81E-11	1.61E-13	0.2253	2.15905E-11	4.86E-12
1.37E-11	0.2033	1.01355E-08	2.06E-09	1.76E-13	0.2632	1.29846E-10	3.42E-11
1.15E-11	0.0965	4.51428E-08	4.36E-09	1.02E-12	0.8402	3.99749E-09	3.36E-09
1.46E-11	0.0982	2.48362E-07	2.44E-08	2.51E-13	0.1953	4.27888E-09	8.36E-10
1.33E-11	0.043	7.8551E-07	3.38E-08	2.57E-13	0.0658	1.51764E-08	9.99E-10
1.07E-11	0.0573	1.04364E-06	5.98E-08	2.36E-13	0.117	2.31093E-08	2.7E-09
4.40E-12	0.0617	5.86526E-07	3.62E-08	1.12E-13	0.1128	1.497E-08	1.69E-09
1.83E-12	0.085	2.79606E-07	2.38E-08	9.36E-14	0.3878	1.42717E-08	5.53E-09
2.37E-12	0.0479	4.16897E-07	2E-08	6.94E-13	0.8911	1.22178E-07	1.09E-07
9.65E-13	0.0671	2.20624E-07	1.48E-08	1.78E-13	0.8509	4.05926E-08	3.45E-08
7.29E-14	0.1894	1.88095E-08	3.56E-09	5.99E-15	0.4461	1.54521E-09	6.89E-10
Total AD (rad/s) =				Total AD (rad/s) =			
Total AD (mrad/hr) =				Total AD (mrad/hr) =			
3.65689E-06				2.40277E-07			
8.85E-08				0.864995757			
0.318761				0.412049			

Detector Response for the X-344A/342A Complex						
The source is located in the center of the southern most autoclave in X-344A (S1)						
	Upper Energy Boundary (MeV)	Henderson Free in Air Tissue Kerma Factor (rads/(n/cm^2))	X-344A East Detector Neutron Fluence/sp (Point Detector)	Relative Error	Absorbed Dose Rate (rads/s)	Error
Source Rate (n/s)	1.00E-11		0.00E+00	0		
6.52E+13	1.00E-08	6.03E-17	1.01E-11	0.1167	3.96131E-14	4.62E-15
5% U-235	3.00E-08	2.46E-16	4.89E-11	0.084	7.83586E-13	6.58E-14
P = 2881 W	5.00E-08	3.69E-16	5.19E-11	0.0795	1.24861E-12	9.93E-14
	1.00E-07	6.52E-16	7.11E-11	0.1093	3.02302E-12	3.3E-13
	2.25E-07	1.40E-15	2.97E-11	0.0808	2.70944E-12	2.19E-13
	3.25E-07	2.54E-15	7.46E-12	0.1861	1.23456E-12	2.3E-13
	4.00E-07	3.37E-15	3.81E-12	0.2889	8.36708E-13	2.42E-13
	8.00E-07	5.39E-15	8.33E-12	0.085	2.92453E-12	2.49E-13
	1.00E-06	8.37E-15	2.39E-12	0.1273	1.30095E-12	1.66E-13
	1.13E-06	9.93E-15	2.85E-12	0.3611	1.84628E-12	6.67E-13
	1.30E-06	1.13E-14	1.74E-12	0.1312	1.28116E-12	1.68E-13
	1.77E-06	1.42E-14	4.50E-12	0.1282	4.1634E-12	5.34E-13
	3.05E-06	2.20E-14	7.43E-12	0.1239	1.06566E-11	1.32E-12
	1.00E-05	5.46E-14	1.95E-11	0.1269	6.94851E-11	8.82E-12
	3.00E-05	1.70E-13	1.71E-11	0.0938	1.8913E-10	1.77E-11
	1.00E-04	5.43E-13	1.72E-11	0.0764	6.07844E-10	4.64E-11
	5.50E-04	2.46E-12	2.62E-11	0.0751	4.19235E-09	3.15E-10
	3.00E-03	1.35E-11	2.44E-11	0.0703	2.14736E-08	1.51E-09
	1.70E-02	7.20E-11	1.90E-11	0.0923	8.90428E-08	8.22E-09
	1.00E-01	3.12E-10	9.13E-12	0.1131	1.85739E-07	2.1E-08
	4.00E-01	1.08E-09	4.41E-12	0.0932	3.10131E-07	2.89E-08
	9.00E-01	1.79E-09	2.55E-12	0.0532	2.97718E-07	1.58E-08
	1.40E+00	2.44E-09	6.88E-13	0.1121	1.09342E-07	1.23E-08
	1.85E+00	2.79E-09	3.60E-13	0.1911	6.54053E-08	1.25E-08
	3.00E+00	3.22E-09	4.21E-13	0.0903	8.8283E-08	7.97E-09
	6.43E+00	4.18E-09	1.99E-13	0.0351	5.42116E-08	1.9E-09
	2.00E+01	4.72E-09	1.94E-14	0.1369	5.96496E-09	8.17E-10
				Total AD (rad/s) =	1.2324E-06	4.44E-08
				Total AD (mrad/hr) =	4.436645956	0.159859

X-344A West Detector		Absorbed Dose Rate (rads/s)	Error
Neutron Fluence/sp (Point Detector)	Relative Error		
0.00E+00	0		
6.26E-11	0.0253	2.46031E-13	6.2246E-15
3.16E-10	0.0128	5.06011E-12	6.47694E-14
3.29E-10	0.0177	7.90843E-12	1.39979E-13
4.46E-10	0.0111	1.89554E-11	2.10405E-13
2.14E-10	0.0336	1.95035E-11	6.55317E-13
3.82E-11	0.0239	6.32927E-12	1.5127E-13
1.97E-11	0.0319	4.33437E-12	1.38266E-13
7.08E-11	0.0281	2.48667E-11	6.98753E-13
2.30E-11	0.0434	1.25217E-11	5.4344E-13
1.29E-11	0.0428	8.3363E-12	3.56794E-13
1.40E-11	0.0397	1.02944E-11	4.08689E-13
3.12E-11	0.0272	2.88372E-11	7.84372E-13
5.61E-11	0.0223	8.04662E-11	1.7944E-12
1.27E-10	0.0182	4.53336E-10	8.25071E-12
1.28E-10	0.0159	1.41341E-09	2.24733E-11
1.56E-10	0.018	5.53472E-09	9.96249E-11
2.51E-10	0.0182	4.0257E-08	7.32678E-10
2.57E-10	0.0273	2.26342E-07	6.17914E-09
2.00E-10	0.0182	9.39541E-07	1.70997E-08
7.40E-11	0.0182	1.50497E-06	2.73905E-08
3.21E-11	0.0317	2.26158E-06	7.16921E-08
1.66E-11	0.0389	1.93546E-06	7.52893E-08
5.01E-12	0.0752	7.97362E-07	5.99616E-08
2.44E-12	0.0662	4.43304E-07	2.93467E-08
3.83E-12	0.0554	8.03204E-07	4.44975E-08
1.92E-12	0.1059	5.22012E-07	5.52811E-08
2.20E-13	0.2179	6.75646E-08	1.47223E-08
Total AD (rad/s)		9.54923E-06	1.46966E-07
Total AD (mrad/		34.3772158	0.52907758

Detector Response for the X-344A/342A Complex						
The source is located in the center of the right autoclave in X-342A (S2)						
	Upper Energy Boundary (MeV)	Henderson Free in Air Tissue Kerma Factor (rads/(n/cm^2))	X-344A East Detector Neutron Fluence/sp (Point Detector)	Relative Error	Absorbed Dose Rate (rads/s)	Error
Source Rate (n/s)	1.00E-11		0.00E+00	0		
6.52E+13	1.00E-08	6.03E-17	3.37E-11	0.0746	1.3224E-13	9.87E-15
5% U-235	3.00E-08	2.46E-16	1.95E-10	0.0842	3.12095E-12	2.63E-13
P = 2881 W	5.00E-08	3.69E-16	1.57E-10	0.0537	3.78747E-12	2.03E-13
	1.00E-07	6.52E-16	2.33E-10	0.0561	9.90852E-12	5.56E-13
	2.25E-07	1.40E-15	1.15E-10	0.1333	1.04624E-11	1.39E-12
	3.25E-07	2.54E-15	1.34E-11	0.1075	2.21026E-12	2.38E-13
	4.00E-07	3.37E-15	1.42E-11	0.4576	3.11722E-12	1.43E-12
	8.00E-07	5.39E-15	2.58E-11	0.0828	9.0587E-12	7.5E-13
	1.00E-06	8.37E-15	8.22E-12	0.1037	4.48249E-12	4.65E-13
	1.13E-06	9.93E-15	3.65E-12	0.1023	2.36114E-12	2.42E-13
	1.30E-06	1.13E-14	4.46E-12	0.1034	3.28684E-12	3.4E-13
	1.77E-06	1.42E-14	1.32E-11	0.1158	1.22374E-11	1.42E-12
	3.05E-06	2.20E-14	2.79E-11	0.1294	3.99678E-11	5.17E-12
	1.00E-05	5.46E-14	4.79E-11	0.0903	1.70527E-10	1.54E-11
	3.00E-05	1.70E-13	4.64E-11	0.1028	5.13571E-10	5.28E-11
	1.00E-04	5.43E-13	5.24E-11	0.1242	1.85544E-09	2.3E-10
	5.50E-04	2.46E-12	7.57E-11	0.1371	1.21336E-08	1.66E-09
	3.00E-03	1.35E-11	6.82E-11	0.1086	6.00035E-08	6.52E-09
	1.70E-02	7.20E-11	4.23E-11	0.0502	1.98284E-07	9.95E-09
	1.00E-01	3.12E-10	1.37E-11	0.0891	2.78744E-07	2.48E-08
	4.00E-01	1.08E-09	9.72E-12	0.3288	6.84466E-07	2.25E-07
	9.00E-01	1.79E-09	4.36E-12	0.1734	5.08846E-07	8.82E-08
	1.40E+00	2.44E-09	8.84E-13	0.096	1.40516E-07	1.35E-08
	1.85E+00	2.79E-09	3.98E-13	0.0881	7.2359E-08	6.37E-09
	3.00E+00	3.22E-09	9.19E-13	0.1303	1.92818E-07	2.51E-08
	6.43E+00	4.18E-09	3.41E-13	0.1168	9.29244E-08	1.09E-08
	2.00E+01	4.72E-09	3.95E-14	0.0792	1.21655E-08	9.64E-10
				Total AD (rad/s) =	2.2559E-06	2.45E-07
				Total AD (mrad/hr) =	8.121253481	0.883047

X-344A West Detector			
Neutron Fluence/sp (Point Detector)	Relative Error	Absorbed Dose Rate (rads/s)	Error
0.00E+00	0		
8.34E-12	0.4693	3.27669E-14	1.53775E-14
2.05E-11	0.0479	3.28069E-13	1.57145E-14
2.10E-11	0.0532	5.04452E-13	2.68368E-14
3.14E-11	0.0597	1.33291E-12	7.95749E-14
1.46E-11	0.0423	1.32797E-12	5.61731E-14
3.64E-12	0.1085	6.01845E-13	6.53002E-14
1.74E-12	0.1019	3.81434E-13	3.88682E-14
6.36E-12	0.0557	2.23418E-12	1.24444E-13
2.00E-12	0.0843	1.09247E-12	9.20955E-14
1.21E-12	0.118	7.84364E-13	9.25549E-14
1.43E-12	0.132	1.05087E-12	1.38714E-13
2.91E-12	0.0661	2.6885E-12	1.7771E-13
6.22E-12	0.0776	8.92454E-12	6.92545E-13
1.32E-11	0.0417	4.68206E-11	1.95242E-12
1.38E-11	0.0582	1.53364E-10	8.92579E-12
1.55E-11	0.0507	5.50156E-10	2.78929E-11
2.02E-11	0.0389	3.24051E-09	1.26056E-10
1.73E-11	0.0347	1.52406E-08	5.28849E-10
1.23E-11	0.0426	5.78234E-08	2.46328E-09
6.45E-12	0.0861	1.31106E-07	1.12882E-08
3.54E-12	0.1015	2.4947E-07	2.53212E-08
1.81E-12	0.0995	2.10888E-07	2.09833E-08
5.46E-13	0.1584	8.68795E-08	1.37617E-08
2.40E-13	0.2656	4.37033E-08	1.16076E-08
2.93E-13	0.2693	6.15199E-08	1.65673E-08
1.28E-13	0.2304	3.48269E-08	8.02411E-09
6.51E-15	0.1174	2.0013E-09	2.34953E-10
Total AD (rad/s)		8.97471E-07	4.33392E-08
Total AD (mrad/		3.230894259	0.156021227

Detector Response for the X-344A/342A Complex						
The source is located in the bottom of the scale pit in the southeast corner of X-342A (S3)						
	Upper Energy Boundary (MeV)	Henderson Free in Air Tissue Kerma Factor (rads/(n/cm^2))	X-344A East Detector Neutron Fluence/sp (Point Detector)	Relative Error	Absorbed Dose Rate (rads/s)	Error
Source Rate (n/s)	1.00E-11		0.00E+00	0		
6.52E+13	1.00E-08	6.03E-17	9.79E-11	0.0936	3.84844E-13	3.6E-14
5% U-235	3.00E-08	2.46E-16	5.14E-10	0.0515	8.23909E-12	4.24E-13
P = 2881 W	5.00E-08	3.69E-16	5.35E-10	0.0896	1.28681E-11	1.15E-12
	1.00E-07	6.52E-16	7.01E-10	0.0621	2.97671E-11	1.85E-12
	2.25E-07	1.40E-15	3.22E-10	0.0711	2.93858E-11	2.09E-12
	3.25E-07	2.54E-15	5.23E-11	0.152	8.65121E-12	1.31E-12
	4.00E-07	3.37E-15	2.94E-11	0.1762	6.45841E-12	1.14E-12
	8.00E-07	5.39E-15	7.69E-11	0.0861	2.70206E-11	2.33E-12
	1.00E-06	8.37E-15	2.20E-11	0.1005	1.19855E-11	1.2E-12
	1.13E-06	9.93E-15	1.19E-11	0.1127	7.70457E-12	8.68E-13
	1.30E-06	1.13E-14	1.74E-11	0.2445	1.27973E-11	3.13E-12
	1.77E-06	1.42E-14	4.46E-11	0.2424	4.13089E-11	1E-11
	3.05E-06	2.20E-14	7.74E-11	0.2133	1.1092E-10	2.37E-11
	1.00E-05	5.46E-14	1.27E-10	0.0669	4.50315E-10	3.01E-11
	3.00E-05	1.70E-13	1.31E-10	0.1388	1.45299E-09	2.02E-10
	1.00E-04	5.43E-13	1.44E-10	0.1207	5.08686E-09	6.14E-10
	5.50E-04	2.46E-12	2.22E-10	0.1144	3.55919E-08	4.07E-09
	3.00E-03	1.35E-11	1.81E-10	0.118	1.5924E-07	1.88E-08
	1.70E-02	7.20E-11	1.61E-10	0.0647	7.54841E-07	4.88E-08
	1.00E-01	3.12E-10	1.64E-10	0.1169	3.33771E-06	3.9E-07
	4.00E-01	1.08E-09	1.70E-10	0.0638	1.19761E-05	7.64E-07
	9.00E-01	1.79E-09	1.08E-10	0.0907	1.25711E-05	1.14E-06
	1.40E+00	2.44E-09	4.49E-11	0.0641	7.14026E-06	4.58E-07
	1.85E+00	2.79E-09	2.27E-11	0.0591	4.12632E-06	2.44E-07
	3.00E+00	3.22E-09	4.13E-11	0.1674	8.65715E-06	1.45E-06
	6.43E+00	4.18E-09	1.64E-11	0.0998	4.46301E-06	4.45E-07
	2.00E+01	4.72E-09	6.62E-13	0.0683	2.03481E-07	1.39E-08
				Total AD (rad/s) =	5.34322E-05	2.15E-06
				Total AD (mrad/hr) =	192.3557618	7.726678

X-344A West Detector Neutron Fluence/sp (Point Detector)	Relative Error	Absorbed Dose Rate (rads/s)	Error
3.76E-15	1		
1.59E-11	0.0877	6.25043E-14	5.48162E-15
9.00E-11	0.0883	1.4434E-12	1.27453E-13
9.25E-11	0.0556	2.2239E-12	1.23649E-13
1.27E-10	0.0485	5.39846E-12	2.61825E-13
6.84E-11	0.0654	6.24152E-12	4.08195E-13
1.60E-11	0.1052	2.64139E-12	2.77874E-13
1.04E-11	0.1707	2.28142E-12	3.89439E-13
2.82E-11	0.0941	9.92236E-12	9.33694E-13
6.82E-12	0.1106	3.72154E-12	4.11602E-13
4.03E-12	0.1533	2.60819E-12	3.99836E-13
6.52E-12	0.1717	4.80361E-12	8.24779E-13
1.10E-11	0.1003	1.01498E-11	1.01803E-12
1.87E-11	0.0846	2.67512E-11	2.26315E-12
4.59E-11	0.0725	1.63388E-10	1.18456E-11
4.05E-11	0.097	4.48173E-10	4.34727E-11
4.88E-11	0.0819	1.72694E-09	1.41437E-10
5.67E-11	0.0563	9.08977E-09	5.11754E-10
5.79E-11	0.0632	5.09452E-08	3.21974E-09
5.37E-11	0.0555	2.51808E-07	1.39753E-08
6.47E-11	0.0396	1.31459E-06	5.20578E-08
8.28E-11	0.106	5.82794E-06	6.17761E-07
5.18E-11	0.0409	6.03847E-06	2.46973E-07
2.44E-11	0.0473	3.88344E-06	1.83687E-07
1.18E-11	0.0522	2.14516E-06	1.11978E-07
1.44E-11	0.0651	3.02732E-06	1.97079E-07
6.98E-12	0.041	1.90098E-06	7.79404E-08
5.10E-13	0.1279	1.56846E-07	2.00605E-08
Total AD (rad/s) =		2.4609E-05	7.32897E-07
Total AD (mrad/hr) =		88.592456655	2.638429107

Detector Response for the X-344A/342A Complex						
The source is located in the bottom of the Sump pit in X-342A (S4)						
	Upper Energy Boundary (MeV)	Henderson Free in Air Tissue Kerma Factor (rads/(n/cm^2))	X-344A East Detector Neutron Fluence/sp (Point Detector)	Relative Error	Absorbed Dose Rate (rads/s)	Error
Source Rate (n/s)	1.00E-11		0.00E+00	0		
6.52E+13	1.00E-08	6.03E-17	3.67E-11	0.15	1.44347E-13	2.17E-14
5% U-235	3.00E-08	2.46E-16	1.36E-10	0.064	2.18387E-12	1.4E-13
P = 2881 W	5.00E-08	3.69E-16	1.44E-10	0.0643	3.45859E-12	2.22E-13
	1.00E-07	6.52E-16	2.05E-10	0.0686	8.71479E-12	5.98E-13
	2.25E-07	1.40E-15	7.55E-11	0.0819	6.8858E-12	5.64E-13
	3.25E-07	2.54E-15	6.04E-12	0.1561	9.99721E-13	1.56E-13
	4.00E-07	3.37E-15	2.42E-12	0.1551	5.30765E-13	8.23E-14
	8.00E-07	5.39E-15	1.28E-11	0.1723	4.48486E-12	7.73E-13
	1.00E-06	8.37E-15	3.41E-12	0.1773	1.86147E-12	3.3E-13
	1.13E-06	9.93E-15	3.72E-12	0.4979	2.40603E-12	1.2E-12
	1.30E-06	1.13E-14	2.51E-12	0.1913	1.84649E-12	3.53E-13
	1.77E-06	1.42E-14	5.85E-12	0.2273	5.415E-12	1.23E-12
	3.05E-06	2.20E-14	7.71E-12	0.1287	1.10491E-11	1.42E-12
	1.00E-05	5.46E-14	2.16E-11	0.1655	7.6861E-11	1.27E-11
	3.00E-05	1.70E-13	1.81E-11	0.1604	2.0004E-10	3.21E-11
	1.00E-04	5.43E-13	1.40E-11	0.1074	4.94725E-10	5.31E-11
	5.50E-04	2.46E-12	2.00E-11	0.1112	3.20179E-09	3.56E-10
	3.00E-03	1.35E-11	2.47E-11	0.2537	2.17115E-08	5.51E-09
	1.70E-02	7.20E-11	3.63E-11	0.4176	1.70182E-07	7.11E-08
	1.00E-01	3.12E-10	1.57E-11	0.1344	3.1895E-07	4.29E-08
	4.00E-01	1.08E-09	1.40E-11	0.144	9.87207E-07	1.42E-07
	9.00E-01	1.79E-09	1.10E-11	0.2709	1.28796E-06	3.49E-07
	1.40E+00	2.44E-09	4.36E-12	0.0906	6.92565E-07	6.27E-08
	1.85E+00	2.79E-09	2.99E-12	0.0982	5.43491E-07	5.34E-08
	3.00E+00	3.22E-09	5.83E-12	0.2072	1.22257E-06	2.53E-07
	6.43E+00	4.18E-09	1.90E-12	0.0645	5.16594E-07	3.33E-08
	2.00E+01	4.72E-09	1.47E-13	0.2349	4.53492E-08	1.07E-08
				Total AD (rad/s) =	5.8106E-06	4.7E-07
				Total AD (mrad/hr) =	20.91817457	1.692547

X-344A West Detector		Absorbed Dose Rate (rads/s)	Error
Neutron Fluence/sp (Point Detector)	Relative Error		
0.00E+00	0		
3.77E-12	0.1531	1.48053E-14	2.2667E-15
5.67E-11	0.6665	9.09599E-13	6.06248E-13
2.17E-11	0.0736	5.21756E-13	3.84013E-14
3.28E-11	0.0967	1.3939E-12	1.3479E-13
1.32E-11	0.0811	1.20331E-12	9.75885E-14
1.94E-12	0.1447	3.21261E-13	4.64864E-14
8.69E-13	0.2431	1.90946E-13	4.64189E-14
3.94E-12	0.1232	1.38255E-12	1.7033E-13
9.63E-13	0.2595	5.25097E-13	1.36263E-13
6.14E-13	0.3307	3.97491E-13	1.3145E-13
6.19E-13	0.2884	4.55546E-13	1.31379E-13
1.47E-12	0.1439	1.35915E-12	1.95581E-13
2.57E-12	0.1299	3.68285E-12	4.78402E-13
5.73E-12	0.1209	2.04016E-11	2.46655E-12
5.81E-12	0.1565	6.43922E-11	1.00774E-11
6.81E-12	0.1975	2.4083E-10	4.7564E-11
8.39E-12	0.148	1.34449E-09	1.98984E-10
5.67E-12	0.1013	4.98942E-09	5.05429E-10
6.57E-12	0.1483	3.08199E-08	4.57058E-09
6.00E-12	0.0908	1.2202E-07	1.10794E-08
7.42E-12	0.1495	5.22191E-07	7.80675E-08
3.62E-12	0.1182	4.21881E-07	4.98664E-08
1.50E-12	0.0695	2.39034E-07	1.66129E-08
8.66E-13	0.0658	1.57405E-07	1.03573E-08
1.19E-12	0.1312	2.50029E-07	3.28038E-08
4.51E-13	0.0682	1.2279E-07	8.37425E-09
2.30E-14	0.1054	7.06409E-09	7.44555E-10
Total AD (rad/s)		1.87991E-06	1.01268E-07
Total AD (mrad/		6.767661995	0.364564066

Detector Response for the X-344A/342A Complex						
The source is located in the Northeast corner of the lunch room in X-344A (S5)						
	Upper Energy Boundary (MeV)	Henderson Free in Air Tissue Kerma Factor (rads/(n/cm^2))	X-344A East Detector Neutron Fluence/sp (Point Detector)	Relative Error	Absorbed Dose Rate (rads/s)	Error
Source Rate (n/s)	1.00E-11		0.00E+00	0		
6.52E+13	1.00E-08	6.03E-17	1.36E-10	0.1081	5.33731E-13	5.77E-14
5% U-235	3.00E-08	2.46E-16	6.82E-10	0.1308	1.0931E-11	1.43E-12
P = 2881 W	5.00E-08	3.69E-16	6.06E-10	0.0522	1.4582E-11	7.61E-13
	1.00E-07	6.52E-16	7.55E-10	0.061	3.21014E-11	1.96E-12
	2.25E-07	1.40E-15	3.39E-10	0.0988	3.08876E-11	3.05E-12
	3.25E-07	2.54E-15	4.06E-11	0.1193	6.71549E-12	8.01E-13
	4.00E-07	3.37E-15	1.84E-11	0.1382	4.03557E-12	5.58E-13
	8.00E-07	5.39E-15	7.36E-11	0.1536	2.58567E-11	3.97E-12
	1.00E-06	8.37E-15	2.58E-11	0.2816	1.40941E-11	3.97E-12
	1.13E-06	9.93E-15	9.57E-12	0.1383	6.19122E-12	8.56E-13
	1.30E-06	1.13E-14	9.22E-11	0.8015	6.79175E-11	5.44E-11
	1.77E-06	1.42E-14	2.24E-11	0.2653	2.07172E-11	5.5E-12
	3.05E-06	2.20E-14	5.99E-11	0.2182	8.58351E-11	1.87E-11
	1.00E-05	5.46E-14	1.25E-10	0.1102	4.45963E-10	4.91E-11
	3.00E-05	1.70E-13	1.12E-10	0.2172	1.24088E-09	2.7E-10
	1.00E-04	5.43E-13	8.28E-11	0.1039	2.93099E-09	3.05E-10
	5.50E-04	2.46E-12	1.31E-10	0.1576	2.10041E-08	3.31E-09
	3.00E-03	1.35E-11	9.97E-11	0.0894	8.76907E-08	7.84E-09
	1.70E-02	7.20E-11	1.33E-10	0.3067	6.2541E-07	1.92E-07
	1.00E-01	3.12E-10	1.07E-10	0.2944	2.17844E-06	6.41E-07
	4.00E-01	1.08E-09	1.01E-10	0.28	7.12317E-06	1.99E-06
	9.00E-01	1.79E-09	6.24E-11	0.1925	7.27917E-06	1.4E-06
	1.40E+00	2.44E-09	4.85E-11	0.4712	7.71123E-06	3.63E-06
	1.85E+00	2.79E-09	1.77E-11	0.2598	3.21576E-06	8.35E-07
	3.00E+00	3.22E-09	1.86E-11	0.128	3.91286E-06	5.01E-07
	6.43E+00	4.18E-09	7.66E-12	0.0842	2.08643E-06	1.76E-07
	2.00E+01	4.72E-09	4.89E-13	0.2078	1.50509E-07	3.13E-08
				Total AD (rad/s) =	3.43966E-05	4.54E-06
				Total AD (mrad/hr) =	123.8278217	16.32863

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