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PFP Vertical Calciner Shield Wall Dose Rate Calculations Using MCNP

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Abstract: This report yields a neutron shield wall design for a full time occupancy dose rate of 0.25 mrem/h. ORIGEN2 generated gamma ray spectrum and neutron intensity for plutonium. MCNP modeled the calciner glovebox and room for reflection of neutrons off concrete walls and ceiling. Neutron calculations used MCNP in mode n,p to include neutron capture gammas. Photon calculations used MCNP in mode p for gamma rays.

Neutron shield with lower 137.16 cm (4.5 feet) of 12.7 cm (5 inch) thick Lucite®[1] and 0.3175 cm (0.125 inch) stainless steel on both sides, and upper 76.2 cm (2.5 feet) of 10.16 cm (4 inch) thick Lucite® and 1.905 cm (0.75 inch) thick glass on each side gave a total weighted dose rate of 0.23 mrem/h, fulfilling the design goal. Lucite® is considered to be equivalent to Plexiglas®[2] since both are methylmethacrylate polymers.

[1]Lucite is a registered trademark of E. I. du Pont de Nemours and Co.
[2]Plexiglas is a registered trademark of Rohm & Haas.

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PFP VERTICAL CALCINER SHIELD WALL DOSE RATE CALCULATIONS USING MCNP

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PFP VERTICAL CALCINER SHIELD WALL DOSE RATE CALCULATIONS USING MCNP

1.0 INTRODUCTION AND SUMMARY

This evaluation supports the fulfillment of the 0.25 mrem/h full time occupancy dose rate goal due to the calcining process inside this glovebox.

Assumptions for the source term included 350 g Pu/L in the $Pu(NO_3)_4$ solution with 10 Liters in both the feed tank (receipt) and feed tank (pump). The source term assumed in the vertical calciner is 3.5 kg Pu. The source term assumed 4.5 g Pu/cm^3 in the PuO_2 compound in the two 1 L receipt cans and in four 0.5 L slip lid cans (total 4.0 L in cans). This quantities yielded a total of 7.0 kg Pu in the feed tanks, 3.5 kg Pu in the calciner, and 18.0 kg Pu in cans as the source term for the calciner glovebox. The dose rates from the different ^{240}Pu wt% plutonium inventories were weighted according to their quantities for an effective average dose rate.

The design goal of 0.25 mrem/h for full time occupancy can be accomplished using 10.16 cm to 12.70 cm (4 in. to 5 in.) of Lucite®[1] plastic neutron shielding with Stainless Steel and glass on each side of the Lucite® per the present design. The present design uses 12.70 cm (5 in.) of Lucite® with 0.3175 cm (0.125 in.) stainless steel on both sides on the lower 137.16 cm (4.5 ft) and uses 10.16 cm (4 in.) of Lucite® with 1.905 cm (0.75 in.) glass on both sides on the upper 76.20 cm (2.5 ft).

Lucite® is equivalent to Plexiglas®[2] since both are methylmethacrylate ($:CH_2$-CH_3-$C:$-CO_2-CH_3 or $C_5H_8O_2$) polymers. The main difference it that these are the trade names used by different manufacturers. The processing may be different, leading to different length polymer chains, but similar elemental composition and similar densities are anticipated. In this document, when Lucite® is stated, this is to be considered equivalent to Plexiglas® as far as neutron and gamma (photon) shielding is concerned.

Operator dose rate was summed for the gamma, capture gamma, and neutron dose contributions from the feed tanks, the calciner, and the plutonium oxide collected in cans. Annual dose rates were scaled proportionately for the three categories of ^{240}Pu material. The conversion from flux to dose used the ANS 6.1.1 1991 standard with the factor of 2 multiplied times the calculated neutron dose, as specified in ANS 6.1.1 1991.

The Lucite® shield achieved the design goal of 0.25 mrem/h, replacement with Lexan®[3] calculated to 0.30 mrem/h exceeding the design goal using the same plutonium source and shield thickness as for the Lucite® calculation. The Lexan® is polycarbonate ($:O$-C_6H_4-$C(CH_3)_2(C_6H_4)OCO:$ or $C_{16}H_{14}O_3$) and was modeled as 1.2 g/cm^3, while Lucite was modeled as 1.185 g/cm^3.

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[1] Lucite is a registered trademark of E. I. duPont de Nemours & Company

[2] Plexiglas is a registered trademark of Rohm & Haas Company

[3] Lexan is a registered trademark of General Electric Company, Chemical Materials Department

2.0 DESCRIPTION OF SYSTEM AND FACILITY

The 234-5Z Building, commonly referred to as PFP (Plutonium Finishing Plant), is located in the 200 West area. This facility was historically used to process plutonium into oxide or metal forms. The facility is undergoing cleanup to stabilize plutonium still stored there.

The plutonium stabilization program at PFP includes conversion of acidic plutonium nitrate solution into plutonium oxide. Conversion is facilitated through use of a vertical calciner installed in Glovebox HC-230C-2, which is to be installed in room 230C of this facility.

3.0 PROCESS FLOW DESCRIPTION

Feed material enters as plutonium nitrate solution ($Pu(NO_3)_4$) of at least 1.3M HNO_3 or greater (Stubbs, 1997) and is collected in the two feed tanks. This feed material is pumped over to the vertical calciner and heated to an overall process temperature of 1000 °C in excess oxygen/air. A residence time in the calciner of at least 4 hours assists in heating the product to obtain PuO_2 with a low loss of weight on ignition (LOI).

Plutonium nitrate suitable for calcination in the vertical calciner is transferred from the HC-227S glovebox through double encased transfer line to a feed receipt tank located in glovebox HC-230C-2, room 230C. A controlled volume is then gravity fed into the feed pump tank. Once the feed pump tank contains the appropriate amount of solution, the valve from the feed receipt tank is closed, and the solution in the feed pump tank is mixed with atomizing air flow into a preheated bed of PuO_2 powder in the vertical calciner. The vertical calciner agitates the injected mixture between external and internal heaters to 1000°C to form plutonium oxide (PuO_2).

Off-gases from this process are removed through the top of the calciner by vacuum. Sintered ceramic filter elements are used to remove any entrained plutonium dioxide powder. The off-gases are then circulated through a scrubber before leaving the glovebox. Spent scrubber solution is staged within the glovebox for sampling before removal from the glovebox. The scrubber system is not expected to contain more than a token amount of fissile material (less than 0.01 g Pu/cm^3) during normal operations.

4.0 GLOVEBOX MODELING FOR SHIELDING CALCULATIONS

General arrangement of the vertical calciner with the approximate location of the neutron shield wall and operator at the electrical control panel are shown in Figure 1, Vertical Calciner Glovebox and Neutron Shield Wall. Interior details of the Vertical Calciner Glovebox, from hand measurements are illustrated in Figure 2, Vertical Calciner Glovebox Interior Measurements.

Plutonium isotopic compositions were calculated in ORIGEN2 (Croff, 1980; Wittekind, 1994; Schmittroth, 1993) for the gamma ray intensity and energy spectrum and the neutron activity. The neutron activity came from spontaneous fission of, primarily ^{240}Pu, and from (α,n) reaction in light elements, primarily oxygen.

Figure 1. Vertical Calciner Glovebox and Neutron Shield Wall.

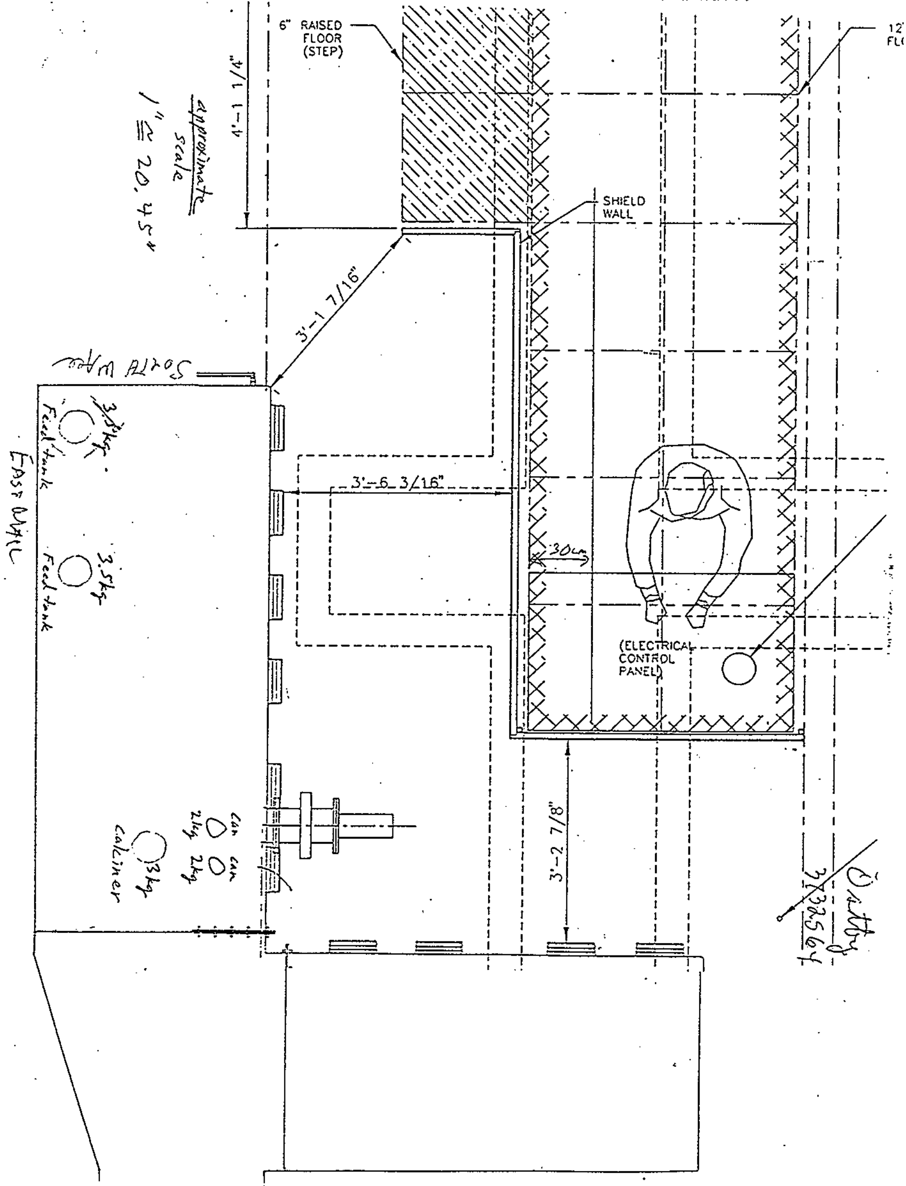
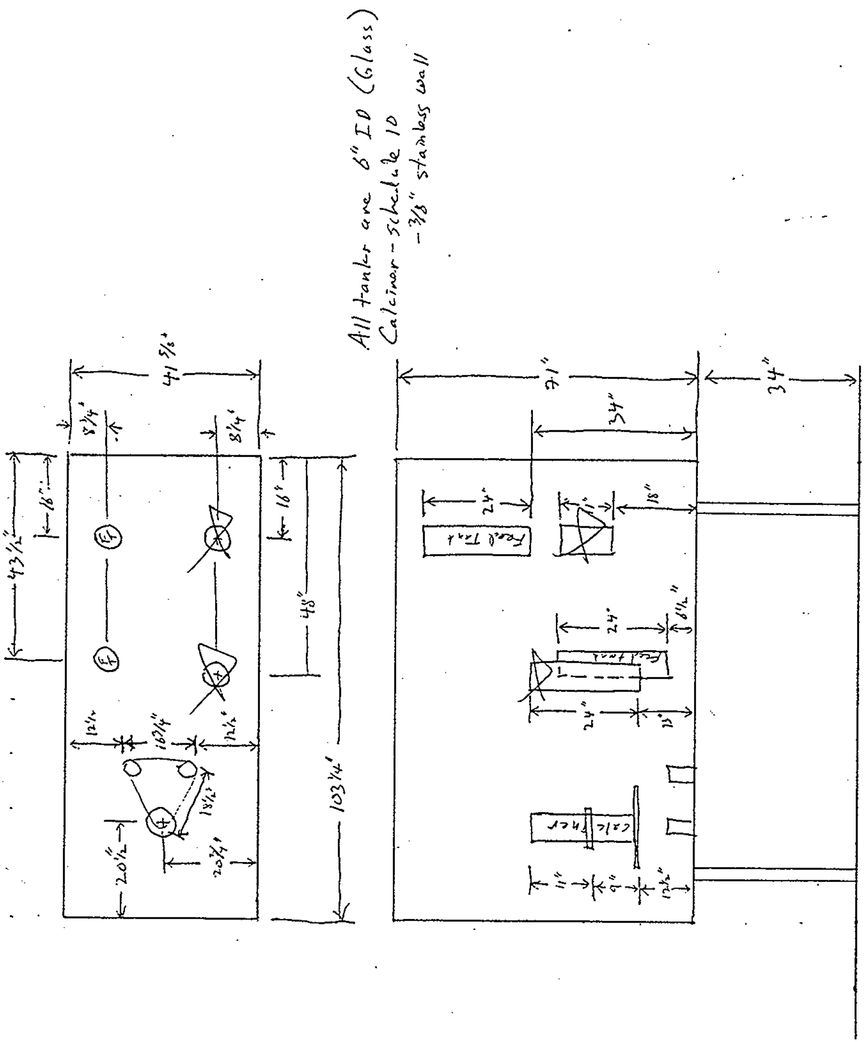


Figure 2. Vertical Calciner Glovebox Interior Measurements.



MCNP (Briesmeister, 1993; Carter, 1996) was used to calculate the radiation exposure from the gamma ray source using mode p. MCNP was also used to calculate the radiation exposure from the neutron source due to neutrons and gamma rays due to capture gammas using the mode n, p. MCNP modeled the vertical calciner glovebox and the entire room with concrete floor, concrete roof, two concrete walls and two metal walls.

The conversion from flux to dose used the ANS 6.1.1 1991 standard with the factor of 2 multiplied times the calculated neutron dose, as specified in ANS 6.1.1 1991. The one exception is that ANS 6.1.1 1977 was used to convert neutron flux to dose for hands around plutonium containers. The ANS 6.1.1 1991 standard with the factor of 2 multiplied times the calculated neutron dose was used for all whole body dose calculations. The ANS 6.1.1 1977 neutron and photon dose conversion factors were reported in (rem/hr)/(n/cm^2-s) and were multiplied by (1000. mrem/rem) to get (mrem/hr)/(n/cm^2-s) for use in MCNP. The ANS 6.1.1 1991 neutron and photon dose conversion factors were reported in (Sv-cm^2) and were multiplied by (3600. s/hr)*(100. rem/Sv)*(1000. mrem/rem) to get (mrem/hr)/(n/cm^2-s) for use in MCNP.

4.1 CONCENTRATION AND COMPOSITION OF THE FISSILE MATERIAL

Average inventory plutonium isotopic composition is shown in Table 4.1.

Table 4.1 Average Inventory Isotopic Composition
Plutonium Finishing Plant Stabilization DE Estimate dated May 16, 1996

Isotope	Low ^{240}Pu Wt%	Mid ^{240}Pu Wt%	High ^{240}Pu Wt%
Pu-238	0.01	0.15	0.18
Pu-239	92.40	85.63	80.06
Pu-240	6.12	12.45	17.84
Pu-241	0.26	1.20	1.22
Pu-242	0.04	0.37	0.73
Am-241	0.18	1.06	1.79
Total Mass (g)	1,542,620	586,298	1,520,313

4.1.1 Feed Solution

The feed tank plutonium inventory assumption of 3.5 kg plutonium in each 10 Liter tank volume calculates to a concentration of 350 g Pu/L in the plutonium nitrate ($Pu(NO_3)_4$) solution. The density of plutonium nitrate solution is 1.58 g/cm^3. Feed solution at PFP may vary in plutonium concentration in PFP and PUREX solution processes. This 350 g Pu/L plutonium concentration is conservative based on the material balance flow sheet expected concentration of 250 g Pu/L (Table 1 in Stubbs, 1997). This 350 g Pu/L plutonium concentration is reasonable based on the plutonium concentration upper limit is the criticality limit (Limit and Control #2 in Hillesland, 1997) of 450 g (^{239}Pu plus ^{235}U)/L.

4.1.2 Vertical Calciner Charge

The vertical denitration calciner is expected (Section 3.4 in Stubbs, 1997) to be precharged with approximately 3 kg of PuO_2 (2.65 kg Pu) and feed solution is added at 2 L to 3 L per hour (500 g Pu to 750 g Pu per hour) and the PuO_2 drops out into the receipt can as atomized solution is added into the vertical calciner for normal operating conditions. The assumption of 3.5 kg Pu mass in the vertical calciner is reasonable based on this reference.

4.1.3 Calcine (PuO_2) Product

The maximum expected tap density of the calcine product is 5.0 g Pu/cm^3, or 5.67 g PuO_2/cm^3 for normal operating conditions. This is based on experience with the PFP laboratory calciner, where normal product tap density was found to be 4.0 to 4.3 g Pu/cm^3. A product density of 4.75 g Pu/cm^3 was reached when it was continuously heated and stirred without addition of fresh feed solution.

Calcine product average density of 4.5 g Pu/cm^3 was assumed for evaluation of the radiation dose rate due to plutonium oxide in containers.

4.2 ROOM 230C MODELING ASSUMPTIONS

Room 230C is modeled with:

- Interior height (949.96 cm -0.0000 cm =) 949.96 cm (31 ft 2 in.),
- Interior width (541.02 cm +231.14 cm =) 772.16 cm (25 ft 4 in.),
- Interior depth (735.0125 cm +327.3425 cm) 1062.355 cm (34 ft 10.25 in.),
- Roof Concrete 10.16 cm (4 in.),
- Floor Concrete 60.96 cm (24 in.),
- Walls -Steel 0.2913 cm (0.1146 in.) [corrugated 18 gauge (0.0516 in.)],
  -Concrete 20.32 cm (8 in.),
- Glovebox distance from concrete wall 190.50 cm (75 in.),
- Glovebox distance from steel wall 243.84 cm (96 in.).

The corrugated steel was estimated to be 4.0 times as long as the distance covered for an effective increase in the 18 gauge thickness from 0.0516 in. to 0.1146 in.

4.3 GLOVEBOX

Most of glovebox HC-230C-2 was originally constructed for the Fuels and Materials Examination Facility (FMEF). One portion of the glovebox, calciner section, is primarily used for the calcination process. Another section, waste section, is used to process waste scrubber solution. The third section, connecting section, connects the HC-230C-2 glovebox to the HC-3 conveyer for further processing.

4.3.1 Calciner Section of Glovebox

The calciner section of glovebox is modeled with:

- Interior height (265.7475 cm -87.3125 cm =) 178.435 cm (70.25 in.),
- Interior width (220.6625 cm +39.6875 cm =) 260.35 cm (102.50 in.),
- Interior depth (21.2725 cm +82.5500 cm =) 103.8225 cm (40.875 in.),
- Walls -Stainless Steel 0.2381 cm (3/32 in.),
  -Lead 0.4763 cm (3/16 in.),
  -Stainless Steel 0.2381 cm (3/32 in.),
- Exterior height (266.7000 cm -86.3600 cm =) 180.34 cm (71.000 in.),
- Exterior width (221.6150 cm +40.6400 cm =) 262.255 cm (103.25 in.),
- Exterior depth (22.2250 cm +83.5025 cm =) 105.7275 cm (41.625 in.).
- Glovebox height above concrete floor 86.36 cm (34.00 in.).

These values are based on scaling from a preliminary drawing and hand measurements. The walls of the glovebox are made from lead sealed between two layers of steel. The lead is 0.476 cm (3/16 in.) thick between the stainless steel layers. The stainless steel layers are each 0.238 cm (3/32 in.) thick.

The basic model for the calciner section contains the following fissile quantities:

- Both feed tanks filled to 10 Liters of 350 g Pu/L solution is 7.0 kg Pu.

- The calciner contains 3.5 kg Pu. This section of the calciner is surrounded by 30.48 cm (12 in.) thick insulation.

- Product receiver can or storage cans may hold 3.6 kg Pu in a single container. Each container is filled with 4.5 g Pu/cm^3, dry product. A 4 Liter volume at 4.5 g Pu/cm^3 dry PuO_2 product is 18.0 kg Pu.

The calciner section of the glovebox, as compared to the waste section and the connection section of the glovebox, contains the bulk of the fissile material for analysis of the entire glovebox. This calciner section is used as the model throughout this analysis.

4.3.2 Waste Section of Glovebox

The waste section of the glovebox contains solution used for scrubbing of the off-gasses that come from the calciner. The width of the glovebox (minimum horizontal dimension) is indicated as 107 cm (42 in.) based on a preliminary drawing with dimensions, and scaling from a second preliminary drawing. The total length of the waste section is only 124.5 cm (49 in.). The waste section includes two tanks (four cylinders) for storage of spent scrubber solution. These tanks are referred to as spent scrubber receipt tanks (SSRTs).

Because the calciner section of the glovebox contains the bulk of the fissile material of the entire glovebox, the waste section was not modeled in the shielding calculations.

4.3.3 Connecting Section of Glovebox

The connecting section of the glovebox will provide access to one end of the HC-3 conveyer glovebox. Operators will need to move 0.5 L slip-lid cans 1.8 m (6 ft) by hand from the connecting section of the glovebox to the end of the conveyor to be transported to glovebox HC-21A for and into storage in the Hanford Convenience Can (HCC). The phase separation tank is on the border of this section and the calciner section.

Because the calciner section of the glovebox contains the bulk of the fissile material of the entire glovebox, the connecting section was not modeled in the shielding calculations.

4.4 FEED SYSTEM

The feed system for the calciner is mainly located within the calciner portion of the glovebox. The calciner portion of the glovebox includes two feed tanks, a flush tank, feed lines, valves, air supply, and a pump for the feed system. The vent catch tank in the waste section of the glovebox is used to catch overflow from the feed tanks and the flush tank.

4.4.1 Feed Tanks

A feed tank has a nominal capacity of 10 L, which means that a feed tank filled with 350 g Pu/cm^3 feed solution holds a total of 3.5 kg.

Both feed tanks are made from 6 inch Pyrex®[4] pipe. The feed receipt tank is modeled with:

- Inside radius 7.7610 cm (3.0555 in.),
- Outside radius 8.4534 cm (3.3281 in.),
- Pyrex® wall thickness 0.6924 cm (0.2726 in.),
  Assumes 5/16 in. wall less 0.040 in. tolerance,
- Height (233.6800 cm -171.7200 cm =) 61.96 cm (24.3937 in.),
- Solution height (224.5663 cm -171.7200 cm =) 52.8463 cm (20.8056 in.),
- Distance feed tank centerline to east wall 21.2725 cm (8.375 in.),
- Distance feed tank centerline to south wall 39.6875 cm (15.625 in.),
- Distance feed tank bottom to glovebox floor
  (171.72 cm -87.3125 cm =) 84.4075 cm (33.2313 in.).

Vendor data indicates an inside diameter of 15.71 cm (6.186 in.) including tolerances. The height of both feed tanks is nominally 60.96 cm (24 in.). The bottom and top of each tank is a 28.575 cm (11.25 in.) diameter, 1.27 cm (1/2 in.) thick steel flange as measured in the fabrication shop. There is a second flange on both the top and bottom used to hold the pipe in place, which is not included in the model. The feed pump tank was not modeled.

[4] Pyrex is a registered trademark of Corning Glass Works

The feed pump tank is about 109.5 cm (43 1/8 in.) from the south wall, and the feed receipt tank about 40.01 cm (15 3/4 in.) from the south wall, as determined by scaling from a preliminary drawing and confirmation by hand measurement. The bottom of the feed pump tank internal volume is 16.51 cm (6 1/2 in.) from the floor as determined by hand measurement, and the bottom of the internal volume for the feed receipt tank is 83.32 cm (33 in.) from the floor as determined by scaling from a preliminary drawing and confirmed by hand measurement. Dose rate from feed receipt tank was multiplied by two that assumes 350 g Pu/L in 10 Liters in both feed tanks.

4.4.2 Other Feed System Volumes

All pumps in the glovebox have negligible holdup volume for the purpose of this analysis. The waste section of the glovebox contains a vent catch tank, which collects liquid overflow from the feed system. There is a flush tank connected to the feed pump that is used to facilitate restart after unplanned shutdown, and an air supply tank used to atomize feed solution for injection into the calciner. The flush tank has a nominal capacity of only 4 L, the air supply has even less, and neither will contain fissile material under normal conditions.

No other feed system volumes were modeled in the shielding calculations.

4.5 VERTICAL CALCINER

The production vertical calciner is virtually identical to the prototype currently in the 188-1 glovebox at PFP. Drawing number H-2-95609 (BWHC, 1997) shows dimensions for this new production calciner. The outer vessel of the calciner consists of two sections of 310 stainless steel, 6 inch schedule 10 pipe. The dimensions for this pipe as modeled are 16.15 cm (6.357 in.) ID, 16.83 cm (6.625 in.) OD. Details specific to each section of pipe are given below.

4.5.1 The Lower Section

The heating and agitation of the product take place in the lower portion of the calciner. There is a dome made from 4 inch pipe and pipe cap in the center extending up 17.95 cm (7.066 in.) into the internal volume of the calciner from the bottom. Although the product collection tube will often be filled with product during normal operating conditions, it is of negligible importance for shielding calculations and because it only extends up into the annular region of the calciner.

This section is wrapped in a highly water absorbent insulation. The thickest portion of the insulation is 15.24 cm (6 in.), the insulation is modelled as a close-fitting annulus just over 30.48 cm (12 in.) thick along its entire axial length. The insulation is 10.16 cm (4 in.) thick and its inner surface is 9.366 cm (3.688 in.) from the outside surface of the calciner vessel along most of the middle portion of the insulation's axial length.

4.5.2 The Upper Section

The upper calcining section contains filter elements for filtering particulates from the off-gasses produced in the calcining process. The filters were modeled based on dimensions from the model used in CSER 95-005 for the calciner in glovebox 188-1 (Geiger, 1995a and 1995b) and a third party reference to personal correspondence with L.H. Rodgers, as there were no drawings made available for these dimensions. These dimensions were used in the base case model for the calciner section of the glovebox as described in Section 4.2.1. Later hand measurements of the production calciner filters by J.F. Durnil yielded different internal dimensions. A list of dimensions for both filter models is given in Table 4.2 below. The inside dimensions are important only for the case of feed solution filling the calciner.

Table 4.2 Off-Gas Filter Dimensions

Dimension	From CSER 95-005 (Geiger, 1995a)	Measurement by J.F. Durnil
Total Length	30.48 cm (12 in.)	30.80 cm (12 1/8 in.) - modeled as 30.48 cm (12 in.)
Outside Diameter	5.080 cm (2 in.)	5.080 cm (2 in.)
Inside Diameter	2.870 cm (1.13 in.)	3.651 cm (1 7/16 in.)
Bottom Thickness	3.810 cm (1.5 in.)	2.858 cm (1 1/8 in.)

This section is wrapped in metal reflective insulation that does not absorb liquids (see Appendix B of Geiger, 1995b). The manufacturer supplied drawings show an outside diameter of 40 cm (15.75 in.) and a height of 36.83 cm (14.5 in) for the prototype calciner. These are the dimensions used for the production calciner, as there was no information available on these dimensions at the time of the analysis. The insulation was modeled as being 10% density 304L steel to accommodate the concentric sheets and narrow strips of sheet metal used to create many spaces of dead air within the insulation. In any case, the amount of steel modeled is small.

4.5.3 Product Collection Tube

A product collection tube is used to feed the final product from the calciner into product receipt cans. The outside pipe of the tube is 1 in. schedule 10s pipe. The top of the tube is inside the center dome of the calciner. There is a 11.43 cm (4.5 in.) tall slot in the side of the dome, and a slot cut into the side of the tube to allow product to flow from the calciner down the tube into an attached product receipt can. The height of the product inside the calciner is controlled by a weir inside the tube. The flow of product is controlled by a valve attached to the product collection tube. The tube was found to adjust such that the bottom may range between 12.7 cm (5 in.) to 30.48 cm (12 in.) from the glovebox floor based on hand measurement in the fabrication shop.

4.6 CONTAINERS

There are three types of plutonium oxide containers that will be allowed in the glovebox: product receiver vessels, 0.5 L containers (1 pound slip lid cans and polyjars), and 30 mL sample jars. A limit requires that no more than two unit masses of 2 L each be in the glovebox at one time.

Two receipt cans are considered: a 3.6 kg Pu can, and a 1.8 kg Pu can. The dimensions of the 3.6 kg Pu receipt can are:
4.6038 cm (1.8125 in. or 1 13/16 in.) Inside Radius
4.7625 cm (1.8750 in. or 1 7/8 in.) Outside Radius
11.2713 cm (4.4375 in. or 4 7/16 in.) Inside Height
11.43 cm (4.5 in. or 4 1/2 in.) Outside Height
The dimensions of the 1.8 kg Pu receipt can are:
3.8894 cm (1.53125 in. or 1 17/32 in.) Inside Radius
4.0481 cm (1.5937 in. or 1 19/32 in.) Outside Radius
7.8582 cm (3.0938 in. or 3 3/32 in.) Inside Height
8.0169 cm (3.1563 in. or 3 5/32 in.) Outside Height

The 0.5 L (nominal) containers proposed for use in the HC-230C-2 glovebox are the 1 pound slip lid can (part number 42-1500-300) with the dimensions of 8.89 cm (3.5 in.) OD x 8.89 cm (3.5 in.) height, and the polyjar (part number 57-6359-160) with the dimensions of 8.255 cm (3.25 in.) OD x 10.16 cm (4 in.) height. The total internal volume for the 1 pound slip lid can is 552 mL, and for the polyjar it is 543 mL.

A unit mass is considered to be 2 Liters. There are permitted to be two unit masses in containers inside the vertical calciner glovebox at the same time. This is a total volume of 4 Liters of PuO_2. Because of the assumed density of 4.5 g Pu/L, this equates to 4 L * 4.5 kg Pu/L = 18 kg Pu total. The dose calculation is performed for 3.6 kg Pu per receipt can, so the contribution to the total radiation dose rate from PuO_2 in containers is calculated for five of these 3.6 kg Pu receipt cans.

4.7 SCRUBBER SYSTEM

The scrubber system is not expected to contain more than a token amount of fissile material (less than 0.01 g Pu/cm^3) during normal operations. No scrubber system volumes were modeled in the shielding calculations.

5.0 EVALUATION AND RESULTS

5.1 PLUTONIUM INVENTORY OF VERTICAL CALCINER GLOVEBOX

The vertical calciner glovebox plutonium inventory is assumed to be:

- 7.0 kg plutonium in $Pu(NO_3)_4$ solution in the two 10 Liter feed tanks,
- 3.5 kg plutonium in PuO_2 in the vertical calciner, and
- 18.0 kg plutonium in PuO_2 in 4 Liter total volume of containers.

There is sufficient plutonium assumed in these separate components to compensate for the plutonium solution in the piping into the feed tank in the glovebox, and between the feed tanks and the vertical calciner, as well as the possibility that there may be spilled plutonium on the glovebox floor.

The feed tank plutonium inventory assumption of 3.5 kg plutonium in each 10 Liter tank volume calculates to a concentration of 350 g Pu/L in the plutonium nitrate ($Pu(NO_3)_4$) solution. This plutonium concentration is conservative based on the material balance flow sheet assumption (Table 1 in Stubbs, 1997) of 250 g Pu/L. This plutonium concentration is reasonable based on the plutonium concentration upper limit is the criticality limit (Limit and Control #2 in Hillesland, 1997) of 450 g (^{239}Pu plus ^{235}U)/L.

The vertical calciner plutonium inventory assumption is 3.5 kg plutonium. This plutonium inventory in the vertical calciner is reasonable based on the material balance flow sheet assumption of 3.0 kg plutonium for calciner bed holdup (Table 1 in Stubbs, 1997).

The container plutonium inventory in receipt cans (two at 1 Liter each) and storage cans (four slip lid cans at 0.5 Liters each) assumption of 18 kg plutonium in a total volume of 4 Liters calculates to a density of 4.5 g Pu/cm^3. Normal tap density for a PFP laboratory calciner was reported to be 4.0 g Pu/cm^3 to 4.3 g Pu/cm^3 (Page 5 in Hillesland, 1997). This plutonium density is reasonable based on the 3.6 g PuO_2/cm^3 highest observed calcined plutonium density starting with plutonium nitrate (Page II.C.2-2 in ARC-600). The plutonium density upper limit is the criticality limit (Limit and Control #1 in Hillesland, 1997) of 5.5 g Pu/cm^3.

5.2 PLUTONIUM ACTIVITY CALCULATION BY ORIGEN2

This radiation shielding calculation began with the isotopic compositions of the plutonium in the calciner feed stock. An ORIGEN2 calculation converted the plutonium into gamma ray intensity and energy spectrum, as well as a spontaneous neutron activity and an (α,n) neutron activity. The gamma ray intensity and energy spectrum were used for the source term in MCNP in mode p to calculate the direct gamma ray flux. The neutron activity was used for the source term in MCNP in mode n,p to calculate the neutron flux and the associated (n,γ) induced gamma ray flux.

The ORIGEN2 input file as well as calculated gamma ray energy spectrum and neutron sources are listed in Appendix B, ORIGEN2 Plutonium Input File and Output Results.

5.3 COMPONENT DOSE RATE CALCULATION BY MCNP

The conversion from flux to dose used the ANS 6.1.1 1991 standard. The photon flux to dose rate conversion was used directly, but the neutron flux to dose rate conversion was multiplied by the factor of 2, as specified in ANS 6.1.1 1991. The total radiation dose rate from a single plutonium source is the sum of these individual gamma ray, neutron, and induced gamma ray dose rate contributions. The total calciner glovebox radiation dose rate expected from the calciner glovebox is the sum of contributions from plutonium in all the individual sources within the glovebox such as the feed tank, the vertical calciner, and the storage cans. There are two feed tanks, one is the feed tank (receipt), and the other is the feed tank (pump), but both are the same 10 Liter volume. The vertical calciner is considered for its plutonium inventory. The plutonium oxide in storage cans without the shielding of the feed tank or the vertical calciner contributes more to the radiation dose rate for the same quantity of plutonium.

The plutonium mass assumed 350 g Pu/L in the $Pu(NO_3)_4$ solution with a total of 10 Liters in both the feed tank (receipt) and feed tank (pump). The plutonium mass assumed in the calciner is 3.5 kg Pu. The container plutonium mass assumed 4.5 g Pu/cm^3 in the PuO_2 compound in the two 1 L receipt cans and in four 0.5 L slip lid cans (total 4.0 L in cans). This quantities yielded a total of 7.0 kg Pu in the feed tanks, 3.5 kg Pu in the calciner, and 18.0 kg Pu in cans as the source term for the calciner glovebox.

5.4 EFFECTIVE DOSE RATE CALCULATION BY WEIGHTING

Operator dose rate is added from gamma, capture gamma, and neutron dose contributions from feed tanks, vertical calciner, and plutonium oxide collected in cans. Annual dose rates were scaled proportionately for the three categories of ^{240}Pu material.

Table 5.1 neutron shield wall design with lower 137.16 cm (4.5 feet) of 12.7 cm (5 in.) thick Lucite® and 0.3175 cm (0.125 in.) stainless steel on both sides, and upper 76.20 cm (2.5 feet) of 10.16 cm (4 in.) thick Lucite® and 1.905 cm (0.75 in.) thick glass on each side gave a total dose rates of 0.034 mrem/h (high ^{240}Pu), 0.025 mrem/h (medium ^{240}Pu), and 0.012 mrem/h (low ^{240}Pu) for 3.5 kg plutonium inside the vertical calciner.

Table 5.1 Lucite® Neutron Shield
Bottom 4.5 ft. is 5 in. Lucite® and 1/8 in. SST Both Sides
Top 2.5 ft. is 4 in. Lucite® and 3/4 in. Glass Both Sides
Source Term used High ^{240}Pu Category Plutonium
0.23 mrem/h = 1xCalciner + 2xFeed Tank + 5xStorage Can

Calciner with 3.5 kg Plutonium - Dose Rates behind Neutron Shield (mrem/h)					
cca08anp.out			High Pu-240	Mid Pu-240	Low Pu-240
3.13090E-02 0.0680		Neutron	3.13090e-02	2.28184e-02	1.11439e-02
1.03211E-03 0.0648		Gamma (n,γ)	1.03211e-03	7.52216e-04	3.67361e-04
1.68063E-03 0.3923		Gamma	1.68063e-03	1.11423e-03	3.16599e-04
0.229874	0.023004	Total	3.40217e-02	2.46849e-02	1.18278e-02
Feed Tank with 3.5 kg Plutonium - Dose Rates behind Neutron Shield (mrem/h)					
cft08anp.out			High Pu-240	Mid Pu-240	Low Pu-240
3.47302E-02 0.0216		Neutron	3.47302e-02	2.53118e-02	1.23616e-02
1.90412E-03 0.0183		Gamma (n,γ)	1.90412e-03	1.38775e-03	6.77738e-04
6.89650E-03 0.0799		Gamma	6.89650e-03	4.57228e-03	1.29917e-03
	0.02905	Total	4.35308e-02	3.12719e-02	1.43385e-02
Storage Can's 3.6 kg Plutonium - Dose Rates behind Neutron Shield (mrem/h)					
csc08anp.out			High Pu-240	Mid Pu-240	Low Pu-240
4.10801E-02 0.0602		Neutron	4.10801e-02	2.99397e-02	1.46217e-02
1.44262E-03 0.0537		Gamma (n,γ)	1.44262e-03	1.05140e-03	5.13475e-04
1.38752E-03 0.2774		Gamma	1.38752e-03	9.19907e-04	2.61383e-04
	0.029754	Total	4.39102e-02	3.19110e-02	1.53966e-02

Weighting an annual dose rate proportional to plutonium quantities in the different ^{240}Pu wt% categories for an average radiation dose rate is:

(0.034*1,542,620. +0.025*586,298. +0.012*1,520,313.)/3,649,231. = 0.023 mrem/h

for 3.5 kg plutonium in the vertical calciner. Similar calculations are performed in Table 5.1 for 3.5 kg plutonium in the feed tank, and for 3.6 kg plutonium in storage cans. Adding:

1*(vertical calciner) + 2*(feed tank) + 5*(storage cans) = average mrem/h
1*(0.023 mrem/h) + 2*(0.029 mrem/h) + 5*(0.030 mrem/h) = 0.23 mrem/h

satisfying the 0.25 mrem/h design limit, fulfilling the design goal.

5.5 COMPARISON OF LUCITE AND LEXAN NEUTRON SHIELDING MATERIAL

Table 5.2 neutron shield wall design with lower 4 1/2 feet of 5 inches thick Lexan® and 1/8 inch stainless steel on both sides, and upper 2 1/2 feet of 4 inches thick Lexan® and 3/4 inches thick glass on each side gave a total weighted dose rate of 0.30 mrem/h, exceeding the design goal.

Table 5.2 Lexan® Neutron Shield
Bottom 4.5 ft. is 5 in. Lexan® and 1/8 in. SST Both Sides
Top 2.5 ft. is 4 in. Lexan® and 3/4 in. Glass Both Sides
Source Term used High ^{240}Pu Category Plutonium
0.30 mrem/h = 1xCalciner + 2xFeed Tank + 5xStorage Can

Calciner with 3.5 kg Plutonium - Dose Rates behind Neutron Shield (mrem/h)					
cca08bnp.out			High Pu-240	Mid Pu-240	Low Pu-240
3.92718E-02 0.0640		Neutron	3.92718e-02	2.86218e-02	1.39781e-02
8.50756E-04 0.0696		Gamma (n,γ)	8.50756e-04	6.20043e-04	3.02811e-04
1.90409E-03 0.3617		Gamma	1.90409e-03	1.26239e-03	3.58695e-04
0.295817	0.028431	Total	4.20266e-02	3.05042e-02	1.46396e-02
Feed Tank with 3.5 kg Plutonium - Dose Rates behind Neutron Shield (mrem/h)					
cft08bnp.out			High Pu-240	Mid Pu-240	Low Pu-240
4.26543E-02 0.0194		Neutron	4.26543e-02	3.10870e-02	1.51820e-02
1.79059E-03 0.0191		Gamma (n,γ)	1.79059e-03	1.30501e-03	6.37329e-04
7.12845E-03 0.0729		Gamma	7.12845e-03	4.72606e-03	1.34287e-03
	0.034501	Total	5.15733e-02	3.71181e-02	1.71622e-02
Storage Can's 3.6 kg Plutonium - Dose Rates behind Neutron Shield (mrem/h)					
csc08bnp.out			High Pu-240	Mid Pu-240	Low Pu-240
5.58616E-02 0.0513		Neutron	5.58616e-02	4.07127e-02	1.98829e-02
1.30592E-03 0.0590		Gamma (n,γ)	1.30592e-03	9.51772e-04	4.64819e-04
1.32357E-03 0.2906		Gamma	1.32357e-03	8.77509e-04	2.49336e-04
	0.039677	Total	5.84911e-02	4.25420e-02	2.05971e-02

The Lucite® was modeled as methyl methacrylate ($C_5H_8O_2$ at 1.185 g/cm^3), while the Lexan® was modeled as polycarbonate ($C_{16}H_{14}O_3$ at 1.2 g/cm^3) (Table 9.2-33 in Jaeger et. al. 1975).

5.6 COMPENSATION FOR INCREASED (α,n) IN PLUTONIUM NITRATE SOLUTION

The (α,n) activity for plutonium is calculated in ORIGEN2 according to the plutonium being plutonium oxide (PuO_2), while the plutonium in the feed tanks is actually in $Pu(NO_3)_4$ in aqueous solution. The (α,n) reaction could be twice as large in the solution as the (α,n) activity in PuO_2.

Table 5.3 Increased (α,n) Effect
Effect of Increased (α,n) Yield in Plutonium Nitrate Solution Compared to Plutonium Oxide

	Low ^{240}Pu	Medium ^{240}Pu	High ^{240}Pu
(α,N) NEUTRON SOURCE (n/sec)			
TABLE	53.44	104.6	134.6
SPONTANEOUS FISSION NEUTRON SOURCE (n/sec)			
TABLE	50.5	108.1	155.6
OVERALL TOTAL			
TOTAL	103.9	212.7	290.2
2.0*(α,n) NEUTRON SOURCE (n/sec)			
TABLE	106.88	209.2	269.2
SPONTANEOUS FISSION NEUTRON SOURCE (n/sec)			
TABLE	50.5	108.1	155.6
OVERALL TOTAL			
TOTAL	157.38	317.3	424.8
RATIO OF TOTAL NEUTRON SOURCE WITH (α,n) DOUBLED TO ORIGINAL ORIGEN2 NEUTRON SOURCE			
	1.514726	1.491772	1.463818

Table 5.4 Lucite® Neutron Shield and Increased (α,n) in $Pu(NO_3)_4$
Factors from Table 1.3 Applied
Bottom 4.5 ft. is 5 in. Lucite® and 1/8 in. SST Both Sides
Top 2.5 ft. is 4 in. Lucite® and 3/4 in. Glass Both Sides
Source Term used High ^{240}Pu Category Plutonium
0.25 mrem/h = 1xCalciner + 2xFeed Tank + 5xStorage Can

Calciner with 3.5 kg Plutonium - Dose Rates behind Neutron Shield (mrem/h)					
cca08anp.out			High Pu-240	Mid Pu-240	Low Pu-240
3.13090E-02 0.0680		Neutron	3.13090e-02	2.28184e-02	1.11439e-02
1.03211E-03 0.0648		Gamma (n,γ)	1.03211e-03	7.52216e-04	3.67361e-04
1.68063E-03 0.3923		Gamma	1.68063e-03	1.11423e-03	3.16599e-04
0.253781	0.023004	Total	3.40217e-02	2.46849e-02	1.18278e-02
Feed Tank with 3.5 kg Plutonium - Dose Rates behind Neutron Shield (mrem/h)					
cft08anp.out			High Pu-240	Mid Pu-240	Low Pu-240
3.47302E-02 0.0216		Neutron	3.47302e-02	2.53118e-02	1.23616e-02
1.90412E-03 0.0183		Gamma (n,γ)	1.90412e-03	1.38775e-03	6.77738e-04
6.89650E-03 0.0799		Gamma	6.89650e-03	4.57228e-03	1.29917e-03
	0.041003	Total	6.05225e-02	4.44020e-02	2.10502e-02
Storage Can's 3.6 kg Plutonium - Dose Rates behind Neutron Shield (mrem/h)					
csc08anp.out			High Pu-240	Mid Pu-240	Low Pu-240
4.10801E-02 0.0602		Neutron	4.10801e-02	2.99397e-02	1.46217e-02
1.44262E-03 0.0537		Gamma (n,γ)	1.44262e-03	1.05140e-03	5.13475e-04
1.38752E-03 0.2774		Gamma	1.38752e-03	9.19907e-04	2.61383e-04
	0.029754	Total	4.39102e-02	3.19110e-02	1.53966e-02

5.7 DOSE RATE PATHWAYS TO OPERATOR BEHIND NEUTRON SHIELD

The dose rate pathways were calculated by using MCNP to flag tallies that arrived at the cell behind the neutron shield after having traversed specified cells that completely surround the operator. The results are tabulated in Table 5.5, Radiation Dose Rate From The Different Pathways. These results can be tabulated as follows:

Plutonium Source:	Calciner	Feed Tank	Containers
Dominant Radiation:	Neutron	Neutron	Neutron
Principal Pathway(s): F-L=Front Lower, S-L=Side Lower, etc.	F-L n Shield, & S-L n Shield.	Open End, & F-U n Shield, & F-L n Shield.	F-L n Shield, & Concrete Floor.

Table 5.5 Radiation Dose Rate From The Different Pathways
Upper n Shield: Lucite® 4 inches, 3/4" Glass Both Sides
Lower n Shield: Lucite® 5 inches, 1/8" Stainless Steel Both Sides
End n Shield: Lucite® 1 inch, Glass on Upper, SST on Lower

Radiation Leakage or Reflection Path	Neutron mrem/h	Gamma (n,γ) mrem/h	Gamma mrem/h
3.5 kg Pu-Calciner	cca08anp.out		cca08ap.out
Open End Leakage	3.58199E-03 0.1537	9.99946E-05 0.2490	1.81439E-07 1.0000
Front Lower Leakage	8.89764E-03 0.1281	6.83875E-04 0.0802	1.53766E-03 0.4263
Front Upper Leakage	4.46445E-03 0.1578	2.71602E-04 0.1326	1.42788E-04 0.4964
Side Lower Leakage	9.02347E-03 0.1349	1.05918E-04 0.2128	1.23192E-05 1.0000
Side Upper Leakage	2.61693E-03 0.2266	4.47746E-05 0.3100	5.29858E-06 1.0000
Roof Reflection	6.58581E-03 0.1427	6.59565E-05 0.3428	0.00000E+00 0.0000
Steel Wall Reflect	3.60208E-04 0.8342	1.52006E-06 0.8779	0.00000E+00 0.0000
Concrete Floor Effect	1.02145E-02 0.1137	4.22720E-04 0.1016	7.52464E-05 0.8600
Total mrem/h	**3.13090E-02 0.0680**	**1.03211E-03 0.0648**	**1.68063E-03 0.3923**
3.5 kg Pu-Feed Tank	cft08anp.out		cft08ap.out
Open End Leakage	1.15342E-02 0.0383	1.68144E-04 0.0573	3.61090E-04 0.2958
Front Lower Leakage	8.53409E-03 0.0427	1.05428E-03 0.0248	2.75062E-03 0.1286
Front Upper Leakage	1.04826E-02 0.0393	7.24873E-04 0.0290	3.70877E-03 0.1096
Side Lower Leakage	2.22065E-03 0.0865	7.95798E-05 0.0892	5.76960E-05 0.7623
Side Upper Leakage	1.16436E-03 0.1189	3.21004E-05 0.1263	4.65579E-05 0.5542
Roof Reflection	7.92388E-03 0.0460	8.25587E-05 0.0870	1.70399E-04 0.3378
Steel Wall Reflect	2.42680E-05 0.2353	5.82765E-06 0.2999	3.79737E-05 1.0000
Concrete Floor Effect	6.02326E-03 0.0452	3.69543E-04 0.0394	1.33840E-04 0.3316
Total mrem/h	**3.47302E-02 0.0216**	**1.90412E-03 0.0183**	**6.89650E-03 0.0799**
3.6 kg Pu-Container	csc08anp.out		csc08ap.out
Open End Leakage	5.94915E-03 0.1369	1.03303E-04 0.2023	0.00000E+00 0.0000
Front Lower Leakage	1.68798E-02 0.0942	1.02927E-03 0.0646	7.40678E-04 0.4289
Front Upper Leakage	7.92102E-03 0.1416	3.75458E-04 0.1009	6.30898E-04 0.3438
Side Lower Leakage	6.53228E-03 0.1512	1.18019E-04 0.2268	1.47267E-05 0.9442
Side Upper Leakage	2.41222E-03 0.2851	1.91220E-05 0.4054	2.05582E-06 0.8855
Roof Reflection	6.53887E-03 0.1348	4.83391E-05 0.3522	2.64173E-07 1.0000
Steel Wall Reflect	3.57984E-05 0.4548	2.32480E-07 1.0000	0.00000E+00 0.0000
Concrete Floor Effect	1.23256E-02 0.0976	5.46129E-04 0.0895	1.91549E-05 0.7516
Total mrem/h	**4.10801E-02 0.0602**	**1.44262E-03 0.0537**	**1.38752E-03 0.2774**

5.8 DOSE RATE ADJACENT TO CALCINER GLOVEBOX SOURCES

Table 5.6 Radiation Dose Adjacent to Unshielded Glovebox

Dose Rate Location	Neutron mrem/h	Gamma mrem/h
3.5 kg Pu-Calciner	cca08anp.out	cca08ap.out
x,y,z=-1.68593E+02 6.98500E+01 1.25971E+02	7.84649E+00 0.0281	1.25636E+00 0.0689
x,y,z=-1.68593E+02 1.13502E+02 1.25971E+02	1.63511E+00 0.0170	4.64801E-02 0.0533
x,y,z=-1.68593E+02 2.35903E+02 1.25971E+02	3.44401E-01 0.0111	9.66447E-03 0.0706
3.5 kg Pu-Feed Tank	cft08anp.out	cft08ap.out
x,y,z= 0.00000E+00 3.84534E+01 2.00000E+02	6.96388E+00 0.0046	3.09575E+02 0.0041
x,y,z= 0.00000E+00 1.13502E+02 2.00000E+02	9.86556E-01 0.0060	1.64459E-01 0.0270
x,y,z= 0.00000E+00 2.35903E+02 2.00000E+02	5.13981E-02 0.0248	1.46022E-02 0.1000
3.6 kg Pu-Containers	csc08anp.out	csc08ap.out
x,y,z=-1.26693E+02 8.58800E+01 9.31068E+01	1.24164E+01 0.0428	2.80244E-01 0.0407
x,y,z=-1.26693E+02 1.13502E+02 9.31068E+01	3.81204E+00 0.0126	9.70591E-02 0.0474
x,y,z=-1.26693E+02 2.35903E+02 9.31068E+01	4.98551E-01 0.0689	1.14574E-02 0.0564

5.9 HANDS AROUND CONTAINERS

To study the effects of hands in the glovebox, case was modified to form a case by placing a latex, water, latex layers around the radius of the receipt cans. The inside latex is 0.2381 cm (0.0937 in. or 3/32 in.) thick, the water representing hands is 2.54 cm (1 in.) thick, and the outside latex is 0.2382 cm (0.0938 in. or 3/32 in.) thick. The neutron and activation gamma dose rate as well as the direct gamma dose rate is calculated in the water annulus. The containers each hold dry 3.6 kg Pu or 1.8 kg Pu.

The tabulated results in Table 5.7, Hand Dose Rate from Receipt Cans, indicates that the dose rate to hands while holding a can is:

- 680 mrem/h for a 3.6 kg Pu can, and
- 475 mrem/h for a 1.8 kg Pu can.

Table 5.7 Hand Dose Rate From Receipt Cans Source Term used High ^{240}Pu Category Plutonium Neutron, Gamma Activation from mode n,p Gamma Dose from mode p 3.6 kg Pu can and 1.8 kg Pu can		
MCNP Results	mrem/h	$\pm\sigma$
crch02np.out, 3.6 kg Pu can, mode n,p		
3.48344E+02 0.0096	3.48344e+02	0.0096
2.60610E+00 0.0277	2.60610e+00	0.0277
crch02p.out, 3.6 kg Pu can, mode p		
3.29047E+02 0.1057	3.29047e+02	0.1057
TOTAL mrem/h	6.79997e+02	0.0562
crch03np.out, 1.8 kg Pu can, mode n,p		
1.99876E+02 0.0090	1.99876e+02	0.0090
1.39118E+00 0.0295	1.39118e+00	0.0295
crch03p.out, 1.8 kg Pu can, mode p		
2.75128E+02 0.0971	2.75128e+02	0.0971
TOTAL mrem/h	4.76395e+02	0.0599

Calculation of the relative uncertainty for the total dose rate to the hands would be done differently depending upon the assumptions. If the assumption of correlated uncertainties is made, then the uncertainty is:

(0.0096*3.48344E+2 + 0.0277*2.60610E0 + 0.1057*3.29047E+2)/6.79997E+2
= 0.0569 for a combined uncertainty on total mrem/h.

If the assumption of uncorrelated uncertainties is made, then the uncertainty is:

$SQRT((0.0096*3.48344E+2)^2+(0.0277*2.60610E0)^2+(0.1057*3.29047E+2)^2)/6.79997E+2$
= 0.0514 for a combined uncertainty on total mrem/h.

5.10 SHIELDS AROUND CONTAINERS

The reduction of neutron and gamma dose rates from containers is possible by shielding the containers by a neutron shield.
Two geometries were considered:

- Cylindrical, and
- Square or box.

Three materials were considered for container neutron shielding material:

- Borated Polyethylene 207,
- Borated Polyethylene 210,
- Lucite® or Plexiglas® (both are methylmethacrylate polymers).

Table 5.8 Storage Can Cylindrical Shields - Dose Rates
Neutron (n.) and Photon Dose Rates (p.) (mrem/h)
Source Term is 3.6 kg Plutonium in Dry PuO_2

PuO_2 +30 cm	glovebox +30 cm	glovebox +152.8 cm
csc002an.out, no additional shield		
1.43506E+01 0.0695	4.45063E+00 0.0462	5.71320E-01 0.0541
csc002ap.out, no additional shield		
2.72155E-01 0.1384	1.10414E-01 0.3093	1.19380E-02 0.2616
csc003an.out, 1" cylindrical shield of borated poly 207		
8.52330E+00 0.0845	2.71223E+00 0.0452	3.60051E-01 0.0616
csc003ap.out, 1" cylindrical shield of borated poly 207		
2.21859E-01 0.1557	9.69784E-02 0.3526	1.02630E-02 0.3003
csc003bn.out, 1" cylindrical shield of borated poly 210		
8.24647E+00 0.0486	2.84517E+00 0.0462	3.69602E-01 0.0549
csc003bp.out, 1" cylindrical shield of borated poly 210		
2.30997E-01 0.1517	9.78125E-02 0.3456	1.03615E-02 0.2933
csc003en.out, 1" cylindrical shield of Lucite®		
8.88006E+00 0.0505	3.03598E+00 0.0459	3.97229E-01 0.0479
csc003ep.out, 1" cylindrical shield of Lucite®		
2.28606E-01 0.1533	9.69384E-02 0.3503	1.01284E-02 0.3009

Table 5.9 Storage Can Square Shields - Dose Rates
Neutron (n.) and Photon Dose Rates (p.) (mrem/h)
Source Term is 3.6 kg Plutonium in Dry PuO_2

PuO_2 +30 cm	glovebox +30 cm	glovebox +152.8 cm
csc002an.out, no additional shield		
1.43506E+01 0.0695	4.45063E+00 0.0462	5.71320E-01 0.0541
csc002ap.out, no additional shield		
2.72155E-01 0.1384	1.10414E-01 0.3093	1.19380E-02 0.2616
csc003cn.out, 1" square shield of borated poly 207		
1.44633E+01 0.3689	2.89555E+00 0.0601	3.80961E-01 0.0565
csc003cp.out, 1" square shield of borated poly 207		
2.14533E-01 0.1526	9.24376E-02 0.3626	9.88685E-03 0.3047
csc003dn.out, 1" square shield of borated poly 210		
8.41078E+00 0.0525	2.82536E+00 0.0437	3.81597E-01 0.0644
csc003dp.out, 1" square shield of borated poly 210		
2.22954E-01 0.1508	9.62518E-02 0.3510	1.03783E-02 0.2939
csc003fn.out, 1" square shield of Lucite®		
1.05240E+01 0.0664	3.31358E+00 0.0492	4.14267E-01 0.0551
csc003fp.out, 1" square shield of Lucite®		
2.21675E-01 0.1508	9.51206E-02 0.3542	1.04571E-02 0.2917

6.0 REFERENCES

Aftanas, B. L., April 30, 1996, *PFP Solution Stabilization*, WHC-SD-CP-FDC-003 Rev. 0, Westinghouse Hanford Company, Richland, Washington.

ANSI/ANS-6.1.1-1977, 1977, *Neutron and Gamma-Ray Flux-to-Dose-Rate Factors*, American Nuclear Society, La Grange Park, Illinois

ANSI/ANS-6.1.1-1991, 1992, *Neutron and Gamma-Ray Fluence-to-Dose Factors*, American Nuclear Society, La Grange Park, Illinois

Briesmeister, J. F., Editor, November 1993, *MCNP - A General Monte Carlo N-Particle Transport Code, Version 4A*, LA-12625, Los Alamos National Laboratory, Los Alamos, New Mexico.

Carter, L. L., June 10, 1996, *Certification of MCNP Version 4A for the WHC Computer Platforms*, ECN-630773, WHC-SD-MP-SWD-30001, Rev. 8, Westinghouse Hanford Company, Richland, Washington.

Carter, R. D., G. R. Kiel and K. R. Ridgeway, 1968, *Criticality Handbook*, ARH-600, Atlantic Richfield Hanford Company, Richland, Washington.

Compton, J. A., January 23, 1997, *Prototype Vertical Calciner Introductory Guide*, HNF-SD-CP-LB-037, Rev. 0, Babcock & Wilcox Hanford Company, Richland, Washington.

Croff, A. G., July 1980, *A User's Manual for the ORIGEN2 Computer Code*, ORNL/TM-7175, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Durnil, J. F. and S. B. Dutta, January 26, 1996, *Location Assessment of Vertical Calciner*, WHC-SD-CP-TI-200, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Geiger, J. L., 1995a, *CSER 95-005: PFP Vertical Denitration Calciner*, WHC-SD-SQA-20392, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Geiger, J. L., 1995b, *CSER 95-005 Addendum 1 Stainless Steel Insulation*, WHC-SD-SQA-CSA-20404, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

General Electric, February 10, 1993, *234-5Z Building Elevation of Concrete Walls Enclosing Process Area*, H-2-16174, General Electric Co. Hanford Works, Richland, Washington.

Hillesland, K. E., May 1997, *CSER 97-004: PFP Production Denitration Calciner System*, HNF-SD-SQA-CSA-529, Rev. 0, Fluor Daniel Northwest, Richland, Washington.

Jaeger, R. G., E. P. Blizard, A. B. Chilton, M. Grotenhuis, A. Honig, Th. A. Jaeger, H. H. Eisenlohr, Editors, 1975, *Engineering Compendium on Radiation Shielding, Volume II Shielding Materials*, Springer-Verlag, New York, New York.

Merrick, S. B., and P. M. Rickords, January 29, 1996, *Technical Assessment of the PFP Vertical Direct Denitration Calciner*, WHC-SD-CP-TA-009, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Schmittroth, F. A., September 1993, *Conversion of ORIGEN2 to Sun Workstations*, ECN-186709, WHC-SD-NR-SWD-006, Rev. 0-A, Westinghouse Hanford Company, Richland, Washington.

Stubbs, A. M., 1997, Plutonium Finishing Plant Process Flow Document; *Calcination of Plutonium Nitrate Solution*, PFD-Z-300-001, Rev. A-0, Babcock and Wilcox Hanford Company, Richland, Washington.

U. S. DOE, July 7, 1994, *First Floor Plan Part 'C' 234-5Z Building*, H-2-16170, Rev. 17, U.S. Department of Energy, DOE Field Office, Richland, Westinghouse Hanford Company, Richland, Washington.

U. S. DOE, Expected in 1997, *Calciner Assembly*, H-2-95609, Rev. 0, U.S. Department of Energy, Richland Operations Office, B & W Hanford Company, Richland, Washington.

Wittekind, W. D., July 19, 1994, *Software Configuration Control Package for the ORIGEN2 Code*, WHC-SD-NR-SWD-006, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A

INDEPENDENT REVIEW COMMENTS AND CHECKLIST

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TECHNICAL PEER REVIEW

H.J. Goldberg of the Criticality and Shielding group in Specialty Engineering carried out an independent, technical peer review of this shielding calculation.

CHECKLIST FOR INDEPENDENT TECHNICAL REVIEW

NUMBER: HNF-SD-CP-TI-218 Rev. 0
DOCUMENT REVIEWED: PFP Vertical Calciner Shield Wall Dose Rate Calculations Using MCNP
AUTHOR(s): Warren D. Wittekind

I. Method(s) of Review

(✓) Input data checked for accuracy
( ) Independent calculation performed
( ) Hand calculation
( ) Alternate computer code: ______
( ) Comparison to experiment or previous results
( ) Alternate method (define) ______

II. Checklist (either check or enter NA if not applied)

(✓) Task completely defined
(✓) Activity consistent with task specification
(✓) Necessary assumptions explicitly stated and supported
(✓) Resources properly identified and referenced
(✓) Resource documentation appropriate for this application
(✓) Input data explicitly stated
(✓) Input data verified to be consistent with original source
(✓) Geometric model adequate representation of actual geometry
(✓) Material properties appropriate and reasonable
(NA) Mathematical derivations checked including dimensional consistency
(NA) Hand calculations checked for errors
(✓) Assumptions explicitly stated and justified
(✓) Computer software appropriate for task and used within range of validity
(NA) Use of resource outside range of established validity is justified
(✓) Software runstreams correct and consistent with results
(✓) Software output consistent with input
(NA) Results consistent with applicable previous experimental or analytical findings
(✓) Results and conclusions address all points and are consistent with task requirements and/or established limits or criteria
(✓) Conclusions consistent with analytical results and established limits
(✓) Uncertainty assessment appropriate and reasonable
( ) Other (define)

______

______

III. Comments:
The variances on the results are relative errors (in %) and not σ. This should be made explicit.

IV. REVIEWER: Harvey Goldberg DATE: 7 July 1997

APPENDIX B

ORIGEN2 PLUTONIUM INPUT FILE AND OUTPUT RESULTS

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ORIGEN2 PLUTONIUM INPUT FILE

```
-1
-1
-1
TIT     ORIGEN-II CALCULATIONS FOR CALCINER PuO2
LIP     0 0 0
LIB     0 1 2 3 201 202 203 9 3 0 1 0
PHO     101 102 103 10
RDA     1 gram
INP     -1  1  -1  -1  1  1
MOV     -1  1  0  0.008908685969   original vector low Pu-240 wt%
INP     -2  1  -1  -1  1  1
MOV     -2  5  0  0.008745080892   original vector mid Pu-240 wt%
INP     -3  1  -1  -1  1  1
MOV     -3  9  0  0.008663259118   original vector high Pu-240 wt%
BUP
DEC       1.0            1  2 4 1      DECAY   1.0 DAYS
DEC       5.0            2  3 4 0      DECAY   5.0 DAYS
DEC      10.0            3  4 4 0      DECAY  10.0 DAYS
DEC       1.0            5  6 4 1      DECAY   1.0 DAYS
DEC       5.0            6  7 4 0      DECAY   5.0 DAYS
DEC      10.0            7  8 4 0      DECAY  10.0 DAYS
DEC       1.0            9 10 4 1      DECAY   1.0 DAYS
DEC       5.0           10 11 4 0      DECAY   5.0 DAYS
DEC      10.0           11 12 4 0      DECAY  10.0 DAYS
BUP
CUT     5 1.E-05   7 1.E-05   9 1.E-05   10 1.E-05   27 1.0  -1
RDA     ACTIVATION PRODUCTS OUTPUT TABLE OPTIONS
OPTL     8 8 8  8 7 8  7 8 7  8 8 8  8 8 8  8 8 8  8 8 8  8 8 8
RDA     FISSION PRODUCTS OUTPUT TABLE OPTIONS
OPTF     8 8 8  8 7 8  7 8 7  8 8 8  8 8 8  8 8 8  8 8 8  8 8 8
RDA     ACTINIDE AND DAUGHTER PRODUCTS OUTPUT TABLE OPTIONS
OPTA     8 8 8  8 7 8  7 8 7  8 8 8  8 8 8  8 8 8  8 8 8  8 8 8
HED      1 lo  0 D
HED      2 lo  1 D
HED      3 lo  5 D
HED      4 lo 10 D
HED      5 md  0 D
HED      6 md  1 D
HED      7 md  5 D
HED      8 md 10 D
HED      9 hi  0 D
HED     10 hi  1 D
HED     11 hi  5 D
HED     12 hi 10 D
OUT     12 1 -1  0
STP 4
2  942380  0.01  942390 92.40  942400  6.12  942410  0.26
2  942420  0.04  952410  0.18  000000  0.00  000000  0.00
1   80160 13.25  000000  0.00  000000  0.00  000000  0.00
0
2  942380  0.15  942390 85.63  942400 12.45  942410  1.20
2  942420  0.37  952410  1.06  000000  0.00  000000  0.00
1   80160 13.49  000000  0.00  000000  0.00  000000  0.00
0
```

```
2  942380  0.18  942390 80.06  942400 17.84  942410  1.22
2  942420  0.73  952410  1.79  000000  0.00  000000  0.00
1   80160 13.61  000000  0.00  000000  0.00  000000  0.00
0
END
```

ORIGEN2 PLUTONIUM OUTPUT RESULTS

0 5 SUMMARY TABLE: CONCENTRATIONS, GRAMS

	lo 0 D	lo 1 D	lo 5 D	10.0D	md 10 D	md 0 D	md 1 D	md 5 D	hi 10 D	hi 0 D	hi 1 D	hi 5 D
PU238	8.909E-05	8.908E-05	8.908E-05	8.907E-05	1.312E-03	1.312E-03	1.312E-03	1.311E-03	1.559E-03	1.559E-03	1.559E-03	1.559E-03
PU239	8.232E-01	8.232E-01	8.232E-01	8.232E-01	7.488E-01	7.488E-01	7.488E-01	7.488E-01	6.936E-01	6.936E-01	6.936E-01	6.936E-01
PU240	5.452E-02	5.452E-02	5.452E-02	5.452E-02	1.089E-01	1.089E-01	1.089E-01	1.089E-01	1.546E-01	1.546E-01	1.546E-01	1.546E-01
PU241	2.316E-03	2.316E-03	2.315E-03	2.313E-03	1.049E-02	1.049E-02	1.049E-02	1.048E-02	1.057E-02	1.057E-02	1.056E-02	1.056E-02
PU242	3.563E-04	3.563E-04	3.563E-04	3.563E-04	3.236E-03	3.236E-03	3.236E-03	3.236E-03	6.324E-03	6.324E-03	6.324E-03	6.324E-03
AM241	1.604E-03	1.604E-03	1.605E-03	1.607E-03	9.270E-03	9.271E-03	9.276E-03	9.283E-03	1.551E-02	1.551E-02	1.551E-02	1.552E-02
SUMTOT	8.820E-01	8.820E-01	8.820E-01	8.820E-01	8.820E-01	8.820E-01	8.820E-01	8.820E-01	8.821E-01	8.821E-01	8.821E-01	8.821E-01
OTOTAL	8.820E-01	8.820E-01	8.820E-01	8.820E-01	8.820E-01	8.820E-01	8.820E-01	8.820E-01	8.821E-01	8.821E-01	8.821E-01	8.821E-01

0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES

	lo 0 D	lo 1 D	lo 5 D	10.0D	md 10 D	md 0 D	md 1 D	md 5 D	hi 10 D	hi 0 D	hi 1 D	hi 5 D
U237	0.000E+00	5.707E-07	2.348E-06	3.751E-06	0.000E+00	2.586E-06	1.064E-05	1.700E-05	0.000E+00	2.604E-06	1.071E-05	1.712E-05
PU238	1.526E-03	1.526E-03	1.526E-03	1.525E-03	2.247E-02	2.246E-02	2.246E-02	2.246E-02	2.671E-02	2.671E-02	2.670E-02	2.670E-02
PU239	5.119E-02	5.119E-02	5.119E-02	5.119E-02	4.657E-02	4.657E-02	4.657E-02	4.657E-02	4.313E-02	4.313E-02	4.313E-02	4.313E-02
PU240	1.243E-02	1.243E-02	1.243E-02	1.243E-02	2.482E-02	2.482E-02	2.482E-02	2.482E-02	3.523E-02	3.523E-02	3.523E-02	3.523E-02
PU241	2.387E-01	2.387E-01	2.386E-01	2.384E-01	1.082E+00	1.081E+00	1.081E+00	1.080E+00	1.089E+00	1.089E+00	1.089E+00	1.088E+00
PU242	1.361E-06	1.361E-06	1.361E-06	1.361E-06	1.236E-05	1.236E-05	1.236E-05	1.236E-05	2.416E-05	2.416E-05	2.416E-05	2.416E-05
AM241	5.506E-03	5.507E-03	5.511E-03	5.516E-03	3.183E-02	3.183E-02	3.185E-02	3.187E-02	5.324E-02	5.325E-02	5.327E-02	5.329E-02
SUMTOT	3.094E-01	3.093E-01	3.092E-01	3.091E-01	1.207E+00	1.207E+00	1.207E+00	1.206E+00	1.248E+00	1.247E+00	1.247E+00	1.246E+00
OTOTAL	3.094E-01	3.093E-01	3.092E-01	3.091E-01	1.207E+00	1.207E+00	1.207E+00	1.206E+00	1.248E+00	1.247E+00	1.247E+00	1.246E+00

1 OUTPUT UNIT = 6 PAGE 27

ORIGEN-II CALCULATIONS FOR CALCINER PuO2
(ALPHA,N) NEUTRON SOURCE, NEUTRONS/SEC

BASIS=

	lo 0 D	lo 1 D	lo 5 D	10.0D	md 10 D	md 0 D	md 1 D	md 5 D	hi 10 D	hi 0 D	hi 1 D	hi 5 D
PU238	1.452E+00	1.452E+00	1.451E+00	1.451E+00	2.137E+01	2.137E+01	2.137E+01	2.137E+01	2.541E+01	2.541E+01	2.541E+01	2.540E+01
PU239	3.729E+01	3.729E+01	3.729E+01	3.729E+01	3.392E+01	3.392E+01	3.392E+01	3.392E+01	3.142E+01	3.142E+01	3.142E+01	3.142E+01
PU240	9.417E+00	9.417E+00	9.417E+00	9.417E+00	1.881E+01	1.881E+01	1.881E+01	1.881E+01	2.670E+01	2.670E+01	2.670E+01	2.670E+01
AM241	5.281E+00	5.282E+00	5.286E+00	5.291E+00	3.053E+01	3.053E+01	3.055E+01	3.057E+01	5.107E+01	5.107E+01	5.109E+01	5.111E+01
TOTALS												
TABLE	5.344E+01	5.344E+01	5.344E+01	5.345E+01	1.046E+02	1.046E+02	1.047E+02	1.047E+02	1.346E+02	1.346E+02	1.346E+02	1.346E+02
ACTUAL	5.344E+01	5.344E+01	5.344E+01	5.345E+01	1.046E+02	1.046E+02	1.047E+02	1.047E+02	1.346E+02	1.346E+02	1.346E+02	1.346E+02

1 OUTPUT UNIT = 6 PAGE 28

ORIGEN-II CALCULATIONS FOR CALCINER PuO2
SPONTANEOUS FISSION NEUTRON SOURCE, NEUTRONS/SEC
BASIS=

	lo 0 D	lo 1 D	lo 5 D	10.0D	md 10 D	md 0 D	md 1 D	md 5 D	hi 10 D	hi 0 D	hi 1 D	hi 5 D
PU238	2.367E-01	2.367E-01	2.367E-01	2.367E-01	3.486E+00	3.486E+00	3.485E+00	3.485E+00	4.144E+00	4.144E+00	4.143E+00	4.143E+00
PU240	4.964E+01	4.964E+01	4.964E+01	4.964E+01	9.913E+01	9.913E+01	9.913E+01	9.913E+01	1.407E+02	1.407E+02	1.407E+02	1.407E+02
PU242	6.007E-01	6.007E-01	6.007E-01	6.007E-01	5.454E+00	5.454E+00	5.454E+00	5.454E+00	1.066E+01	1.066E+01	1.066E+01	1.066E+01
TOTALS												
TABLE	5.050E+01	5.050E+01	5.050E+01	5.050E+01	1.081E+02	1.081E+02	1.081E+02	1.081E+02	1.556E+02	1.556E+02	1.556E+02	1.556E+02
ACTUAL	5.050E+01	5.050E+01	5.050E+01	5.050E+01	1.081E+02	1.081E+02	1.081E+02	1.081E+02	1.556E+02	1.556E+02	1.556E+02	1.556E+02
OVERALL TOTALS												
TABLE	1.039E+02	1.039E+02	1.039E+02	1.039E+02	2.127E+02	2.127E+02	2.128E+02	2.128E+02	2.902E+02	2.902E+02	2.902E+02	2.902E+02
ACTUAL	1.039E+02	1.039E+02	1.039E+02	1.039E+02	2.127E+02	2.127E+02	2.128E+02	2.128E+02	2.902E+02	2.902E+02	2.902E+02	2.902E+02

1 OUTPUT UNIT = 6 PAGE 30

1 OUTPUT UNIT = 6 PAGE 31

PHOTON SPECTRUM FOR ACTINIDES + DAUGHTERS

0 ORIGEN-II CALCULATIONS FOR CALCINER PuO2

POWER= 1.00 MW, BURNUP= 1. MWD, FLUX= 1.00E+00 N/CM**2-SEC

0 18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND

BASIS=

EMEAN	lo 0 D	lo 1 D	lo 5 D	10.0D	md 10 D	md 0 D	md 1 D	md 5 D	hi 10 D	hi 0 D	hi 1 D	hi 5 D
1.500E-02	2.343E+08	2.343E+08	2.344E+08	2.345E+08	6.420E+08	6.421E+08	6.425E+08	6.428E+08	8.923E+08	8.924E+08	8.928E+08	8.932E+08
2.500E-02	5.152E+06	5.154E+06	5.160E+06	5.166E+06	2.978E+07	2.979E+07	2.982E+07	2.985E+07	4.983E+07	4.983E+07	4.986E+07	4.989E+07
3.750E-02	5.652E+05	5.654E+05	5.660E+05	5.666E+05	2.920E+06	2.921E+06	2.924E+06	2.926E+06	4.623E+06	4.624E+06	4.627E+06	4.629E+06
5.750E-02	7.632E+07	7.634E+07	7.643E+07	7.652E+07	4.386E+08	4.387E+08	4.391E+08	4.395E+08	7.334E+08	7.335E+08	7.339E+08	7.343E+08
8.500E-02	9.474E+04	9.859E+04	1.106E+05	1.201E+05	3.960E+05	4.134E+05	4.678E+05	5.108E+05	6.002E+05	6.178E+05	6.725E+05	7.158E+05
1.250E-01	2.341E+05	2.408E+05	2.617E+05	2.782E+05	4.733E+05	5.037E+05	5.982E+05	6.730E+05	6.697E+05	7.003E+05	7.955E+05	8.708E+05
2.250E-01	2.741E+04	3.246E+04	4.817E+04	6.058E+04	4.504E+04	6.790E+04	1.391E+05	1.953E+05	5.630E+04	7.932E+04	1.510E+05	2.076E+05
3.750E-01	1.234E+05	1.237E+05	1.246E+05	1.253E+05	1.247E+05	1.261E+05	1.303E+05	1.336E+05	1.266E+05	1.280E+05	1.322E+05	1.356E+05
5.750E-01	5.943E+03	5.944E+03	5.945E+03	5.946E+03	1.236E+04	1.236E+04	1.236E+04	1.237E+04	1.760E+04	1.760E+04	1.761E+04	1.761E+04
8.500E-01	9.461E+02	9.462E+02	9.465E+02	9.469E+02	3.372E+03	3.372E+03	3.373E+03	3.375E+03	5.122E+03	5.122E+03	5.124E+03	5.125E+03
1.250E+00	5.137E+01	5.137E+01	5.137E+01	5.138E+01	1.172E+02	1.172E+02	1.172E+02	1.172E+02	1.637E+02	1.637E+02	1.637E+02	1.637E+02
1.750E+00	2.435E+01	2.435E+01	2.435E+01	2.435E+01	5.115E+01	5.115E+01	5.115E+01	5.116E+01	7.284E+01	7.284E+01	7.285E+01	7.285E+01
2.250E+00	1.393E+01	1.393E+01	1.393E+01	1.393E+01	2.934E+01	2.934E+01	2.934E+01	2.934E+01	4.183E+01	4.183E+01	4.183E+01	4.183E+01
2.750E+00	7.995E+00	7.995E+00	7.995E+00	7.995E+00	1.687E+01	1.687E+01	1.687E+01	1.687E+01	2.408E+01	2.408E+01	2.408E+01	2.408E+01
3.500E+00	7.064E+00	7.064E+00	7.064E+00	7.064E+00	1.494E+01	1.494E+01	1.494E+01	1.494E+01	2.136E+01	2.136E+01	2.136E+01	2.136E+01
5.000E+00	2.974E+00	2.974E+00	2.974E+00	2.974E+00	6.309E+00	6.309E+00	6.309E+00	6.309E+00	9.038E+00	9.038E+00	9.038E+00	9.038E+00
7.000E+00	3.355E-01	3.355E-01	3.355E-01	3.355E-01	7.141E-01	7.141E-01	7.141E-01	7.141E-01	1.025E+00	1.025E+00	1.025E+00	1.025E+00
1.100E+01	3.815E-02	3.815E-02	3.815E-02	3.815E-02	8.135E-02	8.135E-02	8.135E-02	8.135E-02	1.169E-01	1.169E-01	1.169E-01	1.169E-01
0 TOTAL	3.168E+08	3.169E+08	3.171E+08	3.173E+08	1.114E+09	1.115E+09	1.116E+09	1.117E+09	1.682E+09	1.682E+09	1.683E+09	1.684E+09
0MEV/SEC	8.147E+06	8.151E+06	8.165E+06	8.178E+06	3.587E+07	3.588E+07	3.595E+07	3.600E+07	5.719E+07	5.720E+07	5.727E+07	5.732E+07

0 18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC

BASIS=

EMEAN	lo 0 D	lo 1 D	lo 5 D	10.0D	md 10 D	md 0 D	md 1 D	md 5 D	hi 10 D	hi 0 D	hi 1 D	hi 5 D
1.500E-02	3.515E+00	3.515E+00	3.516E+00	3.517E+00	9.629E+00	9.631E+00	9.637E+00	9.642E+00	1.338E+01	1.339E+01	1.339E+01	1.340E+01
2.500E-02	1.288E-01	1.289E-01	1.290E-01	1.292E-01	7.446E-01	7.448E-01	7.455E-01	7.462E-01	1.246E+00	1.246E+00	1.247E+00	1.247E+00
3.750E-02	2.120E-02	2.120E-02	2.123E-02	2.125E-02	1.095E-01	1.095E-01	1.096E-01	1.097E-01	1.734E-01	1.734E-01	1.735E-01	1.736E-01
5.750E-02	4.388E+00	4.390E+00	4.394E+00	4.400E+00	2.522E+01	2.523E+01	2.525E+01	2.527E+01	4.217E+01	4.218E+01	4.220E+01	4.222E+01
8.500E-02	8.053E-03	8.380E-03	9.400E-03	1.021E-02	3.366E-02	3.514E-02	3.976E-02	4.342E-02	5.102E-02	5.251E-02	5.716E-02	6.085E-02
1.250E-01	2.926E-02	3.010E-02	3.271E-02	3.477E-02	5.917E-02	6.296E-02	7.478E-02	8.413E-02	8.371E-02	8.753E-02	9.944E-02	1.088E-01
2.250E-01	6.168E-03	7.303E-03	1.084E-02	1.363E-02	1.013E-02	1.528E-02	3.129E-02	4.394E-02	1.267E-02	1.785E-02	3.398E-02	4.672E-02
3.750E-01	4.626E-02	4.638E-02	4.672E-02	4.700E-02	4.677E-02	4.728E-02	4.886E-02	5.011E-02	4.748E-02	4.799E-02	4.957E-02	5.083E-02
5.750E-01	3.417E-03	3.418E-03	3.418E-03	3.419E-03	7.104E-03	7.105E-03	7.108E-03	7.111E-03	1.012E-02	1.012E-02	1.013E-02	1.013E-02
8.500E-01	8.042E-04	8.043E-04	8.045E-04	8.049E-04	2.866E-03	2.866E-03	2.867E-03	2.869E-03	4.354E-03	4.354E-03	4.355E-03	4.357E-03
1.250E+00	6.422E-05	6.422E-05	6.422E-05	6.422E-05	1.465E-04	1.465E-04	1.465E-04	1.465E-04	2.047E-04	2.047E-04	2.047E-04	2.047E-04
1.750E+00	4.260E-05	4.260E-05	4.260E-05	4.260E-05	8.952E-05	8.952E-05	8.952E-05	8.952E-05	1.275E-04	1.275E-04	1.275E-04	1.275E-04
2.250E+00	3.134E-05	3.134E-05	3.134E-05	3.134E-05	6.601E-05	6.601E-05	6.601E-05	6.601E-05	9.412E-05	9.412E-05	9.412E-05	9.412E-05
2.750E+00	2.199E-05	2.199E-05	2.199E-05	2.199E-05	4.638E-05	4.639E-05	4.639E-05	4.639E-05	6.622E-05	6.622E-05	6.622E-05	6.623E-05
3.500E+00	2.472E-05	2.472E-05	2.472E-05	2.472E-05	5.228E-05	5.228E-05	5.228E-05	5.228E-05	7.475E-05	7.475E-05	7.475E-05	7.475E-05
5.000E+00	1.487E-05	1.487E-05	1.487E-05	1.487E-05	3.154E-05	3.154E-05	3.155E-05	3.155E-05	4.519E-05	4.519E-05	4.519E-05	4.519E-05
7.000E+00	2.349E-06	2.349E-06	2.349E-06	2.349E-06	4.999E-06	4.999E-06	4.999E-06	4.999E-06	7.176E-06	7.176E-06	7.176E-06	7.176E-06
1.100E+01	4.196E-07	4.196E-07	4.196E-07	4.196E-07	8.948E-07	8.948E-07	8.948E-07	8.948E-07	1.286E-06	1.286E-06	1.286E-06	1.286E-06
0 TOTAL	8.147E+00	8.151E+00	8.165E+00	8.178E+00	3.587E+01	3.588E+01	3.595E+01	3.600E+01	5.719E+01	5.720E+01	5.727E+01	5.732E+01
0 GAM POW	1.306E-06	1.307E-06	1.309E-06	1.311E-06	5.749E-06	5.752E-06	5.762E-06	5.771E-06	9.167E-06	9.170E-06	9.180E-06	9.189E-06

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APPENDIX C

NEUTRON SHIELDED OPERATOR DOSE RATE MCNP INPUT FILES

CCA08ANP.INP Vertical Calciner, 3.5 kg Pu, neutron and capture gammas

CCA08AP.INP Vertical Calciner, 3.5 kg Pu, gamma ray calculation

CFT08ANP.INP Feed Tank, 3.5 kg Pu, neutron and capture gammas

CFT08AP.INP Feed Tank, 3.5 kg Pu, gamma ray calculation

CSC08ANP.INP Storage Can, 3.6 kg Pu, neutron and capture gammas

CSC08AP.INP Storage Can, 3.6 kg Pu, gamma ray calculation

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NEUTRON SHIELDED OPERATOR DOSE RATE MCNP INPUT FILES

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CCA08ANP.INP   Vertical Calciner, 3.5 kg Pu, neutron & capture gammas

NEUTRON Dose Rate Calcs for calciner  CCA08ANP
c      CALCINER PuO2 Neutron Source is in Cell 3
c      N Shield Lucite - 1.185 g/cm3 - 4 inches top, 5 inches bottom
c      Lower Shields are 1/8 inch of Stainless Steel (both sides)
c      Upper Shields are 3/4 inch of Glass (no Boron)(both sides)
c      Full Room Model with Concrete Walls, Roof, and Metal Partitions
c              xx -xx  yy -yy  zz -zz  rr -rr $
  1 10 -1.29e-3               65 -66     -69 $ Air Gap
  2  7 -7.84                  65 -66  69 -70 $ SS tube inside
  3  4 -5.00                  65 -66  70 -71 $ PuO2 product
  4 10 -1.29e-3               66 -67     -75 $ SS dome inside
  5  7 -7.84                  66 -67  75 -76 $ SS dome
  6 10 -1.29e-3               66 -67  76 -71 $ Air Annulus
  7  7 -7.84                  65 -67  71 -72 $ SS tube outside
  8 15 -0.387                 65 -67  72 -74 $ Lower Insulation
  9 10 -1.29e-3               67 -68     -71 $ Air Gap
 10  7 -7.84                  67 -68  71 -72 $ SS tube outside
 11  6 -0.793                 67 -68  72 -73 $ Upper Insulation
 12 10 -1.29e-3               67 -68  73 -74 $ Air Annulus
 13 10 -1.29e-3 24 -25  34 -35 9 -15 (-65:68:74) $ Inside Glovebox
 14  7 -7.84 23 -26 33 -36 8 -16(-24:25:-34:35:-9:15) $ SS Inside
 15 8 -11.34 22 -27 32 -37 7 -17(-23:26:-33:36:-8:16) $ Lead Shield
 16  7 -7.84 21 -28 31 -38 6 -18(-22:27:-32:37:-7:17) $ SS Outside
 17 10 -1.29e-3 21 -28  31 -38   5  -6         $ Under  Glovebox
 18 10 -1.29e-3 21 -28  31 -38  18 -19         $ Over   Glovebox
 19 10 -1.29e-3 20 -21  31 -38   5 -19         $ Left   Glovebox
 20 10 -1.29e-3 20 -21  30 -31   5 -19         $ L-B    Glovebox
 21 10 -1.29e-3 21 -28  30 -31   5 -19         $ Behind Glovebox
 22 10 -1.29e-3 28 -29  30 -31   5 -19         $ R-B    Glovebox
 23 10 -1.29e-3 28 -29  31 -38   5 -19         $ Right  Glovebox
 24 10 -1.29e-3 20 -42  38 -39   5 -19         $ Front  Glovebox
 25 10 -1.29e-3 42 -43  38 -44   5 -19         $ Front  Glovebox
 26 10 -1.29e-3 43 -29  38 -39   5 -19         $ Front  Glovebox
 27 10 -1.29e-3 42 -43  44 -48   5 -40         $ Bot Fr Outside air
 28  7 -7.84    55 -43  48 -49   5 -40         $ Bot Fr Outer  1/8"
 29 14 -1.185   52 -43  49 -50   5 -40         $ Bot Fr Middle 5.0"
 30  7 -7.84    53 -43  50 -51   5 -40         $ Bot Fr Inside 1/8"
 31 10 -1.29e-3 56 -43  51 -47   5 -40         $ Bot Fr Inside air
 32 15 -2.14    42 -43  44 -45  40 -41         $ Top Fr Outer  3/4"
 33 14 -1.185   52 -43  45 -46  40 -41         $ Top Fr Middle 4.0"
 34 15 -2.14    53 -43  46 -47  40 -41         $ Top Fr Inside 3/4"
 35 10 -1.29e-3 42 -43  44 -47  41 -19         $ Above Shield
 36 10 -1.29e-3 42 -55  48 -39   5 -40         $ Bot L  Outside air
 37  7 -7.84    55 -52  49 -39   5 -40         $ Bot L  Outer  1/8"
 38 14 -1.185   52 -53  50 -39   5 -40         $ Bot L  Middle 1.0"
 39  7 -7.84    53 -56  51 -39   5 -40         $ Bot L  Inside 1/8"
 40 10 -1.29e-3 56 -54  47 -39   5 -40         $ Bot L  Inside air
 41 15 -2.14    42 -52  45 -39  40 -41         $ Top L  Outer  3/4"
 42 14 -1.185   52 -53  46 -39  40 -41         $ Top L  Middle 1.0"
 43 15 -2.14    53 -54  47 -39  40 -41         $ Top L  Inside 3/4"
```

```
44 10 -1.29e-3 42 -54  47 -39  41 -19          $ Above Shield
45 10 -1.29e-3 54 -43  47 -39   5 -41          $ Behind n Shield
46 10 -1.29e-3 54 -43  47 -39  41 -19          $ Behind n Shield
47 10 -1.29e-3 60 -20  30 -39   5 -19          $ Room, Left Side
48 10 -1.29e-3 60 -20  63 -30   5 -19          $ Room, Left Back
49 10 -1.29e-3 20 -29  63 -30   5 -19          $ Room, Back Part
50 10 -1.29e-3 60 -29  63 -39  19 -57          $ Room to Ceiling
51  7 -7.84    60 -29  62 -63   5 -57          $ SS Wall Back
52  7 -7.84    60 -29  39 -64   5 -57          $ SS Wall Front
53 11 -2.30    59 -60  62 -64   5 -57          $ Concrete Wall Left
54 11 -2.30    29 -61  62 -64   5 -57          $ Concrete Wall Right
55 11 -2.30    59 -61  62 -64  57 -58          $ Concrete Roof
56 11 -2.30    59 -61  62 -64   4  -5          $ Concrete Floor
57  0          61:-59: 64:-62: -4: 58          $ OUTSIDE WORLD

 1        cz    7.7610      $ FEED TANK O.R. - (5/16"-0.040")
 2        cz    8.4534      $ FEED TANK O.R.
 3        cz   14.2875      $ FEED TANK FLANGE O.R.
 4        pz  -60.9600      $ CONCRETE FLOOR bottom (24" thick)
 5        pz    0.0000      $ CONCRETE FLOOR surface
 6        pz   86.3600      $ GLOVEBOX bottom surface
 7        pz   86.5981      $ GLOVEBOX Stainless Steel (3/32")
 8        pz   87.0744      $ GLOVEBOX Lead Shield (3/16")
 9        pz   87.3125      $ GLOVEBOX Stainless Steel (3/32")
10        pz  171.4500      $ FEED TANK Bottom Flange bottom
11        pz  171.7200      $ FEED TANK Bottom Flange top
12        pz  224.5663      $ FEED TANK Solution level (10 L)
13        pz  233.6800      $ FEED TANK Top    Flange bottom
14        pz  234.9500      $ FEED TANK Top    Flange top
15        pz  265.7475      $ GLOVEBOX top inside surface
16        pz  265.9856      $ GLOVEBOX Stainless Steel (3/32")
17        pz  266.4619      $ GLOVEBOX Lead Shield (3/16")
18        pz  266.7000      $ GLOVEBOX Stainless Steel (3/32")
19        pz  366.7000      $ MODEL TOP (GB roof +100 cm)
20        px -321.6150      $ MODEL LEFT SIDE (GB side +100 cm)
21        px -221.6150      $ GLOVEBOX left    surface
22        px -221.3769      $ GLOVEBOX Stainless Steel (3/32")
23        px -220.9006      $ GLOVEBOX Lead Shield (3/16")
24        px -220.6625      $ GLOVEBOX Stainless Steel (3/32")
25        px   39.6875      $ GLOVEBOX right inside surface
26        px   39.9256      $ GLOVEBOX Stainless Steel (3/32")
27        px   40.4019      $ GLOVEBOX Lead Shield (3/16")
28        px   40.6400      $ GLOVEBOX Stainless Steel (3/32")
29        px  231.1400      $ MODEL RIGHT SIDE (GB side +75")
30        py -122.2250      $ MODEL BACK SIDE (GB back +100 cm)
31        py  -22.2250      $ GLOVEBOX back    surface
32        py  -21.9869      $ GLOVEBOX Stainless Steel (3/32")
33        py  -21.5106      $ GLOVEBOX Lead Shield (3/16")
34        py  -21.2725      $ GLOVEBOX Stainless Steel (3/32")
35        py   82.5500      $ GLOVEBOX front inside surface
36        py   82.7881      $ GLOVEBOX Stainless Steel (3/32")
37        py   83.2644      $ GLOVEBOX Lead Shield (3/16")
```

```
  38      py   83.5025     $ GLOVEBOX Stainless Steel (3/32")
  39      py  327.3425     $ MODEL FRONT SIDE (GB front +96")
  40      pz  137.16       $ 4.5' High  n Shield
  41      pz  213.36       $ +2.5' Top  n Shield
  42      px -125.00       $ Left End  n Shield
  43      px  175.00       $ Right End n Shield
  44      py  191.4525     $ 3/4" n Shield Material outside
  45      py  193.3575     $ 4.0" n Shield Material outside
  46      py  203.5175     $ 3/4" n Shield Material outside
  47      py  205.4225     $ Operator Side n Shield
c 44      py  191.4525     $ 3/4" n Shield Material outside
  48      py  191.7700     $ 1/8" n Shield Material outside
  49      py  192.0875     $ 5.0" n Shield Material outside
  50      py  204.7875     $ 1/8" n Shield Material outside
  51      py  205.1050     $ 1/8" n Shield Material inside
c 47      py  205.4225     $ Operator Side n Shield
c 42      px -125.00       $ 3/4" n Shield Material outside
  52      px -123.0950     $ 1.0" n Shield Material outside
  53      px -120.5550     $ 3/4" n Shield Material outside
  54      px -118.6500     $ Operator Side n Shield
c 42      px -125.00       $ 3/4" n Shield Material outside
  55      px -123.4125     $ 1/8" n Shield Material outside
c 52      px -123.0950     $ 1.0" n Shield Material outside
c 53      px -120.5550     $ 3/4" n Shield Material outside
  56      px -120.2375     $ 1/8" n Shield Material inside
c 54      px -118.6500     $ Operator Side n Shield
  57      pz  949.96       $ Ceiling Surface [H-2-16174]
  58      pz  960.12       $ 4 inch concrete roof [H-2-16174]
  59      px -561.34       $ 8 inch concrete wall left side
  60      px -541.02       $ Left Wall Surface [H-2-16140]
  61      px  251.46       $ 8 inch concrete wall right side
  62      py -735.3078     $ 18 Gauge Metal (.0516"*(4.0/1.8)=>.2913 cm)
  63      py -735.0125     $ Back Wall Surface [H-2-16140]
  64      py  327.6338     $ 18 Gauge Metal (.0516"*(4.0/1.8)=>.2913 cm)
  65      pz  118.11       $ CALCINER Bottom
  66      pz  133.8326     $ CALCINER Middle line
  67      pz  142.24       $ CALCINER Midline
  68      pz  156.24       $ CALCINER Top
  69      c/z  -168.5925  29.8450   5.4102 $ S.STEEL Inside
  70      c/z  -168.5925  29.8450   5.7150 $ S.STEEL Outside
  71      c/z  -168.5925  29.8450   8.0734 $ S.STEEL Inside
  72      c/z  -168.5925  29.8450   8.4138 $ S.STEEL Outside
  73      c/z  -168.5925  29.8450  16.0338 $ Upper Insluation Outside
  74      c/z  -168.5925  29.8450  40.0050 $ Lower Insulation Outside
  75      s    -168.5925  29.8450 127.1676  8.0734 $ S.STEEL Inside
  76      s    -168.5925  29.8450 127.1676  8.7851 $ S.STEEL Outside

mode    n p
imp:n   1 55r 0
imp:p   1 55r 0
c   wgt =  3500*105      =  367500 Low  240 Pu
c   wgt =  3500*215      =  752500 Mid  240 Pu
c   wgt =  3500*295      = 1032500 High 240 Pu
sdef    cel= 3   erg= d2   pos = -168.5925 29.8450 0
```

```
        rad= d3  ext= d4   axs = 0 0 1  wgt=1032500.
sc2    (alpha,n) and fission spectrum
si2     s     35     36
sp2       0.504 0.496
sc3     radius
si3     8.0734
sp3     -21 1
sc4     extent
si4     118.1100  133.8326
sp4     -21 0
sc35    (alpha,n) neutron source on OXYGEN from Jacom and Liskien
c        Energy of the alpha particles = 5.5 MeV
#         si35        sp35
           0.0        0.00
           0.1        0.68
           0.2        0.76
           0.3        0.74
           0.4        0.88
           0.5        1.20
           0.6        1.35
           0.7        1.48
           0.8        1.62
           0.9        1.55
           1.0        1.28
           1.1        1.34
           1.2        1.45
           1.3        1.63
           1.4        1.76
           1.5        1.80
           1.6        1.89
           1.7        2.05
           1.8        2.28
           1.9        2.37
           2.0        2.49
           2.1        2.50
           2.2        2.61
           2.3        2.65
           2.4        2.54
           2.5        2.43
           2.6        2.34
           2.7        2.73
           2.8        2.06
           2.9        2.00
           3.0        1.88
           3.1        1.66
           3.2        1.56
           3.3        1.34
           3.4        1.09
           3.5        0.92
           3.6        0.79
           3.7        0.64
           3.8        0.55
           3.9        0.48
           4.0        0.39
```

```
        4.1       0.35
        4.2       0.23
        4.3       0.18
        4.4       0.11
        4.5       0.07
sc36   spontaneous fission source spectrum (Pu240)
sp36   -3  0.799  4.903   $ Watt Fisson Spectrum
m1     94238.50c -0.000279  94239.55c -0.124257  94240.50c -0.027689
       94241.50c -0.001894  94242.50c -0.001133  95241.50c -0.002778
        7014.50c -0.099011   8016.50c -0.693830   1001.50c -0.049129
mt1     lwtr.01t            $ hydrogen in liquid [CALCINE4.WQ1]
m2     94238.50c -0.000089  94239.55c -0.823090  94240.50c -0.054516
       94241.50c -0.002316  94242.50c -0.000356  95241.50c -0.001603
        8016.50c -0.118030  $ PuO2 for Low 240 Weight % [CALCINE2.WQ1]
m3     94238.50c -0.001312  94239.55c -0.748841  94240.50c -0.108876
       94241.50c -0.010494  94242.50c -0.003236  95241.50c -0.009270
        8016.50c -0.117971  $ PuO2 for Med 240 Weight % [CALCINE2.WQ1]
m4     94238.50c -0.001559  94239.55c -0.693581  94240.50c -0.154553
       94241.50c -0.010569  94242.50c -0.006324  95241.50c -0.015507
        8016.50c -0.117907  $ PuO2 for High 240 Weight % [CALCINE2.WQ1]
m5     14000.50c -0.376753   5010.50c -0.007986   5011.55c -0.032386
       11023.50c -0.029674  13027.50c -0.012173  19000.50c -0.000830
        8016.50c -0.540198  $ 7740 PYREX Type I Glass [CALCINE1.WQ1]
m6     26000.55c -0.74  24000.50c -0.18  28000.50c -0.08  $ SS 304L Flanges
m7     26000.55c -0.98  28000.50c -0.02  $ Stainless Steel Glovebox
m8     82000.50c -1.00                   $ Lead Glovebox Shield
m9     26000.55c     -1                  $ SS 310S
m10     7014.50c -.78084  8016.50c -0.20946  18000.35c -0.00934
        1001.50c -.00036  $ Air
mt10      lwtr.01t                  $ hydrogen in liquid, gas
m11    13027.50c -.034   20000.50c -0.044     26000.55c -0.014
        1001.50c -.001    8016.50c -0.532     14000.50c -0.337
       11023.50c -.029   $ Concrete (common Portland) ARH-600 II.F.1-3
mt11      poly.01t                  $ hydrogen in solid
m12     6000.50c -0.5925    5010.50c -0.0590    5011.55c -0.2410 $ Neutron
        1001.50c -0.0854   14000.50c -0.0101    8016.50c -0.0076 $ Shield
       26000.55c -0.0038   13027.50c -0.0004   25055.50c -0.0002 $ 210
mt12      poly.01t     grph.01t     $ hydrogen, carbon in solid (1.19 g/cm3)
m13     8016.50c -0.3649    6000.50c -0.3439   13027.50c -0.1906 $ Neutron
        1001.50c -0.0784   20000.50c -0.0123   14000.50c -0.0009 $ Shield
        5010.50c -0.00138   5011.55c -0.00562 12000.50c -0.0006 $ 207
       11023.50c -0.0006   39089.50c -0.0005   26000.55c -0.0001
       19000.50c -0.0001   16032.50c -0.0001 $ Y89 substituted for Sr.
mt13      poly.01t     grph.01t     $ hydrogen, carbon in solid (1.4 g/cm3)
m14     6000.50c -0.599848  1001.50c -0.080538  8016.50c -0.319614 $ Lucite
mt14      poly.01t     grph.01t     $ hydrogen in solid (1.185 g/cm3) Lucite
m15     8016.50c -0.3649   13027.50c -0.1906   14000.50c -0.0009 $ .387 g/cc
m16     6000.50c -0.755751  1001.50c -0.055491  8016.50c -0.188758 $ Lexan
mt16      poly.01t     grph.01t     $ hydrogen in solid (1.2    g/cm3) Lexan
c      Photon dose conversion factors from ANS 6.1.1 1991
de4    log  .01   .015  .02   .03   .04   .05
            .06   .08   .10   .15   .20   .30
            .40   .50   .60   .80   1.0   1.5
            2.0   3.0   4.0   5.0   6.0   8.0
          10.0  12.0
df4      log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
               1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
               7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
               2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
               8.892e-3 1.040e-2
fc4    Photon Dose behind Neutron Shield, Right Side Leak Around
f4:p   45             $ Operator behind Neutron Shield
cf4    26                             $ Flagging Cells for leak-through,
skyshine
c      Photon dose conversion factors from ANS 6.1.1 1991
de14   log  .01   .015  .02   .03   .04   .05
            .06   .08   .10   .15   .20   .30
            .40   .50   .60   .80   1.0   1.5
            2.0   3.0   4.0   5.0   6.0   8.0
          10.0  12.0
df14     log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
               1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
               7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
               2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
               8.892e-3 1.040e-2
fc14   Photon Dose behind Neutron Shield, Front Lower n Shield Leak Through
f14:p  45             $ Operator behind Neutron Shield
cf14      31                          $ Flagging Cells for leak-through,
skyshine
c      Photon dose conversion factors from ANS 6.1.1 1991
de24   log  .01   .015  .02   .03   .04   .05
            .06   .08   .10   .15   .20   .30
            .40   .50   .60   .80   1.0   1.5
            2.0   3.0   4.0   5.0   6.0   8.0
          10.0  12.0
df24     log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
               1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
               7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
               2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
               8.892e-3 1.040e-2
fc24   Photon Dose behind Neutron Shield, Front Upper n Shield Leak Through
f24:p  45             $ Operator behind Neutron Shield
cf24         34                       $ Flagging Cells for leak-through,
skyshine
c      Photon dose conversion factors from ANS 6.1.1 1991
de34   log  .01   .015  .02   .03   .04   .05
            .06   .08   .10   .15   .20   .30
            .40   .50   .60   .80   1.0   1.5
            2.0   3.0   4.0   5.0   6.0   8.0
          10.0  12.0
df34     log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
               1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
               7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
               2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
               8.892e-3 1.040e-2
fc34   Photon Dose behind Neutron Shield, Left Lower n Shield Leak Through
f34:p  45             $ Operator behind Neutron Shield
cf34            40                    $ Flagging Cells for leak-through,
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 skyshine
c      Photon dose conversion factors from ANS 6.1.1 1991
de44   log  .01   .015  .02   .03   .04   .05
            .06   .08   .10   .15   .20   .30
            .40   .50   .60   .80   1.0   1.5
           2.0   3.0   4.0   5.0   6.0   8.0
          10.0  12.0
df44    log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
              1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
              7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
              2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
              8.892e-3 1.040e-2
fc44   Photon Dose behind Neutron Shield, Left Upper n Shield Leak Through
f44:p  45              $ Operator behind Neutron Shield
cf44                   43              $ Flagging Cells for leak-through,
skyshine
c      Photon dose conversion factors from ANS 6.1.1 1991
de54   log  .01   .015  .02   .03   .04   .05
            .06   .08   .10   .15   .20   .30
            .40   .50   .60   .80   1.0   1.5
           2.0   3.0   4.0   5.0   6.0   8.0
          10.0  12.0
df54    log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
              1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
              7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
              2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
              8.892e-3 1.040e-2
fc54   Photon Dose behind Neutron Shield, Roof Reflection
f54:p  45              $ Operator behind Neutron Shield
cf54                       46          $ Flagging Cells for leak-through,
skyshine
c      Photon dose conversion factors from ANS 6.1.1 1991
de64   log  .01   .015  .02   .03   .04   .05
            .06   .08   .10   .15   .20   .30
            .40   .50   .60   .80   1.0   1.5
           2.0   3.0   4.0   5.0   6.0   8.0
          10.0  12.0
df64    log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
              1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
              7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
              2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
              8.892e-3 1.040e-2
fc64   Photon Dose behind Neutron Shield, Steel Wall Back Reflection
f64:p  45              $ Operator behind Neutron Shield
cf64                         51        $ Flagging Cells for leak-through,
skyshine
c      Photon dose conversion factors from ANS 6.1.1 1991
de74   log  .01   .015  .02   .03   .04   .05
            .06   .08   .10   .15   .20   .30
            .40   .50   .60   .80   1.0   1.5
           2.0   3.0   4.0   5.0   6.0   8.0
          10.0  12.0
df74    log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
              1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
              7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
              2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
              8.892e-3 1.040e-2
fc74   Photon Dose behind Neutron Shield, Concrete Floor Effect
f74:p  45              $ Operator behind Neutron Shield
cf74                                56 $ Flagging Cells
c      Photon dose conversion factors from ANS 6.1.1 1991
de84   log  .01   .015  .02   .03   .04   .05
            .06   .08   .10   .15   .20   .30
            .40   .50   .60   .80   1.0   1.5
           2.0   3.0   4.0   5.0   6.0   8.0
          10.0  12.0
df84    log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
              1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
              7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
              2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
              8.892e-3 1.040e-2
fc84   Photon Dose behind Neutron Shield, Sum of All Cells FLAGGING!!
f84:p  45              $ Operator behind Neutron Shield
cf84   26  31  34  40  43  46  51  56 $ Flagging Cells
c      Neutron dose conversion factors from ANS 6.1.1 1991
de0   2.50e-08  1.00e-07  1.00e-06  1.00e-05  1.00e-04  1.00e-03
      1.00e-02  2.00e-02  5.00e-02  1.00e-01  2.00e-01  5.00e-01
      1.00e+00  1.50e+00  2.00e+00  3.00e+00  4.00e+00  5.00e+00
      6.00e+00  7.00e+00  8.00e+00  1.00e+01  1.40e+01
df0   1.440e-03 1.584e-03 1.735e-03 1.606e-03 1.490e-03 1.379e-03
      1.631e-03 2.113e-03 3.924e-03 7.128e-03 1.390e-02 3.132e-02
      5.148e-02 6.588e-02 7.704e-02 9.504e-02 1.080e-01 1.177e-01
      1.249e-01 1.314e-01 1.368e-01 1.476e-01 1.728e-01
fc204   Neutron Dose behind Neutron Shield, Right Side Leak Around
f204:n  45             $ Operator behind Neutron Shield
fm204    2.0           $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf204   26                     $ Flagging Cells for leak-through,
skyshine
fc214   Neutron Dose behind Neutron Shield, Front Lower n Shield Leak
Through
f214:n  45             $ Operator behind Neutron Shield
fm214    2.0           $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf214       31                 $ Flagging Cells for leak-through,
skyshine
fc224   Neutron Dose behind Neutron Shield, Front Upper n Shield Leak
Through
f224:n  45             $ Operator behind Neutron Shield
fm224    2.0           $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf224           34             $ Flagging Cells for leak-through,
skyshine
fc234   Neutron Dose behind Neutron Shield, Left Lower n Shield Leak
Through
f234:n  45             $ Operator behind Neutron Shield
fm234    2.0           $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf234               40         $ Flagging Cells for leak-through,
skyshine
fc244   Neutron Dose behind Neutron Shield, Left Upper n Shield Leak
Through
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f244:n  45              $ Operator behind Neutron Shield
fm244    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf244                    43            $ Flagging Cells for leak-through,
skyshine
fc254   Neutron Dose behind Neutron Shield, Roof Reflection
f254:n  45              $ Operator behind Neutron Shield
fm254    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf254                       46         $ Flagging Cells for leak-through,
skyshine
fc264   Neutron Dose behind Neutron Shield, Steel Wall Reflection
f264:n  45              $ Operator behind Neutron Shield
fm264    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf264                            51    $ Flagging Cells for leak-through,
skyshine
fc274   Neutron Dose behind Neutron Shield, Sum of All Cells FLAGGING!!
f274:n  45              $ Operator behind Neutron Shield
fm274    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf274                              56 $ Flagging Cells for leak-through,
skyshine
fc284   Neutron Dose behind Neutron Shield, Sum of All Cells FLAGGING!!
f284:n  45              $ Operator behind Neutron Shield
fm284    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf284    26  31  34  40  43  46  51  56 $ Flagging Cells for leak-through,
skyshine
fc5     Neutron dose at 30 cm from outside surface of Calciner
c       Total Dist from outside = 30.0 + 29.8450 + 40.0050 =  69.85   cm
f5:n     -168.5925  69.85   125.9713   0
fm5      2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc15    Neutron dose at 30 cm from outside surface of Glovebox
c       Total Dist from outside = 30.0 + 83.5025 = 113.5025 cm
f15:n    -168.5925 113.5025 125.9713   0
fm15     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc25    Neutron dose at 5 feet from outside surface of Glovebox
c       Total Dist from outside = 152.8 + 83.5025 = 235.9025 cm
f25:n    -168.5925 235.9025 125.9713   0
fm25     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc35    Neutron dose at  6 in. in front of lower n Shield
c       Total Dist from outside = 191.4525 - 6*2.54 = 176.2125 cm
f35:n     0 176.2125  91.44  0
fm35     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc45    Neutron dose in middle of outer 1/8" SST n Shield
c       Total Dist from outside = (191.7700 + 192.0875)/2 = 191.9288 cm
f45:n     0 191.9288  91.44  0
fm45     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc55    Neutron dose in middle of 5.0" lower n Shield
c       Total Dist from outside = (192.0875 + 204.7875)/2 = 198.4375 cm
f55:n     0 198.4375  91.44  0
fm55     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc65    Neutron dose in middle of inner 1/8" Stainless Steel n Shield
c       Total Dist from outside = (204.7875 + 205.1050)/2 = 204.9462 cm
f65:n     0 204.9462  91.44  0
fm65     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc75    Neutron dose at 6 in. behind inside lower n Shield
c       Total Dist from outside = 205.4225 + 6*2.54 = 220.6225 cm
f75:n     0 220.6625  91.44  0
fm75     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc85    Neutron dose at  6 in. in front of upper n Shield
c       Total Dist from outside = 191.4525 - 6*2.54 = 176.2125 cm
f85:n     0 176.2125 182.88  0
fm85     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc95    Neutron dose in middle of outer 3/4" glass n Shield
c       Total Dist from outside = (191.4525 + 193.3575)/2 = 192.4050 cm
f95:n     0 192.4050 182.88  0
fm95     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc105    Neutron dose in middle of 4.0" upper n Shield
c       Total Dist from outside = (193.3575 + 203.5175)/2 = 198.4375 cm
f105:n    0 198.4375 182.88  0
fm105     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc115    Neutron dose in middle of inner 3/4" glass n Shield
c       Total Dist from outside = (203.5175 + 205.4225)/2 = 204.4700 cm
f115:n    0 204.4700 182.88  0
fm115     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc125    Neutron dose at 6 in. behind inside upper n Shield
c       Total Dist from outside = 205.4225 + 6*2.54 = 220.6225 cm
f125:n    0 220.6625 182.88  0
fm125     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
print    10  110  120
ctme     180.0
nps      1.0e5
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CCA08AP.INP   Vertical Calciner, 3.5 kg Pu, gamma ray calculation

PHOTON  Dose Rate Calcs for calciner  CCA08AP
c       CALCINER PuO2 Gamma   Source is in Cell 3
c       N Shield Lucite - 1.185 g/cm3 - 4 inches top, 5 inches bottom
c       Lower Shields are 1/8 inch of Stainless Steel (both sides)
c       Upper Shields are 3/4 inch of Glass (no Boron)(both sides)
c       Full Room Model with Concrete Walls, Roof, and Metal Partitions
c                  xx -xx  yy -yy  zz -zz  rr -rr $
  1 10 -1.29e-3                    65 -66     -69 $ Air Gap
  2  7 -7.84                       65 -66  69 -70 $ SS tube inside
  3  4 -5.00                       65 -66  70 -71 $ PuO2 product
  4 10 -1.29e-3                    66 -67     -75 $ SS dome inside
  5  7 -7.84                       66 -67  75 -76 $ SS dome
  6 10 -1.29e-3                    66 -67  76 -71 $ Air Annulus
  7  7 -7.84                       65 -67  71 -72 $ SS tube outside
  8 15 -0.387                      65 -67  72 -74 $ Lower Insulation
  9 10 -1.29e-3                    67 -68     -71 $ Air Gap
 10  7 -7.84                       67 -68  71 -72 $ SS tube outside
 11  6 -0.793                      67 -68  72 -73 $ Upper Insulation
 12 10 -1.29e-3                    67 -68  73 -74 $ Air Annulus
 13 10 -1.29e-3 24 -25  34 -35 9 -15 (-65:68:74) $ Inside Glovebox
 14  7 -7.84 23 -26 33 -36 8 -16(-24:25:-34:35:-9:15) $ SS Inside
 15 8 -11.34 22 -27 32 -37 7 -17(-23:26:-33:36:-8:16) $ Lead Shield
 16  7 -7.84 21 -28 31 -38 6 -18(-22:27:-32:37:-7:17) $ SS Outside
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17 10 -1.29e-3 21 -28  31 -38   5  -6          $ Under  Glovebox
18 10 -1.29e-3 21 -28  31 -38  18 -19          $ Over   Glovebox
19 10 -1.29e-3 20 -21  31 -38   5 -19          $ Left   Glovebox
20 10 -1.29e-3 20 -21  30 -31   5 -19          $ L-B    Glovebox
21 10 -1.29e-3 21 -28  30 -31   5 -19          $ Behind Glovebox
22 10 -1.29e-3 28 -29  30 -31   5 -19          $ R-B    Glovebox
23 10 -1.29e-3 28 -29  31 -38   5 -19          $ Right  Glovebox
24 10 -1.29e-3 20 -42  38 -39   5 -19          $ Front  Glovebox
25 10 -1.29e-3 42 -43  38 -44   5 -19          $ Front  Glovebox
26 10 -1.29e-3 43 -29  38 -39   5 -19          $ Front  Glovebox
27 10 -1.29e-3 42 -43  44 -48   5 -40          $ Bot Fr Outside air
28  7 -7.84    55 -43  48 -49   5 -40          $ Bot Fr Outer  1/8"
29 14 -1.185   52 -43  49 -50   5 -40          $ Bot Fr Middle 5.0"
30  7 -7.84    53 -43  50 -51   5 -40          $ Bot Fr Inside 1/8"
31 10 -1.29e-3 56 -43  51 -47   5 -40          $ Bot Fr Inside air
32 15 -2.14    42 -43  44 -45  40 -41          $ Top Fr Outer  3/4"
33 14 -1.185   52 -43  45 -46  40 -41          $ Top Fr Middle 4.0"
34 15 -2.14    53 -43  46 -47  40 -41          $ Top Fr Inside 3/4"
35 10 -1.29e-3 42 -43  44 -47  41 -19          $ Above Shield
36 10 -1.29e-3 42 -55  48 -39   5 -40          $ Bot L  Outside air
37  7 -7.84    55 -52  49 -39   5 -40          $ Bot L  Outer  1/8"
38 14 -1.185   52 -53  50 -39   5 -40          $ Bot L  Middle 1.0"
39  7 -7.84    53 -56  51 -39   5 -40          $ Bot L  Inside 1/8"
40 10 -1.29e-3 56 -54  47 -39   5 -40          $ Bot L  Inside air
41 15 -2.14    42 -52  45 -39  40 -41          $ Top L  Outer  3/4"
42 14 -1.185   52 -53  46 -39  40 -41          $ Top L  Middle 1.0"
43 15 -2.14    53 -54  47 -39  40 -41          $ Top L  Inside 3/4"
44 10 -1.29e-3 42 -54  47 -39  41 -19          $ Above Shield
45 10 -1.29e-3 54 -43  47 -39   5 -41          $ Behind n Shield
46 10 -1.29e-3 54 -43  47 -39  41 -19          $ Behind n Shield
47 10 -1.29e-3 60 -20  30 -39   5 -19          $ Room, Left Side
48 10 -1.29e-3 60 -20  63 -30   5 -19          $ Room, Left Back
49 10 -1.29e-3 20 -29  63 -30   5 -19          $ Room, Back Part
50 10 -1.29e-3 60 -29  63 -39  19 -57          $ Room to Ceiling
51  7 -7.84    60 -29  62 -63   5 -57          $ SS Wall Back
52  7 -7.84    60 -29  39 -64   5 -57          $ SS Wall Front
53 11 -2.30    59 -60  62 -64   5 -57          $ Concrete Wall Left
54 11 -2.30    29 -61  62 -64   5 -57          $ Concrete Wall Right
55 11 -2.30    59 -61  62 -64  57 -58          $ Concrete Roof
56 11 -2.30    59 -61  62 -64   4  -5          $ Concrete Floor
57  0          61:-59: 64:-62: -4: 58          $ OUTSIDE WORLD

 1        cz     7.7610     $ FEED TANK O.R. - (5/16"-0.040")
 2        cz     8.4534     $ FEED TANK O.R.
 3        cz    14.2875     $ FEED TANK FLANGE O.R.
 4        pz   -60.9600     $ CONCRETE FLOOR bottom (24" thick)
 5        pz     0.0000     $ CONCRETE FLOOR surface
 6        pz    86.3600     $ GLOVEBOX bottom surface
 7        pz    86.5981     $ GLOVEBOX Stainless Steel (3/32")
 8        pz    87.0744     $ GLOVEBOX Lead Shield (3/16")
 9        pz    87.3125     $ GLOVEBOX Stainless Steel (3/32")
10        pz   171.4500     $ FEED TANK Bottom Flange bottom
11        pz   171.7200     $ FEED TANK Bottom Flange top
12        pz   224.5663     $ FEED TANK Solution level (10 L)

    13          pz  233.6800     $ FEED TANK Top    Flange bottom
    14          pz  234.9500     $ FEED TANK Top    Flange top
    15          pz  265.7475     $ GLOVEBOX top inside surface
    16          pz  265.9856     $ GLOVEBOX Stainless Steel (3/32")
    17          pz  266.4619     $ GLOVEBOX Lead Shield (3/16")
    18          pz  266.7000     $ GLOVEBOX Stainless Steel (3/32")
    19          pz  366.7000     $ MODEL TOP (GB roof +100 cm)
    20          px -321.6150     $ MODEL LEFT SIDE (GB side +100 cm)
    21          px -221.6150     $ GLOVEBOX left   surface
    22          px -221.3769     $ GLOVEBOX Stainless Steel (3/32")
    23          px -220.9006     $ GLOVEBOX Lead Shield (3/16")
    24          px -220.6625     $ GLOVEBOX Stainless Steel (3/32")
    25          px   39.6875     $ GLOVEBOX right inside surface
    26          px   39.9256     $ GLOVEBOX Stainless Steel (3/32")
    27          px   40.4019     $ GLOVEBOX Lead Shield (3/16")
    28          px   40.6400     $ GLOVEBOX Stainless Steel (3/32")
    29          px  231.1400     $ MODEL RIGHT SIDE (GB side +75")
    30          py -122.2250     $ MODEL BACK SIDE (GB back +100 cm)
    31          py  -22.2250     $ GLOVEBOX back   surface
    32          py  -21.9869     $ GLOVEBOX Stainless Steel (3/32")
    33          py  -21.5106     $ GLOVEBOX Lead Shield (3/16")
    34          py  -21.2725     $ GLOVEBOX Stainless Steel (3/32")
    35          py   82.5500     $ GLOVEBOX front inside surface
    36          py   82.7881     $ GLOVEBOX Stainless Steel (3/32")
    37          py   83.2644     $ GLOVEBOX Lead Shield (3/16")
    38          py   83.5025     $ GLOVEBOX Stainless Steel (3/32")
    39          py  327.3425     $ MODEL FRONT SIDE (GB front +96")
    40          pz  137.16       $ 4.5' High  n Shield
    41          pz  213.36       $ +2.5' Top  n Shield
    42          px -125.00       $ Left End  n Shield
    43          px  175.00       $ Right End n Shield
    44          py  191.4525     $ 3/4" n Shield Material outside
    45          py  193.3575     $ 4.0" n Shield Material outside
    46          py  203.5175     $ 3/4" n Shield Material outside
    47          py  205.4225     $ Operator Side n Shield
  c 44          py  191.4525     $ 3/4" n Shield Material outside
    48          py  191.7700     $ 1/8" n Shield Material outside
    49          py  192.0875     $ 5.0" n Shield Material outside
    50          py  204.7875     $ 1/8" n Shield Material outside
    51          py  205.1050     $ 1/8" n Shield Material inside
  c 47          py  205.4225     $ Operator Side n Shield
  c 42          px -125.00       $ 3/4" n Shield Material outside
    52          px -123.0950     $ 1.0" n Shield Material outside
    53          px -120.5550     $ 3/4" n Shield Material outside
    54          px -118.6500     $ Operator Side n Shield
  c 42          px -125.00       $ 3/4" n Shield Material outside
    55          px -123.4125     $ 1/8" n Shield Material outside
  c 52          px -123.0950     $ 1.0" n Shield Material outside
  c 53          px -120.5550     $ 3/4" n Shield Material outside
    56          px -120.2375     $ 1/8" n Shield Material inside
  c 54          px -118.6500     $ Operator Side n Shield
    57          pz  949.96       $ Ceiling Surface [H-2-16174]
    58          pz  960.12       $ 4 inch concrete roof [H-2-16174]
    59          px -561.34       $ 8 inch concrete wall left side
```

```
60       px -541.02        $ Left Wall Surface [H-2-16140]
61       px  251.46        $ 8 inch concrete wall right side
62       py -735.3078      $ 18 Gauge Metal (.0516"*(4.0/1.8)=>.2913 cm)c
63       py -735.0125      $ Back Wall Surface [H-2-16140]
64       py  327.6338      $ 18 Gauge Metal (.0516"*(4.0/1.8)=>.2913 cm)c
65       pz  118.11        $ CALCINER Bottom
66       pz  133.8326      $ CALCINER Middle line
67       pz  142.24        $ CALCINER Midline
68       pz  156.24        $ CALCINER Top
69       c/z  -168.5925  29.8450   5.4102 $ S.STEEL Inside
70       c/z  -168.5925  29.8450   5.7150 $ S.STEEL Outside
71       c/z  -168.5925  29.8450   8.0734 $ S.STEEL Inside
72       c/z  -168.5925  29.8450   8.4138 $ S.STEEL Outside
73       c/z  -168.5925  29.8450  16.0338 $ Upper Insluation Outside
74       c/z  -168.5925  29.8450  40.0050 $ Lower Insulation Outside
75       s    -168.5925  29.8450 127.1676  8.0734 $ S.STEEL Inside
76       s    -168.5925  29.8450 127.1676  8.7851 $ S.STEEL Outside

mode    p
imp:p   1 55r 0
c   wgt =  3500*3.169E+8 = 1.109E+12  Low  240 Pu  Gamma
c   wgt =  3500*1.115E+9 = 3.903E+12  Mid  240 Pu  Gamma
c   wgt =  3500*1.682E+9 = 5.887E+12  High 240 Pu  Gamma
sdef     cel= 3   erg= d5   pos = -168.5925 29.8450 0
         rad= d3  ext= d4   axs = 0 0 1  wgt=5.887E+12
sc2   (alpha,n) and fission spectrum
si2    s     35     36
sp2      0.504 0.496
sc3    radius
si3    8.0734
sp3    -21 1
sc4    extent
si4    118.1100  133.8326
sp4    -21 0
sc5    photon source from ORIGEN2
c        TOTAL PHOTON SPECTRUM
#        si5          sp5         sb5
      0.0            0.0            0
      1.5000e-02     8.9240e+08     200790
      2.5000e-02     4.9830e+07     31144
      3.7500e-02     4.6240e+06     6503
      5.7500e-02     7.3350e+08     2425134
      8.5000e-02     6.1780e+05     4464
      1.2500e-01     7.0030e+05     10942
      2.2500e-01     7.9320e+04     4016
      3.7500e-01     1.2800e+05     18000
      5.7500e-01     1.7600e+04     5819
      8.5000e-01     5.1220e+03     3701
      1.2500e+00     1.6370e+02     256
      1.7500e+00     7.2840e+01     223
      2.2500e+00     4.1830e+01     212
      2.7500e+00     2.4080e+01     182
      3.5000e+00     2.1360e+01     262
      5.0000e+00     9.0380e+00     226
```

```
        7.0000e+00     1.0250e+00     50
        1.1000e+01     1.1690e-01     14
         TOTAL         1.6820e+09
sc35     (alpha,n) neutron source on OXYGEN from Jacom and Liskien
         Energy of the alpha particles = 5.5 MeV
#          si35       sp35
           0.0        0.00
           0.1        0.68
           0.2        0.76
           0.3        0.74
           0.4        0.88
           0.5        1.20
           0.6        1.35
           0.7        1.48
           0.8        1.62
           0.9        1.55
           1.0        1.28
           1.1        1.34
           1.2        1.45
           1.3        1.63
           1.4        1.76
           1.5        1.80
           1.6        1.89
           1.7        2.05
           1.8        2.28
           1.9        2.37
           2.0        2.49
           2.1        2.50
           2.2        2.61
           2.3        2.65
           2.4        2.54
           2.5        2.43
           2.6        2.34
           2.7        2.73
           2.8        2.06
           2.9        2.00
           3.0        1.88
           3.1        1.66
           3.2        1.56
           3.3        1.34
           3.4        1.09
           3.5        0.92
           3.6        0.79
           3.7        0.64
           3.8        0.55
           3.9        0.48
           4.0        0.39
           4.1        0.35
           4.2        0.23
           4.3        0.18
           4.4        0.11
           4.5        0.07
sc36     spontaneous fission source spectrum (Pu240)
sp36     -3  0.799  4.903   $ Watt Fisson Spectrum
```

```
m1     94238. -0.000279  94239. -0.124257  94240. -0.027689
       94241. -0.001894  94242. -0.001133  95241. -0.002778
        7014. -0.099011   8016. -0.693830   1001. -0.049129
c      mt1      lwtr.01t            $ hydrogen in liquid [CALCINE4.WQ1]
m2     94238. -0.000089  94239. -0.823090  94240. -0.054516
       94241. -0.002316  94242. -0.000356  95241. -0.001603
        8016. -0.118030  $ PuO2 for Low 240 Weight % [CALCINE2.WQ1]
m3     94238. -0.001312  94239. -0.748841  94240. -0.108876
       94241. -0.010494  94242. -0.003236  95241. -0.009270
        8016. -0.117971  $ PuO2 for Med 240 Weight % [CALCINE2.WQ1]
m4     94238. -0.001559  94239. -0.693581  94240. -0.154553
       94241. -0.010569  94242. -0.006324  95241. -0.015507
        8016. -0.117907  $ PuO2 for High 240 Weight % [CALCINE2.WQ1]
m5     14000. -0.376753   5010. -0.007986   5011. -0.032386
       11023. -0.029674  13027. -0.012173  19000. -0.000830
        8016. -0.540198  $ 7740 PYREX Type I Glass [CALCINE1.WQ1]
m6     26000. -0.74  24000. -0.18  28000. -0.08  $ SS 304L Flanges
m7     26000. -0.98  28000. -0.02  $ Stainless Steel Glovebox
m8     82000. -1.00                 $ Lead Glovebox Shield
m9     26000.     -1                $ SS 310S
m10     7014. -.78084  8016. -0.20946  18000. -0.00934
        1001. -.00036  $ Air
c      mt10      lwtr.01t                   $ hydrogen in liquid, gas
m11    13027. -.034   20000. -0.044    26000. -0.014
        1001. -.001    8016. -0.532    14000. -0.337
       11023. -.029   $ Concrete (common Portland) ARH-600 II.F.1-3
c      mt11      poly.01t                   $ hydrogen in solid
m12     6000. -0.5925   5010. -0.0590   5011. -0.2410 $ Neutron
        1001. -0.0854  14000. -0.0101   8016. -0.0076 $ Shield
       26000. -0.0038  13027. -0.0004  25055. -0.0002 $ 210
c      mt12      poly.01t    grph.01t    $ hydrogen, carbon in solid (1.19
g/cm3)
m13     8016. -0.3649   6000. -0.3439  13027. -0.1906 $ Neutron
        1001. -0.0784  20000. -0.0123  14000. -0.0009 $ Shield
        5010. -0.00138  5011. -0.00562 12000. -0.0006 $ 207
       11023. -0.0006  39089. -0.0005  26000. -0.0001
       19000. -0.0001  16032 -0.0001 $ Y89 substituted for Sr.
c      mt13      poly.01t    grph.01t    $ hydrogen, carbon in solid (1.4
g/cm3)
m14     6000. -0.599848  1001. -0.080538  8016. -0.319614 $ Lucite
c      mt14      poly.01t    grph.01t    $ hydrogen in solid (1.185 g/cm3)
Lucite
m15     8016. -0.3649  13027. -0.1906  14000. -0.0009 $ .387 g/cc
m16     6000. -0.755751  1001. -0.055491  8016. -0.188758 $ Lexan
c      mt16      poly.01t    grph.01t    $ hydrogen in solid (1.2   g/cm3)
Lexan
c       Photon dose conversion factors from ANS 6.1.1 1991
de0     log  .01   .015  .02   .03   .04   .05
             .06   .08   .10   .15   .20   .30
             .40   .50   .60   .80  1.0   1.5
            2.0   3.0   4.0   5.0   6.0   8.0
           10.0  12.0
df0     log  2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
             1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
```

```
        7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
        2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
        8.892e-3 1.040e-2
fc4     Photon Dose behind Neutron Shield, Right Side Leak Around
f4:p    45           $ Operator behind Neutron Shield
cf4     26                             $ Flagging Cells for leak-through,
skyshine
fc14    Photon Dose behind Neutron Shield, Front Lower n Shield Leak Through
f14:p   45           $ Operator behind Neutron Shield
cf14       31                          $ Flagging Cells for leak-through,
skyshine
fc24    Photon Dose behind Neutron Shield, Front Upper n Shield Leak Through
f24:p   45           $ Operator behind Neutron Shield
cf24          34                       $ Flagging Cells for leak-through,
skyshine
fc34    Photon Dose behind Neutron Shield, Left Lower n Shield Leak Through
f34:p   45           $ Operator behind Neutron Shield
cf34             40                    $ Flagging Cells for leak-through,
skyshine
fc44    Photon Dose behind Neutron Shield, Left Upper n Shield Leak Through
f44:p   45           $ Operator behind Neutron Shield
cf44                43                 $ Flagging Cells for leak-through,
skyshine
fc54    Photon Dose behind Neutron Shield, Roof Reflection
f54:p   45           $ Operator behind Neutron Shield
cf54                   46              $ Flagging Cells for leak-through,
skyshine
fc64    Photon Dose behind Neutron Shield, Steel Wall Back Reflection
f64:p   45           $ Operator behind Neutron Shield
cf64                      51           $ Flagging Cells for leak-through,
skyshine
fc74    Photon Dose behind Neutron Shield, Concrete Floor Effect
f74:p   45           $ Operator behind Neutron Shield
cf74                         56 $ Flagging Cells
fc84    Photon Dose behind Neutron Shield, Sum of All Cells FLAGGING!!
f84:p   45           $ Operator behind Neutron Shield
cf84    26  31  34  40  43  46  51  56 $ Flagging Cells
fc5     Photon dose at 30 cm from outside surface of Calciner
c       Total Dist from outside = 30.0 + 29.8450 + 40.0050 =  69.85   cm
f5:p     -168.5925  69.85   125.9713   0
fc15    Photon dose at 30 cm from outside surface of Glovebox
c       Total Dist from outside = 30.0 + 83.5025 = 113.5025 cm
f15:p    -168.5925 113.5025 125.9713   0
fc25    Photon dose at 5 feet from outside surface of Glovebox
c       Total Dist from outside = 152.8 + 83.5025 = 235.9025 cm
f25:p    -168.5925 235.9025 125.9713   0
fc35    Photon dose at  6 in. in front of lower n Shield
c       Total Dist from outside = 191.4525 - 6*2.54 = 176.2125 cm
f35:p     0 176.2125  91.44  0
fc45    Photon dose in middle of outer 1/8" SST n Shield
c       Total Dist from outside = (191.7700 + 192.0875)/2 = 191.9288 cm
f45:p     0 191.9288  91.44  0
fc55    Photon dose in middle of 5.0" lower n Shield
c       Total Dist from outside = (192.0875 + 204.7875)/2 = 198.4375 cm
```

```
f55:p     0 198.4375  91.44  0
fc65    Photon dose in middle of inner 1/8" Stainless Steel n Shield
c       Total Dist from outside = (204.7875 + 205.1050)/2 = 204.9462 cm
f65:p     0 204.9462  91.44  0
fc75    Photon dose at 6 in. behind inside lower n Shield
c       Total Dist from outside = 205.4225 + 6*2.54 = 220.6225 cm
f75:p     0 220.6625  91.44  0
fc85    Photon dose at  6 in. in front of upper n Shield
c       Total Dist from outside = 191.4525 - 6*2.54 = 176.2125 cm
f85:p     0 176.2125 182.88  0
fc95    Photon dose in middle of outer 3/4" glass n Shield
c       Total Dist from outside = (191.4525 + 193.3575)/2 = 192.4050 cm
f95:p     0 192.4050 182.88  0
fc105    Photon dose in middle of 4.0" upper n Shield
c       Total Dist from outside = (193.3575 + 203.5175)/2 = 198.4375 cm
f105:p    0 198.4375 182.88  0
fc115    Photon dose in middle of inner 3/4" glass n Shield
c       Total Dist from outside = (203.5175 + 205.4225)/2 = 204.4700 cm
f115:p    0 204.4700 182.88  0
fc125    Photon dose at 6 in. behind inside upper n Shield
c       Total Dist from outside = 205.4225 + 6*2.54 = 220.6225 cm
f125:p    0 220.6625 182.88  0
print    10  110  120
ctme     180.0
nps      1.0e7


CFT08ANP.INP   Feed Tank, 3.5 kg Pu, neutron and capture gammas

NEUTRON Dose Rate Calcs for calciner  - CFT08ANP
c       Pu(NO3)4 and H2O Neutron Source is in Cell 1
c       N Shield Lucite - 1.185 g/cm3 - 4 inches top, 5 inches bottom
c       Lower Shields are 1/8 inch of Stainless Steel (both sides)
c       Upper Shields are 3/4 inch of Glass (no Boron)(both sides)
c       Full Room Model with Concrete Walls, Roof, and Metal Partitions
c                 xx -xx  yy -yy  zz -zz  rr -rr $
   1  1 -1.582                    11 -12      -1 $ Pu(NO3)4+H2O
   2 10 -1.29e-3                  12 -13      -1 $ Air Gap
   3  5 -2.23                     11 -13   1  -2 $ PYREX tube
   4 10 -1.29e-3                  11 -13   2  -3 $ Air Annulus
   5  6 -7.93                     10 -11      -3 $ Flange
   6  6 -7.93                     13 -14      -3 $ Flange
   7 10 -1.29e-3 24 -25  34 -35 9 -15 (-10:14:3) $ Inside Glovebox
   8  7 -7.84 23 -26 33 -36 8 -16(-24:25:-34:35:-9:15) $ SS Inside
   9 8 -11.34 22 -27 32 -37 7 -17(-23:26:-33:36:-8:16) $ Lead Shield
  10  7 -7.84 21 -28 31 -38 6 -18(-22:27:-32:37:-7:17) $ SS Outside
  11 10 -1.29e-3 21 -28  31 -38   5  -6          $ Under  Glovebox
  12 10 -1.29e-3 21 -28  31 -38  18 -19          $ Over   Glovebox
  13 10 -1.29e-3 20 -21  31 -38   5 -19          $ Left   Glovebox
  14 10 -1.29e-3 20 -21  30 -31   5 -19          $ L-B    Glovebox
  15 10 -1.29e-3 21 -28  30 -31   5 -19          $ Behind Glovebox
  16 10 -1.29e-3 28 -29  30 -31   5 -19          $ R-B    Glovebox
17 10 -1.29e-3 28 -29  31 -38   5 -19        $ Right  Glovebox
18 10 -1.29e-3 20 -42  38 -39   5 -19        $ Front  Glovebox
19 10 -1.29e-3 42 -43  38 -44   5 -19        $ Front  Glovebox
20 10 -1.29e-3 43 -29  38 -39   5 -19        $ Front  Glovebox
21 10 -1.29e-3 42 -43  44 -48   5 -40        $ Bot Fr Outside air
22  7 -7.84    55 -43  48 -49   5 -40        $ Bot Fr Outer  1/8"
23 14 -1.185   52 -43  49 -50   5 -40        $ Bot Fr Middle 5.0"
24  7 -7.84    53 -43  50 -51   5 -40        $ Bot Fr Inside 1/8"
25 10 -1.29e-3 56 -43  51 -47   5 -40        $ Bot Fr Inside air
26 15 -2.14    42 -43  44 -45  40 -41        $ Top Fr Outer  3/4"
27 14 -1.185   52 -43  45 -46  40 -41        $ Top Fr Middle 4.0"
28 15 -2.14    53 -43  46 -47  40 -41        $ Top Fr Inside 3/4"
29 10 -1.29e-3 42 -43  44 -47  41 -19        $ Above Shield
30 10 -1.29e-3 42 -55  48 -39   5 -40        $ Bot L  Outside air
31  7 -7.84    55 -52  49 -39   5 -40        $ Bot L  Outer  1/8"
32 14 -1.185   52 -53  50 -39   5 -40        $ Bot L  Middle 1.0"
33  7 -7.84    53 -56  51 -39   5 -40        $ Bot L  Inside 1/8"
34 10 -1.29e-3 56 -54  47 -39   5 -40        $ Bot L  Inside air
35 15 -2.14    42 -52  45 -39  40 -41        $ Top L  Outer  3/4"
36 14 -1.185   52 -53  46 -39  40 -41        $ Top L  Middle 1.0"
37 15 -2.14    53 -54  47 -39  40 -41        $ Top L  Inside 3/4"
38 10 -1.29e-3 42 -54  47 -39  41 -19        $ Above Shield
39 10 -1.29e-3 54 -43  47 -39   5 -41        $ Behind n Shield
40 10 -1.29e-3 54 -43  47 -39  41 -19        $ Behind n Shield
41 10 -1.29e-3 60 -20  30 -39   5 -19        $ Room, Left Side
42 10 -1.29e-3 60 -20  63 -30   5 -19        $ Room, Left Back
43 10 -1.29e-3 20 -29  63 -30   5 -19        $ Room, Back Part
44 10 -1.29e-3 60 -29  63 -39  19 -57        $ Room to Ceiling
45  7 -7.84    60 -29  62 -63   5 -57        $ SS Wall Back
46  7 -7.84    60 -29  39 -64   5 -57        $ SS Wall Front
47 11 -2.30    59 -60  62 -64   5 -57        $ Concrete Wall Left
48 11 -2.30    29 -61  62 -64   5 -57        $ Concrete Wall Right
49 11 -2.30    59 -61  62 -64  57 -58        $ Concrete Roof
50 11 -2.30    59 -61  62 -64   4  -5        $ Concrete Floor
51  0          61:-59: 64:-62: -4: 58        $ OUTSIDE WORLD

1         cz     7.7610     $ FEED TANK O.R. - (5/16"-0.040")
2         cz     8.4534     $ FEED TANK O.R.
3         cz    14.2875     $ FEED TANK FLANGE O.R.
4         pz   -60.9600     $ CONCRETE FLOOR bottom (24" thick)
5         pz     0.0000     $ CONCRETE FLOOR surface
6         pz    86.3600     $ GLOVEBOX bottom surface
7         pz    86.5981     $ GLOVEBOX Stainless Steel (3/32")
8         pz    87.0744     $ GLOVEBOX Lead Shield (3/16")
9         pz    87.3125     $ GLOVEBOX Stainless Steel (3/32")
10        pz   171.4500     $ FEED TANK Bottom Flange bottom
11        pz   171.7200     $ FEED TANK Bottom Flange top
12        pz   224.5663     $ FEED TANK Solution level (10 L)
13        pz   233.6800     $ FEED TANK Top    Flange bottom
14        pz   234.9500     $ FEED TANK Top    Flange top
15        pz   265.7475     $ GLOVEBOX top inside surface
16        pz   265.9856     $ GLOVEBOX Stainless Steel (3/32")
17        pz   266.4619     $ GLOVEBOX Lead Shield (3/16")
18        pz   266.7000     $ GLOVEBOX Stainless Steel (3/32")
```

```
19      pz  366.7000    $ MODEL TOP (GB roof +100 cm)
20      px -321.6150    $ MODEL LEFT SIDE (GB side +100 cm)
21      px -221.6150    $ GLOVEBOX left   surface
22      px -221.3769    $ GLOVEBOX Stainless Steel (3/32")
23      px -220.9006    $ GLOVEBOX Lead Shield (3/16")
24      px -220.6625    $ GLOVEBOX Stainless Steel (3/32")
25      px   39.6875    $ GLOVEBOX right inside surface
26      px   39.9256    $ GLOVEBOX Stainless Steel (3/32")
27      px   40.4019    $ GLOVEBOX Lead Shield (3/16")
28      px   40.6400    $ GLOVEBOX Stainless Steel (3/32")
29      px  231.1400    $ MODEL RIGHT SIDE (GB side +75")
30      py -122.2250    $ MODEL BACK SIDE (GB back +100 cm)
31      py  -22.2250    $ GLOVEBOX back   surface
32      py  -21.9869    $ GLOVEBOX Stainless Steel (3/32")
33      py  -21.5106    $ GLOVEBOX Lead Shield (3/16")
34      py  -21.2725    $ GLOVEBOX Stainless Steel (3/32")
35      py   82.5500    $ GLOVEBOX front inside surface
36      py   82.7881    $ GLOVEBOX Stainless Steel (3/32")
37      py   83.2644    $ GLOVEBOX Lead Shield (3/16")
38      py   83.5025    $ GLOVEBOX Stainless Steel (3/32")
39      py  327.3425    $ MODEL FRONT SIDE (GB front +96")
40      pz  137.16      $ 4.5' High  n Shield
41      pz  213.36      $ +2.5' Top  n Shield
42      px -125.00      $ Left End  n Shield
43      px  175.00      $ Right End n Shield
44      py  191.4525    $ 3/4" n Shield Material outside
45      py  193.3575    $ 4.0" n Shield Material outside
46      py  203.5175    $ 3/4" n Shield Material outside
47      py  205.4225    $ Operator Side n Shield
c 44    py  191.4525    $ 3/4" n Shield Material outside
48      py  191.7700    $ 1/8" n Shield Material outside
49      py  192.0875    $ 5.0" n Shield Material outside
50      py  204.7875    $ 1/8" n Shield Material outside
51      py  205.1050    $ 1/8" n Shield Material inside
c 47    py  205.4225    $ Operator Side n Shield
c 42    px -125.00      $ 3/4" n Shield Material outside
52      px -123.0950    $ 1.0" n Shield Material outside
53      px -120.5550    $ 3/4" n Shield Material outside
54      px -118.6500    $ Operator Side n Shield
c 42    px -125.00      $ 3/4" n Shield Material outside
55      px -123.4125    $ 1/8" n Shield Material outside
c 52    px -123.0950    $ 1.0" n Shield Material outside
c 53    px -120.5550    $ 3/4" n Shield Material outside
56      px -120.2375    $ 1/8" n Shield Material inside
c 54    px -118.6500    $ Operator Side n Shield
57      pz  949.96      $ Ceiling Surface [H-2-16174]
58      pz  960.12      $ 4 inch concrete roof [H-2-16174]
59      px -561.34      $ 8 inch concrete wall left side
60      px -541.02      $ Left Wall Surface [H-2-16140]
61      px  251.46      $ 8 inch concrete wall right side
62      py -735.3078    $ 18 Gauge Metal (.0516"*(4.0/1.8)=>.2913 cm)
63      py -735.0125    $ Back Wall Surface [H-2-16140]
64      py  327.6338    $ 18 Gauge Metal (.0516"*(4.0/1.8)=>.2913 cm)
```

```
mode    n p
imp:n   1 49r 0
imp:p   1 49r 0
c   wgt =  3500*105      =  367500 Low  240 Pu
c   wgt =  3500*215      =  752500 Mid  240 Pu
c   wgt =  3500*295      = 1032500 High 240 Pu
sdef    cel=1   erg= d2   pos = 0 0 0  rad= d3
                ext= d4   axs = 0 0 1  wgt=1032500.
sc2   (alpha,n) and fission spectrum
si2    s     35     36
sp2      0.504 0.496
sc3    radius
si3    7.7610
sp3    -21 1
sc4    extent
si4    171.7200  224.5663
sp4    -21 0
sc35   (alpha,n) neutron source on OXYGEN from Jacom and Liskien
c       Energy of the alpha particles = 5.5 MeV
#         si35       sp35
           0.0       0.00
           0.1       0.68
           0.2       0.76
           0.3       0.74
           0.4       0.88
           0.5       1.20
           0.6       1.35
           0.7       1.48
           0.8       1.62
           0.9       1.55
           1.0       1.28
           1.1       1.34
           1.2       1.45
           1.3       1.63
           1.4       1.76
           1.5       1.80
           1.6       1.89
           1.7       2.05
           1.8       2.28
           1.9       2.37
           2.0       2.49
           2.1       2.50
           2.2       2.61
           2.3       2.65
           2.4       2.54
           2.5       2.43
           2.6       2.34
           2.7       2.73
           2.8       2.06
           2.9       2.00
           3.0       1.88
           3.1       1.66
           3.2       1.56
           3.3       1.34
```

```
          3.4       1.09
          3.5       0.92
          3.6       0.79
          3.7       0.64
          3.8       0.55
          3.9       0.48
          4.0       0.39
          4.1       0.35
          4.2       0.23
          4.3       0.18
          4.4       0.11
          4.5       0.07
sc36   spontaneous fission source spectrum (Pu240)
sp36    -3  0.799  4.903   $ Watt Fisson Spectrum
m1     94238.50c -0.000279  94239.55c -0.124257  94240.50c -0.027689
       94241.50c -0.001894  94242.50c -0.001133  95241.50c -0.002778
        7014.50c -0.099011   8016.50c -0.693830   1001.50c -0.049129
mt1     lwtr.01t            $ hydrogen in liquid [CALCINE4.WQ1]
m2     94238.50c -0.000089  94239.55c -0.823090  94240.50c -0.054516
       94241.50c -0.002316  94242.50c -0.000356  95241.50c -0.001603
        8016.50c -0.118030  $ PuO2 for Low 240 Weight % [CALCINE2.WQ1]
m3     94238.50c -0.001312  94239.55c -0.748841  94240.50c -0.108876
       94241.50c -0.010494  94242.50c -0.003236  95241.50c -0.009270
        8016.50c -0.117971  $ PuO2 for Med 240 Weight % [CALCINE2.WQ1]
m4     94238.50c -0.001559  94239.55c -0.693581  94240.50c -0.154553
       94241.50c -0.010569  94242.50c -0.006324  95241.50c -0.015507
        8016.50c -0.117907  $ PuO2 for High 240 Weight % [CALCINE2.WQ1]
m5     14000.50c -0.376753   5010.50c -0.007986   5011.55c -0.032386
       11023.50c -0.029674  13027.50c -0.012173  19000.50c -0.000830
        8016.50c -0.540198  $ 7740 PYREX Type I Glass [CALCINE1.WQ1]
m6     26000.55c -0.74  24000.50c -0.18  28000.50c -0.08  $ SS 304L Flanges
m7     26000.55c -0.98  28000.50c -0.02  $ Stainless Steel Glovebox
m8     82000.50c -1.00                   $ Lead Glovebox Shield
m9     26000.55c      -1                 $ SS 310S
m10     7014.50c -.78084  8016.50c -0.20946  18000.35c -0.00934
        1001.50c -.00036  $ Air
mt10      lwtr.01t                  $ hydrogen in liquid, gas
m11    13027.50c -.034    20000.50c -0.044     26000.55c -0.014
        1001.50c -.001     8016.50c -0.532     14000.50c -0.337
       11023.50c -.029    $ Concrete (common Portland) ARH-600 II.F.1-3
mt11      poly.01t                  $ hydrogen in solid
m12     6000.50c -0.5925    5010.50c -0.0590    5011.55c -0.2410 $ Neutron
        1001.50c -0.0854   14000.50c -0.0101    8016.50c -0.0076 $ Shield
       26000.55c -0.0038   13027.50c -0.0004   25055.50c -0.0002 $ 210
mt12     poly.01t    grph.01t    $ hydrogen, carbon in solid (1.19 g/cm3)
m13     8016.50c -0.3649    6000.50c -0.3439   13027.50c -0.1906 $ Neutron
        1001.50c -0.0784   20000.50c -0.0123   14000.50c -0.0009 $ Shield
        5010.50c -0.00138   5011.55c -0.00562 12000.50c -0.0006 $ 207
       11023.50c -0.0006   39089.50c -0.0005   26000.55c -0.0001
       19000.50c -0.0001   16032.50c -0.0001 $ Y89 substituted for Sr.
mt13     poly.01t    grph.01t    $ hydrogen, carbon in solid (1.4 g/cm3)
m14     6000.50c -0.599848  1001.50c -0.080538  8016.50c -0.319614 $ Lucite
mt14     poly.01t    grph.01t    $ hydrogen in solid (1.185 g/cm3) Lucite
m15    14000.50c -0.392603  $ 7740 PYREX Type I Glass [no Boron, 2.14 g/cm3]
       11023.50c -0.030923  13027.50c -0.012685  19000.50c -0.000865
        8016.50c -0.562924  $ 7740 PYREX Type I Glass [CALCINE1.WQ1]
m16     6000.50c -0.755751  1001.50c -0.055491  8016.50c -0.188758 $ Lexan
mt16      poly.01t     grph.01t     $ hydrogen in solid (1.2   g/cm3) Lexan
c       Photon dose conversion factors from ANS 6.1.1 1991
de4     log  .01   .015  .02   .03   .04   .05
             .06   .08   .10   .15   .20   .30
             .40   .50   .60   .80  1.0   1.5
            2.0   3.0   4.0   5.0   6.0   8.0
           10.0  12.0
df4      log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
               1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
               7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
               2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
               8.892e-3 1.040e-2
fc4     Photon Dose behind Neutron Shield, Right Side Leak Around
f4:p    39              $ Operator behind Neutron Shield
cf4     20                              $ Flagging Cells for leak-through,
skyshine
c       Photon dose conversion factors from ANS 6.1.1 1991
de14    log  .01   .015  .02   .03   .04   .05
             .06   .08   .10   .15   .20   .30
             .40   .50   .60   .80  1.0   1.5
            2.0   3.0   4.0   5.0   6.0   8.0
           10.0  12.0
df14     log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
               1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
               7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
               2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
               8.892e-3 1.040e-2
fc14    Photon Dose behind Neutron Shield, Front Lower n Shield Leak Through
f14:p   39              $ Operator behind Neutron Shield
cf14        25                          $ Flagging Cells for leak-through,
skyshine
c       Photon dose conversion factors from ANS 6.1.1 1991
de24    log  .01   .015  .02   .03   .04   .05
             .06   .08   .10   .15   .20   .30
             .40   .50   .60   .80  1.0   1.5
            2.0   3.0   4.0   5.0   6.0   8.0
           10.0  12.0
df24     log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
               1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
               7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
               2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
               8.892e-3 1.040e-2
fc24    Photon Dose behind Neutron Shield, Front Upper n Shield Leak Through
f24:p   39              $ Operator behind Neutron Shield
cf24          28                        $ Flagging Cells for leak-through,
skyshine
c       Photon dose conversion factors from ANS 6.1.1 1991
de34    log  .01   .015  .02   .03   .04   .05
             .06   .08   .10   .15   .20   .30
             .40   .50   .60   .80  1.0   1.5
            2.0   3.0   4.0   5.0   6.0   8.0
```

```
         10.0  12.0
df34     log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
               1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
               7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
               2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
               8.892e-3 1.040e-2
fc34   Photon Dose behind Neutron Shield, Left Lower n Shield Leak Through
f34:p  39              $ Operator behind Neutron Shield
cf34          34                $ Flagging Cells for leak-through,
skyshine
c      Photon dose conversion factors from ANS 6.1.1 1991
de44   log .01    .015  .02   .03   .04   .05
           .06    .08   .10   .15   .20   .30
           .40    .50   .60   .80  1.0   1.5
          2.0    3.0   4.0   5.0   6.0   8.0
         10.0  12.0
df44     log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
               1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
               7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
               2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
               8.892e-3 1.040e-2
fc44   Photon Dose behind Neutron Shield, Left Upper n Shield Leak Through
f44:p  39              $ Operator behind Neutron Shield
cf44                37          $ Flagging Cells for leak-through,
skyshine
c      Photon dose conversion factors from ANS 6.1.1 1991
de54   log .01    .015  .02   .03   .04   .05
           .06    .08   .10   .15   .20   .30
           .40    .50   .60   .80  1.0   1.5
          2.0    3.0   4.0   5.0   6.0   8.0
         10.0  12.0
df54     log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
               1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
               7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
               2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
               8.892e-3 1.040e-2
fc54   Photon Dose behind Neutron Shield, Roof Reflection
f54:p  39              $ Operator behind Neutron Shield
cf54                    40      $ Flagging Cells for leak-through,
skyshine
c      Photon dose conversion factors from ANS 6.1.1 1991
de64   log .01    .015  .02   .03   .04   .05
           .06    .08   .10   .15   .20   .30
           .40    .50   .60   .80  1.0   1.5
          2.0    3.0   4.0   5.0   6.0   8.0
         10.0  12.0
df64     log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
               1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
               7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
               2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
               8.892e-3 1.040e-2
fc64   Photon Dose behind Neutron Shield, Steel Wall Back Reflection
f64:p  39              $ Operator behind Neutron Shield
cf64                        45  $ Flagging Cells for leak-through,
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skyshine
c      Photon dose conversion factors from ANS 6.1.1 1991
de74   log .01    .015  .02   .03   .04   .05
           .06    .08   .10   .15   .20   .30
           .40    .50   .60   .80  1.0   1.5
          2.0    3.0   4.0   5.0   6.0   8.0
         10.0  12.0
df74     log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
               1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
               7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
               2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
               8.892e-3 1.040e-2
fc74   Photon Dose behind Neutron Shield, Concrete Floor Effect
f74:p  39              $ Operator behind Neutron Shield
cf74                        50 $ Flagging Cells
c      Photon dose conversion factors from ANS 6.1.1 1991
de84   log .01    .015  .02   .03   .04   .05
           .06    .08   .10   .15   .20   .30
           .40    .50   .60   .80  1.0   1.5
          2.0    3.0   4.0   5.0   6.0   8.0
         10.0  12.0
df84     log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
               1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
               7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
               2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
               8.892e-3 1.040e-2
fc84   Photon Dose behind Neutron Shield, Sum of All Cells FLAGGING!!
f84:p  39              $ Operator behind Neutron Shield
cf84   20  25  28  34  37  40  45  50 $ Flagging Cells
c      Neutron dose conversion factors from ANS 6.1.1 1991
de0    2.50e-08  1.00e-07  1.00e-06  1.00e-05  1.00e-04  1.00e-03
       1.00e-02  2.00e-02  5.00e-02  1.00e-01  2.00e-01  5.00e-01
       1.00e+00  1.50e+00  2.00e+00  3.00e+00  4.00e+00  5.00e+00
       6.00e+00  7.00e+00  8.00e+00  1.00e+01  1.40e+01
df0    1.440e-03 1.584e-03 1.735e-03 1.606e-03 1.490e-03 1.379e-03
       1.631e-03 2.113e-03 3.924e-03 7.128e-03 1.390e-02 3.132e-02
       5.148e-02 6.588e-02 7.704e-02 9.504e-02 1.080e-01 1.177e-01
       1.249e-01 1.314e-01 1.368e-01 1.476e-01 1.728e-01
fc204   Neutron Dose behind Neutron Shield, Right Side Leak Around
f204:n  39             $ Operator behind Neutron Shield
fm204    2.0           $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf204   20                             $ Flagging Cells for leak-through,
skyshine
fc214   Neutron Dose behind Neutron Shield, Front Lower n Shield Leak
Through
f214:n  39             $ Operator behind Neutron Shield
fm214    2.0           $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf214      25                          $ Flagging Cells for leak-through,
skyshine
fc224   Neutron Dose behind Neutron Shield, Front Upper n Shield Leak
Through
f224:n  39             $ Operator behind Neutron Shield
fm224    2.0           $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf224          28                      $ Flagging Cells for leak-through,
```

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skyshine
fc234   Neutron Dose behind Neutron Shield, Left Lower n Shield Leak
Through
f234:n  39              $ Operator behind Neutron Shield
fm234    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf234              34                $ Flagging Cells for leak-through,
skyshine
fc244   Neutron Dose behind Neutron Shield, Left Upper n Shield Leak
Through
f244:n  39              $ Operator behind Neutron Shield
fm244    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf244                37              $ Flagging Cells for leak-through,
skyshine
fc254   Neutron Dose behind Neutron Shield, Roof Reflection
f254:n  39              $ Operator behind Neutron Shield
fm254    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf254                    40          $ Flagging Cells for leak-through,
skyshine
fc264   Neutron Dose behind Neutron Shield, Steel Wall Back Reflection
f264:n  39              $ Operator behind Neutron Shield
fm264    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf264                          45    $ Flagging Cells for leak-through,
skyshine
fc274   Neutron Dose behind Neutron Shield, Concrete Floor Effect
f274:n  39              $ Operator behind Neutron Shield
fm274    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf274                                50 $ Flagging Cells for leak-through,
skyshine
fc284   Neutron Dose behind Neutron Shield, Sum of All Cells FLAGGING!!
f284:n  39              $ Operator behind Neutron Shield
fm284    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf284   20  25  28  34  37  40  45  50 $ Flagging Cells for leak-through,
skyshine
fc5     Neutron dose at 30 cm from outside surface of 6 in. pipe
c       Total Dist from outside = 30.0 +  8.4534 =  38.4534 cm
f5:n      0  38.4534 200.0   0
fm5      2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc15    Neutron dose at 30 cm from outside surface of Glovebox
c       Total Dist from outside = 30.0 + 83.5025 = 113.5025 cm
f15:n     0 113.5025 200.0   0
fm15     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc25    Neutron dose at 5 feet from outside surface of Glovebox
c       Total Dist from outside = 152.8 + 83.5025 = 235.9025 cm
f25:n     0 235.9025 200.0   0
fm25     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc35    Neutron dose at  6 in. in front of lower n Shield
c       Total Dist from outside = 191.4525 - 6*2.54 = 176.2125 cm
f35:n     0 176.2125  91.44  0
fm35     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc45    Neutron dose in middle of outer 1/8" SST n Shield
c       Total Dist from outside = (191.7700 + 192.0875)/2 = 191.9288 cm
f45:n     0 191.9288  91.44  0
fm45     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc55    Neutron dose in middle of 5.0" lower n Shield
c       Total Dist from outside = (192.0875 + 204.7875)/2 = 198.4375 cm
f55:n     0 198.4375  91.44  0
fm55     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc65    Neutron dose in middle of inner 1/8" Stainless Steel n Shield
c       Total Dist from outside = (204.7875 + 205.1050)/2 = 204.9462 cm
f65:n     0 204.9462  91.44  0
fm65     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc75    Neutron dose at 6 in. behind inside lower n Shield
c       Total Dist from outside = 205.4225 + 6*2.54 = 220.6225 cm
f75:n     0 220.6625  91.44  0
fm75     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc85    Neutron dose at  6 in. in front of upper n Shield
c       Total Dist from outside = 191.4525 - 6*2.54 = 176.2125 cm
f85:n     0 176.2125 182.88  0
fm85     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc95    Neutron dose in middle of outer 3/4" glass n Shield
c       Total Dist from outside = (191.4525 + 193.3575)/2 = 192.4050 cm
f95:n     0 192.4050 182.88  0
fm95     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc105    Neutron dose in middle of 4.0" upper n Shield
c       Total Dist from outside = (193.3575 + 203.5175)/2 = 198.4375 cm
f105:n     0 198.4375 182.88  0
fm105     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc115    Neutron dose in middle of inner 3/4" glass n Shield
c       Total Dist from outside = (203.5175 + 205.4225)/2 = 204.4700 cm
f115:n     0 204.4700 182.88  0
fm115     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc125    Neutron dose at 6 in. behind inside upper n Shield
c       Total Dist from outside = 205.4225 + 6*2.54 = 220.6225 cm
f125:n     0 220.6625 182.88  0
fm125     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
print   10  110  120
ctme    576.0
nps     1.6e5
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CFT08AP.INP   Feed Tank, 3.5 kg Pu, gamma ray calculation

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PHOTON  Dose Rate Calcs for calciner  - CFT08AP
c       Pu(NO3)4 and H2O Photon  Source is in Cell 1
c       N Shield Lucite - 1.185 g/cm3 - 4 inches top, 5 inches bottom
c       Lower Shields are 1/8 inch of Stainless Steel (both sides)
c       Upper Shields are 3/4 inch of Glass (no Boron)(both sides)
c       Full Room Model with Concrete Walls, Roof, and Metal Partitions
c                 xx -xx  yy -yy  zz -zz  rr -rr $
   1  1 -1.582                    11 -12      -1 $ Pu(NO3)4+H2O
   2 10 -1.29e-3                  12 -13      -1 $ Air Gap
   3  5 -2.23                     11 -13   1  -2 $ PYREX tube
   4 10 -1.29e-3                  11 -13   2  -3 $ Air Annulus
   5  6 -7.93                     10 -11      -3 $ Flange
   6  6 -7.93                     13 -14      -3 $ Flange
   7 10 -1.29e-3 24 -25  34 -35 9 -15 (-10:14:3) $ Inside Glovebox
   8  7 -7.84 23 -26 33 -36 8 -16(-24:25:-34:35:-9:15) $ SS Inside
```

```
9 8 -11.34 22 -27 32 -37 7 -17(-23:26:-33:36:-8:16) $ Lead Shield
10  7 -7.84 21 -28 31 -38 6 -18(-22:27:-32:37:-7:17) $ SS Outside
11 10 -1.29e-3 21 -28  31 -38   5  -6        $ Under  Glovebox
12 10 -1.29e-3 21 -28  31 -38  18 -19        $ Over   Glovebox
13 10 -1.29e-3 20 -21  31 -38   5 -19        $ Left   Glovebox
14 10 -1.29e-3 20 -21  30 -31   5 -19        $ L-B    Glovebox
15 10 -1.29e-3 21 -28  30 -31   5 -19        $ Behind Glovebox
16 10 -1.29e-3 28 -29  30 -31   5 -19        $ R-B    Glovebox
17 10 -1.29e-3 28 -29  31 -38   5 -19        $ Right  Glovebox
18 10 -1.29e-3 20 -42  38 -39   5 -19        $ Front  Glovebox
19 10 -1.29e-3 42 -43  38 -44   5 -19        $ Front  Glovebox
20 10 -1.29e-3 43 -29  38 -39   5 -19        $ Front  Glovebox
21 10 -1.29e-3 42 -43  44 -48   5 -40        $ Bot Fr Outside air
22  7 -7.84    55 -43  48 -49   5 -40        $ Bot Fr Outer  1/8"
23 14 -1.185   52 -43  49 -50   5 -40        $ Bot Fr Middle 5.0"
24  7 -7.84    53 -43  50 -51   5 -40        $ Bot Fr Inside 1/8"
25 10 -1.29e-3 56 -43  51 -47   5 -40        $ Bot Fr Inside air
26 15 -2.14    42 -43  44 -45  40 -41        $ Top Fr Outer  3/4"
27 14 -1.185   52 -43  45 -46  40 -41        $ Top Fr Middle 4.0"
28 15 -2.14    53 -43  46 -47  40 -41        $ Top Fr Inside 3/4"
29 10 -1.29e-3 42 -43  44 -47  41 -19        $ Above Shield
30 10 -1.29e-3 42 -55  48 -39   5 -40        $ Bot L  Outside air
31  7 -7.84    55 -52  49 -39   5 -40        $ Bot L  Outer  1/8"
32 14 -1.185   52 -53  50 -39   5 -40        $ Bot L  Middle 1.0"
33  7 -7.84    53 -56  51 -39   5 -40        $ Bot L  Inside 1/8"
34 10 -1.29e-3 56 -54  47 -39   5 -40        $ Bot L  Inside air
35 15 -2.14    42 -52  45 -39  40 -41        $ Top L  Outer  3/4"
36 14 -1.185   52 -53  46 -39  40 -41        $ Top L  Middle 1.0"
37 15 -2.14    53 -54  47 -39  40 -41        $ Top L  Inside 3/4"
38 10 -1.29e-3 42 -54  47 -39  41 -19        $ Above Shield
39 10 -1.29e-3 54 -43  47 -39   5 -41        $ Behind n Shield
40 10 -1.29e-3 54 -43  47 -39  41 -19        $ Behind n Shield
41 10 -1.29e-3 60 -20  30 -39   5 -19        $ Room, Left Side
42 10 -1.29e-3 60 -20  63 -30   5 -19        $ Room, Left Back
43 10 -1.29e-3 20 -29  63 -30   5 -19        $ Room, Back Part
44 10 -1.29e-3 60 -29  63 -39  19 -57        $ Room to Ceiling
45  7 -7.84    60 -29  62 -63   5 -57        $ SS Wall Back
46  7 -7.84    60 -29  39 -64   5 -57        $ SS Wall Front
47 11 -2.30    59 -60  62 -64   5 -57        $ Concrete Wall Left
48 11 -2.30    29 -61  62 -64   5 -57        $ Concrete Wall Right
49 11 -2.30    59 -61  62 -64  57 -58        $ Concrete Roof
50 11 -2.30    59 -61  62 -64   4  -5        $ Concrete Floor
51  0          61:-59: 64:-62: -4: 58        $ OUTSIDE WORLD

1      cz    7.7610     $ FEED TANK O.R. - (5/16"-0.040")
2      cz    8.4534     $ FEED TANK O.R.
3      cz   14.2875     $ FEED TANK FLANGE O.R.
4      pz  -60.9600     $ CONCRETE FLOOR bottom (24" thick)
5      pz    0.0000     $ CONCRETE FLOOR surface
6      pz   86.3600     $ GLOVEBOX bottom surface
7      pz   86.5981     $ GLOVEBOX Stainless Steel (3/32")
8      pz   87.0744     $ GLOVEBOX Lead Shield (3/16")
9      pz   87.3125     $ GLOVEBOX Stainless Steel (3/32")
10     pz  171.4500     $ FEED TANK Bottom Flange bottom
```

```
11      pz  171.7200    $ FEED TANK Bottom Flange top
12      pz  224.5663    $ FEED TANK Solution level (10 L)
13      pz  233.6800    $ FEED TANK Top    Flange bottom
14      pz  234.9500    $ FEED TANK Top    Flange top
15      pz  265.7475    $ GLOVEBOX top inside surface
16      pz  265.9856    $ GLOVEBOX Stainless Steel (3/32")
17      pz  266.4619    $ GLOVEBOX Lead Shield (3/16")
18      pz  266.7000    $ GLOVEBOX Stainless Steel (3/32")
19      pz  366.7000    $ MODEL TOP (GB roof +100 cm)
20      px -321.6150    $ MODEL LEFT SIDE (GB side +100 cm)
21      px -221.6150    $ GLOVEBOX left   surface
22      px -221.3769    $ GLOVEBOX Stainless
Steel (3/32")
23      px -220.9006    $ GLOVEBOX Lead Shield (3/16")
24      px -220.6625    $ GLOVEBOX Stainless Steel (3/32")
25      px   39.6875    $ GLOVEBOX right inside surface
26      px   39.9256    $ GLOVEBOX Stainless Steel (3/32")
27      px   40.4019    $ GLOVEBOX Lead Shield (3/16")
28      px   40.6400    $ GLOVEBOX Stainless Steel (3/32")
29      px  231.1400    $ MODEL RIGHT SIDE (GB side +75")
30      py -122.2250    $ MODEL BACK SIDE (GB back +100 cm)
31      py  -22.2250    $ GLOVEBOX back   surface
32      py  -21.9869    $ GLOVEBOX Stainless Steel (3/32")
33      py  -21.5106    $ GLOVEBOX Lead Shield (3/16")
34      py  -21.2725    $ GLOVEBOX Stainless Steel (3/32")
35      py   82.5500    $ GLOVEBOX front inside surface
36      py   82.7881    $ GLOVEBOX Stainless Steel (3/32")
37      py   83.2644    $ GLOVEBOX Lead Shield (3/16")
38      py   83.5025    $ GLOVEBOX Stainless Steel (3/32")
39      py  327.3425    $ MODEL FRONT SIDE (GB front +96")
40      pz  137.16      $ 4.5' High  n Shield
41      pz  213.36      $ +2.5' Top  n Shield
42      px -125.00      $ Left End  n Shield
43      px  175.00      $ Right End n Shield
44      py  191.4525    $ 3/4" n Shield Material outside
45      py  193.3575    $ 4.0" n Shield Material outside
46      py  203.5175    $ 3/4" n Shield Material outside
47      py  205.4225    $ Operator Side n Shield
c 44    py  191.4525    $ 3/4" n Shield Material outside
48      py  191.7700    $ 1/8" n Shield Material outside
49      py  192.0875    $ 5.0" n Shield Material outside
50      py  204.7875    $ 1/8" n Shield Material outside
51      py  205.1050    $ 1/8" n Shield Material inside
c 47    py  205.4225    $ Operator Side n Shield
c 42    px -125.00      $ 3/4" n Shield Material outside
52      px -123.0950    $ 1.0" n Shield Material outside
53      px -120.5550    $ 3/4" n Shield Material outside
54      px -118.6500    $ Operator Side n Shield
c 42    px -125.00      $ 3/4" n Shield Material outside
55      px -123.4125    $ 1/8" n Shield Material outside
c 52    px -123.0950    $ 1.0" n Shield Material outside
c 53    px -120.5550    $ 3/4" n Shield Material outside
56      px -120.2375    $ 1/8" n Shield Material inside
c 54    px -118.6500    $ Operator Side n Shield
```

```
 57        pz  949.96        $ Ceiling Surface [H-2-16174]
 58        pz  960.12        $ 4 inch concrete roof [H-2-16174]
 59        px -561.34        $ 8 inch concrete wall left side
 60        px -541.02        $ Left Wall Surface [H-2-16140]
 61        px  251.46        $ 8 inch concrete wall right side
 62        py -735.3078      $ 18 Gauge Metal (.0516"*(4.0/1.8)=>.2913 cm)
 63        py -735.0125      $ Back Wall Surface [H-2-16140]
 64        py  327.6338      $ 18 Gauge Metal (.0516"*(4.0/1.8)=>.2913 cm)

mode    p
imp:p   1 49r 0
c   wgt =  3500*3.169E+8 = 1.109E+12  Low  240 Pu
c   wgt =  3500*1.115E+9 = 3.903E+12  Mid  240 Pu
c   wgt =  3500*1.682E+9 = 5.887E+12  High 240 Pu
sdef     cel=1    erg= d5    pos = 0 0 0   rad= d3
                  ext= d4    axs = 0 0 1   wgt=5.887E+12
sc2   (alpha,n) and fission spectrum
si2    s     35     36
sp2      0.504 0.496
sc3    radius
si3    7.7610
sp3    -21 1
sc4    extent
si4    171.7200  224.5663
sp4    -21 0
sc5    photon source from ORIGEN2
c        TOTAL PHOTON SPECTRUM
#        si5          sp5        sb5
      0.0            0.0            0
      1.5000e-02     8.9240e+08     200790
      2.5000e-02     4.9830e+07     31144
      3.7500e-02     4.6240e+06     6503
      5.7500e-02     7.3350e+08     2425134
      8.5000e-02     6.1780e+05     4464
      1.2500e-01     7.0030e+05     10942
      2.2500e-01     7.9320e+04     4016
      3.7500e-01     1.2800e+05     18000
      5.7500e-01     1.7600e+04     5819
      8.5000e-01     5.1220e+03     3701
      1.2500e+00     1.6370e+02     256
      1.7500e+00     7.2840e+01     223
      2.2500e+00     4.1830e+01     212
      2.7500e+00     2.4080e+01     182
      3.5000e+00     2.1360e+01     262
      5.0000e+00     9.0380e+00     226
      7.0000e+00     1.0250e+00     50
      1.1000e+01     1.1690e-01     14
c       TOTAL        1.6820e+09
sc35   (alpha,n) neutron source on OXYGEN from Jacom and Liskien
c       Energy of the alpha particles = 5.5 MeV
#        si35       sp35
          0.0        0.00
          0.1        0.68
          0.2        0.76
          0.3        0.74
          0.4        0.88
          0.5        1.20
          0.6        1.35
          0.7        1.48
          0.8        1.62
          0.9        1.55
          1.0        1.28
          1.1        1.34
          1.2        1.45
          1.3        1.63
          1.4        1.76
          1.5        1.80
          1.6        1.89
          1.7        2.05
          1.8        2.28
          1.9        2.37
          2.0        2.49
          2.1        2.50
          2.2        2.61
          2.3        2.65
          2.4        2.54
          2.5        2.43
          2.6        2.34
          2.7        2.73
          2.8        2.06
          2.9        2.00
          3.0        1.88
          3.1        1.66
          3.2        1.56
          3.3        1.34
          3.4        1.09
          3.5        0.92
          3.6        0.79
          3.7        0.64
          3.8        0.55
          3.9        0.48
          4.0        0.39
          4.1        0.35
          4.2        0.23
          4.3        0.18
          4.4        0.11
          4.5        0.07
sc36    spontaneous fission source spectrum (Pu240)
sp36    -3  0.799  4.903   $ Watt Fisson Spectrum
m1      94238. -0.000279  94239. -0.124257  94240. -0.027689
        94241. -0.001894  94242. -0.001133  95241. -0.002778
         7014. -0.099011   8016. -0.693830   1001. -0.049129
c       mt1     lwtr.01t             $ hydrogen in liquid [CALCINE4.WQ1]
m2      94238. -0.000089  94239. -0.823090  94240. -0.054516
        94241. -0.002316  94242. -0.000356  95241. -0.001603
         8016. -0.118030  $ PuO2 for Low 240 Weight % [CALCINE2.WQ1]
m3      94238. -0.001312  94239. -0.748841  94240. -0.108876
        94241. -0.010494  94242. -0.003236  95241. -0.009270
```

```
      8016. -0.117971  $ PuO2 for Med 240 Weight % [CALCINE2.WQ1]
m4   94238. -0.001559  94239. -0.693581  94240. -0.154553
     94241. -0.010569  94242. -0.006324  95241. -0.015507
      8016. -0.117907  $ PuO2 for High 240 Weight % [CALCINE2.WQ1]
m5   14000. -0.376753   5010. -0.007986   5011. -0.032386
     11023. -0.029674  13027. -0.012173  19000. -0.000830
      8016. -0.540198  $ 7740 PYREX Type I Glass [CALCINE1.WQ1]
m6   26000. -0.74  24000. -0.18  28000. -0.08  $ SS 304L Flanges
m7   26000. -0.98  28000. -0.02  $ Stainless Steel Glovebox
m8   82000. -1.00                 $ Lead Glovebox Shield
m9   26000.     -1                $ SS 310S
m10   7014. -.78084  8016. -0.20946  18000.35c -0.00934
      1001. -.00036  $ Air
c    mt10      lwtr.01t                  $ hydrogen in liquid, gas
m11  13027. -.034   20000. -0.044    26000. -0.014
      1001. -.001    8016. -0.532    14000. -0.337
     11023. -.029   $ Concrete (common Portland) ARH-600 II.F.1-3
c    mt11      poly.01t                  $ hydrogen in solid
m12   6000. -0.5925   5010. -0.0590   5011. -0.2410 $ Neutron
      1001. -0.0854  14000. -0.0101   8016. -0.0076 $ Shield
     26000. -0.0038  13027. -0.0004  25055. -0.0002 $ 210
c    mt12      poly.01t    grph.01t    $ hydrogen, carbon in solid (1.19
g/cm3)
m13   8016. -0.3649    6000. -0.3439  13027. -0.1906 $ Neutron
      1001. -0.0784  20000. -0.0123  14000. -0.0009 $ Shield
      5010. -0.00138  5011. -0.00562 12000. -0.0006 $ 207
     11023. -0.0006  39089. -0.0005  26000. -0.0001
     19000. -0.0001  16032. -0.0001 $ Y89 substituted for Sr.
c    mt13      poly.01t    grph.01t    $ hydrogen, carbon in solid (1.4
g/cm3)
m14   6000. -0.599848  1001. -0.080538  8016. -0.319614 $ Lucite
c    mt14      poly.01t    grph.01t    $ hydrogen in solid (1.185 g/cm3)
Lucite
m15  14000. -0.392603  $ 7740 PYREX Type I Glass [no Boron, 2.14 g/cm3]
     11023. -0.030923  13027. -0.012685  19000. -0.000865
      8016. -0.562924  $ 7740 PYREX Type I Glass [CALCINE1.WQ1]
m16   6000. -0.755751  1001. -0.055491  8016. -0.188758 $ Lexan
c    mt16      poly.01t    grph.01t    $ hydrogen in solid (1.2   g/cm3)
Lexan
c     Photon dose conversion factors from ANS 6.1.1 1991
de0    log  .01    .015  .02    .03    .04    .05
            .06    .08   .10    .15    .20    .30
            .40    .50   .60    .80   1.0    1.5
           2.0    3.0   4.0    5.0    6.0    8.0
          10.0   12.0
df0     log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
              1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
              7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
              2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
              8.892e-3 1.040e-2
fc4   Photon Dose behind Neutron Shield, Right Side Leak Around
f4:p   39            $ Operator behind Neutron Shield
cf4    20                             $ Flagging Cells for leak-through,
skyshine
```

```
fc14   Photon Dose behind Neutron Shield, Front Lower n Shield Leak Through
f14:p  39              $ Operator behind Neutron Shield
cf14       25                         $ Flagging Cells for leak-through,
skyshine
fc24   Photon Dose behind Neutron Shield, Front Upper n Shield Leak Through
f24:p  39              $ Operator behind Neutron Shield
cf24           28                     $ Flagging Cells for leak-through,
skyshine
fc34   Photon Dose behind Neutron Shield, Left Lower n Shield Leak Through
f34:p  39              $ Operator behind Neutron Shield
cf34               34                 $ Flagging Cells for leak-through,
skyshine
fc44   Photon Dose behind Neutron Shield, Left Upper n Shield Leak Through
f44:p  39              $ Operator behind Neutron Shield
cf44                   37             $ Flagging Cells for leak-through,
skyshine
fc54   Photon Dose behind Neutron Shield, Roof Reflection
f54:p  39              $ Operator behind Neutron Shield
cf54                       40         $ Flagging Cells for leak-through,
skyshine
fc64   Photon Dose behind Neutron Shield, Steel Wall Back Reflection
f64:p  39              $ Operator behind Neutron Shield
cf64                           45     $ Flagging Cells for leak-through,
skyshine
fc74   Photon Dose behind Neutron Shield, Concrete Floor Effect
f74:p  39              $ Operator behind Neutron Shield
cf74                               50 $ Flagging Cells
fc84   Photon Dose behind Neutron Shield, Sum of All Cells FLAGGING!!
f84:p  39              $ Operator behind Neutron Shield
cf84   20  25  28  34  37  40  45  50 $ Flagging Cells
fc5    Photon dose at 30 cm from outside surface of 6 in. pipe
c      Total Dist from outside = 30.0 +  8.4534 =  38.4534 cm
f5:p     0  38.4534 200.0   0
fc15   Photon dose at 30 cm from outside surface of Glovebox
c      Total Dist from outside = 30.0 + 83.5025 = 113.5025 cm
f15:p    0 113.5025 200.0   0
fc25   Photon dose at 5 feet from outside surface of Glovebox
c      Total Dist from outside = 152.8 + 83.5025 = 235.9025 cm
f25:p    0 235.9025 200.0   0
fc35   Photon dose at  6 in. in front of lower n Shield
c      Total Dist from outside = 191.4525 - 6*2.54 = 176.2125 cm
f35:p    0 176.2125  91.44  0
fc45   Photon dose in middle of outer 1/8" SST n Shield
c      Total Dist from outside = (191.7700 + 192.0875)/2 = 191.9288 cm
f45:p    0 191.9288  91.44  0
fc55   Photon dose in middle of 5.0" lower n Shield
c      Total Dist from outside = (192.0875 + 204.7875)/2 = 198.4375 cm
f55:p    0 198.4375  91.44  0
fc65   Photon dose in middle of inner 1/8" Stainless Steel n Shield
c      Total Dist from outside = (204.7875 + 205.1050)/2 = 204.9462 cm
f65:p    0 204.9462  91.44  0
fc75   Photon dose at 6 in. behind inside lower n Shield
c      Total Dist from outside = 205.4225 + 6*2.54 = 220.6225 cm
f75:p    0 220.6625  91.44  0
```

```
fc85    Photon dose at  6 in. in front of upper n Shield
c       Total Dist from outside = 191.4525 - 6*2.54 = 176.2125 cm
f85:p     0 176.2125 182.88  0
fc95    Photon dose in middle of outer 3/4" glass n Shield
c       Total Dist from outside = (191.4525 + 193.3575)/2 = 192.4050 cm
f95:p     0 192.4050 182.88  0
fc105    Photon dose in middle of 4.0" upper n Shield
c       Total Dist from outside = (193.3575 + 203.5175)/2 = 198.4375 cm
f105:p     0 198.4375 182.88  0
fc115    Photon dose in middle of inner 3/4" glass n Shield
c       Total Dist from outside = (203.5175 + 205.4225)/2 = 204.4700 cm
f115:p     0 204.4700 182.88  0
fc125    Photon dose at 6 in. behind inside upper n Shield
c       Total Dist from outside = 205.4225 + 6*2.54 = 220.6225 cm
f125:p     0 220.6625 182.88  0
print   10  110  120
ctme    576.0
nps     1.6e7


CSC08ANP.INP    Storage Can, 3.6 kg Pu, neutron and capture gammas

NEUTRON Dose Rate Calcs for calciner - CSC08ANP
c       Hi 240Pu PuO2 Storage Can Neutron Source is in Cell 1
c       N Shield Lucite - 1.185 g/cm3 - 4 inches top, 5 inches bottom
c       Lower Shields are 1/8 inch of Stainless Steel (both sides)
c       Upper Shields are 3/4 inch of Glass (no Boron)(both sides)
c       Full Room Model with Concrete Walls, Roof, and Metal Partitions
c                      xx -xx  yy -yy  zz -zz  rr -rr imp:n=  $
   1  4 -5.438                          68 -69      -65 $ Hi 240PuO2
   2  9 -7.84                            9 -68      -65 $ Can SS Bot
   3  9 -7.84                            9 -69  65 -66 $ Can SS Walls
   4  8 -11.34                           9 -69  66 -67 $ Can Lead Shield
   5 10 -1.29e-3 24 -25  34 -35 9 -15 (69:67)   $ Inside Glovebox
   6  7 -7.84 23 -26 33 -36 8 -16(-24:25:-34:35:-9:15) $ SS Inside
   7 8 -11.34 22 -27 32 -37 7 -17(-23:26:-33:36:-8:16) $ Lead Shield
   8  7 -7.84 21 -28 31 -38 6 -18(-22:27:-32:37:-7:17) $ SS Outside
   9 10 -1.29e-3 21 -28  31 -38   5  -6          $ Under  Glovebox
  10 10 -1.29e-3 21 -28  31 -38  18 -19          $ Over   Glovebox
  11 10 -1.29e-3 20 -21  31 -38   5 -19          $ Left   Glovebox
  12 10 -1.29e-3 20 -21  30 -31   5 -19          $ L-B    Glovebox
  13 10 -1.29e-3 21 -28  30 -31   5 -19          $ Behind Glovebox
  14 10 -1.29e-3 28 -29  30 -31   5 -19          $ R-B    Glovebox
  15 10 -1.29e-3 28 -29  31 -38   5 -19          $ Right  Glovebox
  16 10 -1.29e-3 20 -42  38 -39   5 -19          $ Front  Glovebox
  17 10 -1.29e-3 42 -43  38 -44   5 -19          $ Front  Glovebox
  18 10 -1.29e-3 43 -29  38 -39   5 -19          $ Front  Glovebox
  19 10 -1.29e-3 42 -43  44 -48   5 -40          $ Bot Fr Outside air
  20  7 -7.84     55 -43  48 -49   5 -40          $ Bot Fr Outer  1/8"
  21 14 -1.185    52 -43  49 -50   5 -40          $ Bot Fr Middle 5.0"
  22  7 -7.84     53 -43  50 -51   5 -40          $ Bot Fr Inside 1/8"
  23 10 -1.29e-3 56 -43  51 -47   5 -40          $ Bot Fr Inside air
  24 15 -2.14     42 -43  44 -45  40 -41          $ Top Fr Outer  3/4"
  25 14 -1.185    52 -43  45 -46  40 -41          $ Top Fr Middle 4.0"
  26 15 -2.14     53 -43  46 -47  40 -41          $ Top Fr Inside 3/4"
  27 10 -1.29e-3 42 -43  44 -47  41 -19          $ Above Shield
  28 10 -1.29e-3 42 -55  48 -39   5 -40          $ Bot L  Outside air
  29  7 -7.84     55 -52  49 -39   5 -40          $ Bot L  Outer  1/8"
  30 14 -1.185    52 -53  50 -39   5 -40          $ Bot L  Middle 1.0"
  31  7 -7.84     53 -56  51 -39   5 -40          $ Bot L  Inside 1/8"
  32 10 -1.29e-3 56 -54  47 -39   5 -40          $ Bot L  Inside air
  33 15 -2.14     42 -52  45 -39  40 -41          $ Top L  Outer  3/4"
  34 14 -1.185    52 -53  46 -39  40 -41          $ Top L  Middle 1.0"
  35 15 -2.14     53 -54  47 -39  40 -41          $ Top L  Inside 3/4"
  36 10 -1.29e-3 42 -54  47 -39  41 -19          $ Above Shield
  37 10 -1.29e-3 54 -43  47 -39   5 -41          $ Behind n Shield
  38 10 -1.29e-3 54 -43  47 -39  41 -19          $ Behind n Shield
  39 10 -1.29e-3 60 -20  30 -39   5 -19          $ Room, Left Side
  40 10 -1.29e-3 60 -20  63 -30   5 -19          $ Room, Left Back
  41 10 -1.29e-3 20 -29  63 -30   5 -19          $ Room, Back Part
  42 10 -1.29e-3 60 -29  63 -39  19 -57          $ Room to Ceiling
  43  7 -7.84     60 -29  62 -63   5 -57          $ SS Wall Back
  44  7 -7.84     60 -29  39 -64   5 -57          $ SS Wall Front
  45 11 -2.30     59 -60  62 -64   5 -57          $ Concrete Wall Left
  46 11 -2.30     29 -61  62 -64   5 -57          $ Concrete Wall Right
  47 11 -2.30     59 -61  62 -64  57 -58          $ Concrete Roof
  48 11 -2.30     59 -61  62 -64   4  -5          $ Concrete Floor
  49  0           61:-59: 64:-62: -4: 58          $ OUTSIDE WORLD

 1        cz    7.7610      $ FEED TANK O.R. - (5/16"-0.040")
 2        cz    8.4534      $ FEED TANK O.R.
 3        cz   14.2875      $ FEED TANK FLANGE O.R.
 4        pz  -60.9600      $ CONCRETE FLOOR bottom (24" thick)
 5        pz    0.0000      $ CONCRETE FLOOR surface
 6        pz   86.3600      $ GLOVEBOX bottom surface
 7        pz   86.5981      $ GLOVEBOX Stainless Steel (3/32")
 8        pz   87.0744      $ GLOVEBOX Lead Shield (3/16")
 9        pz   87.3125      $ GLOVEBOX Stainless Steel (3/32")
10        pz  171.4500      $ FEED TANK Bottom Flange bottom
11        pz  171.7200      $ FEED TANK Bottom Flange top
12        pz  224.5663      $ FEED TANK Solution level (10 L)
13        pz  233.6800      $ FEED TANK Top    Flange bottom
14        pz  234.9500      $ FEED TANK Top    Flange top
15        pz  265.7475      $ GLOVEBOX top inside surface
16        pz  265.9856      $ GLOVEBOX Stainless Steel (3/32")
17        pz  266.4619      $ GLOVEBOX Lead Shield (3/16")
18        pz  266.7000      $ GLOVEBOX Stainless Steel (3/32")
19        pz  366.7000      $ MODEL TOP (GB roof +100 cm)
20        px -321.6150      $ MODEL LEFT SIDE (GB side +100 cm)
21        px -221.6150      $ GLOVEBOX left    surface
22        px -221.3769      $ GLOVEBOX Stainless Steel (3/32")
23        px -220.9006      $ GLOVEBOX Lead Shield (3/16")
24        px -220.6625      $ GLOVEBOX Stainless Steel (3/32")
25        px   39.6875      $ GLOVEBOX right inside surface
26        px   39.9256      $ GLOVEBOX Stainless Steel (3/32")
27        px   40.4019      $ GLOVEBOX Lead Shield (3/16")
28        px   40.6400      $ GLOVEBOX Stainless Steel (3/32")
```

```
  29       px  231.1400      $ MODEL RIGHT SIDE (GB side +75")
  30       py -122.2250      $ MODEL BACK SIDE (GB back +100 cm)
  31       py  -22.2250      $ GLOVEBOX back   surface
  32       py  -21.9869      $ GLOVEBOX Stainless Steel (3/32")
  33       py  -21.5106      $ GLOVEBOX Lead Shield (3/16")
  34       py  -21.2725      $ GLOVEBOX Stainless Steel (3/32")
  35       py   82.5500      $ GLOVEBOX front inside surface
  36       py   82.7881      $ GLOVEBOX Stainless Steel (3/32")
  37       py   83.2644      $ GLOVEBOX Lead Shield (3/16")
  38       py   83.5025      $ GLOVEBOX Stainless Steel (3/32")
  39       py  327.3425      $ MODEL FRONT SIDE (GB front +96")
  40       pz  137.16        $ 4.5' High  n Shield
  41       pz  213.36        $ +2.5' Top  n Shield
  42       px -125.00        $ Left End  n Shield
  43       px  175.00        $ Right End n Shield
  44       py  191.4525      $ 3/4" n Shield Material outside
  45       py  193.3575      $ 4.0" n Shield Material outside
  46       py  203.5175      $ 3/4" n Shield Material outside
  47       py  205.4225      $ Operator Side n Shield
c 44       py  191.4525      $ 3/4" n Shield Material outside
  48       py  191.7700      $ 1/8" n Shield Material outside
  49       py  192.0875      $ 5.0" n Shield Material outside
  50       py  204.7875      $ 1/8" n Shield Material outside
  51       py  205.1050      $ 1/8" n Shield Material inside
c 47       py  205.4225      $ Operator Side n Shield
c 42       px -125.00        $ 3/4" n Shield Material outside
  52       px -123.0950      $ 1.0" n Shield Material outside
  53       px -120.5550      $ 3/4" n Shield Material outside
  54       px -118.6500      $ Operator Side n Shield
c 42       px -125.00        $ 3/4" n Shield Material outside
  55       px -123.4125      $ 1/8" n Shield Material outside
c 52       px -123.0950      $ 1.0" n Shield Material outside
c 53       px -120.5550      $ 3/4" n Shield Material outside
  56       px -120.2375      $ 1/8" n Shield Material inside
c 54       px -118.6500      $ Operator Side n Shield
  57       pz  949.96        $ Ceiling Surface [H-2-16174]
  58       pz  960.12        $ 4 inch concrete roof [H-2-16174]
  59       px -561.34        $ 8 inch concrete wall left side
  60       px -541.02        $ Left Wall Surface [H-2-16140]
  61       px  251.46        $ 8 inch concrete wall right side
  62       py -735.3078      $ 18 Gauge Metal (.0516"*(4.0/1.8)=>.2913 cm)
  63       py -735.0125      $ Back Wall Surface [H-2-16140]
  64       py  327.6338      $ 18 Gauge Metal (.0516"*(4.0/1.8)=>.2913 cm)
  65       c/z  -126.6933  50.8000  4.6038 $ Storage Can Inside Radius
  66       c/z  -126.6933  50.8000  4.7625 $ Storage Can Outside Radius
  67       c/z  -126.6933  50.8000  5.0800 $ 1/8" Lead   Outside Radius
  68       pz    87.4712     $ Storage Can Stainless Steel Floor
  69       pz    98.7425     $ Storage Can Height

mode    n p
imp:n   1 47r 0
imp:p   1 47r 0
c    wgt =  3600*105     =  378000 Low  240 Pu
c    wgt =  3600*215     =  774000 Mid  240 Pu
```

```
c     wgt =  3600*295      = 1062000 High 240 Pu
sdef    cel=1   erg= d2   pos = -126.6933 50.8000 0
        rad= d3   ext= d4   axs = 0 0 1  wgt=1062000.
sc2    (alpha,n) and fission spectrum
si2     s     35     36
sp2       0.504 0.496
sc3     radius
si3     4.6038
sp3     -21 1
sc4     extent
si4      87.4712    98.7425
sp4     -21 0
sc35    (alpha,n) neutron source on OXYGEN from Jacom and Liskien
c        Energy of the alpha particles = 5.5 MeV
#         si35        sp35
           0.0        0.00
           0.1        0.68
           0.2        0.76
           0.3        0.74
           0.4        0.88
           0.5        1.20
           0.6        1.35
           0.7        1.48
           0.8        1.62
           0.9        1.55
           1.0        1.28
           1.1        1.34
           1.2        1.45
           1.3        1.63
           1.4        1.76
           1.5        1.80
           1.6        1.89
           1.7        2.05
           1.8        2.28
           1.9        2.37
           2.0        2.49
           2.1        2.50
           2.2        2.61
           2.3        2.65
           2.4        2.54
           2.5        2.43
           2.6        2.34
           2.7        2.73
           2.8        2.06
           2.9        2.00
           3.0        1.88
           3.1        1.66
           3.2        1.56
           3.3        1.34
           3.4        1.09
           3.5        0.92
           3.6        0.79
           3.7        0.64
           3.8        0.55
```

```
         3.9        0.48
         4.0        0.39
         4.1        0.35
         4.2        0.23
         4.3        0.18
         4.4        0.11
         4.5        0.07
sc36   spontaneous fission source spectrum (Pu240)
sp36    -3  0.799  4.903   $ Watt Fisson Spectrum
m1     94239.55c -0.197551   7014.50c -0.047731   8016.50c -0.682422
        1001.50c -0.065371  $ Pu(NO3)4 711.69 g/L, H2O 1000 g/L.
mt1      lwtr.01t                   $ hydrogen in liquid
m2     94238.50c -0.000089  94239.55c -0.823090  94240.50c -0.054516
       94241.50c -0.002316  94242.50c -0.000356  95241.50c -0.001603
        8016.50c -0.118030  $ PuO2 for Low 240 Weight % [CALCINE2.WQ1]
m3     94238.50c -0.001312  94239.55c -0.748841  94240.50c -0.108876
       94241.50c -0.010494  94242.50c -0.003236  95241.50c -0.009270
        8016.50c -0.117971  $ PuO2 for Med 240 Weight % [CALCINE2.WQ1]
m4     94238.50c -0.001559  94239.55c -0.693581  94240.50c -0.154553
       94241.50c -0.010569  94242.50c -0.006324  95241.50c -0.015507
        8016.50c -0.117907  $ PuO2 for High 240 Weight % [CALCINE2.WQ1]
m5     14000.50c -0.376753   5010.50c -0.007986   5011.55c -0.032386
       11023.50c -0.029674  13027.50c -0.012173  19000.50c -0.000830
        8016.50c -0.540198  $ 7740 PYREX Type I Glass [CALCINE1.WQ1]
m6     26000.55c -0.74  24000.50c -0.18  28000.50c -0.08  $ SS 304L Flanges
m7     26000.55c -0.98  28000.50c -0.02  $ Stainless Steel Glovebox
m8     82000.50c -1.00                   $ Lead Glovebox Shield
m9     26000.55c     -1                  $ SS 310S
m10     7014.50c -.78084  8016.50c -0.20946  18000.35c -0.00934
        1001.50c -.00036  $ Air
mt10     lwtr.01t                    $ hydrogen in liquid, gas
m11    13027.50c -.034    20000.50c -0.044     26000.55c -0.014
        1001.50c -.001     8016.50c -0.532     14000.50c -0.337
       11023.50c -.029    $ Concrete (common Portland) ARH-600 II.F.1-3
mt11     poly.01t                    $ hydrogen in solid
m12     6000.50c -0.5925    5010.50c -0.0590    5011.55c -0.2410 $ Neutron
        1001.50c -0.0854   14000.50c -0.0101    8016.50c -0.0076 $ Shield
       26000.55c -0.0038   13027.50c -0.0004   25055.50c -0.0002 $ 210
mt12     poly.01t    grph.01t    $ hydrogen, carbon in solid (1.19 g/cm3)
m13     8016.50c -0.3649    6000.50c -0.3439   13027.50c -0.1906 $ Neutron
        1001.50c -0.0784   20000.50c -0.0123   14000.50c -0.0009 $ Shield
        5010.50c -0.00138   5011.55c -0.00562  12000.50c -0.0006 $ 207
       11023.50c -0.0006   39089.50c -0.0005   26000.55c -0.0001
       19000.50c -0.0001   16032.50c -0.0001 $ Y89 substituted for Sr.
mt13     poly.01t    grph.01t    $ hydrogen, carbon in solid (1.4 g/cm3)
m14     6000.50c -0.599848  1001.50c -0.080538  8016.50c -0.319614 $ Lucite
mt14     poly.01t    grph.01t    $ hydrogen in solid (1.185 g/cm3) Lucite
m15    14000.50c -0.392603  $ 7740 PYREX Type I Glass [no Boron, 2.14 g/cm3]
       11023.50c -0.030923  13027.50c -0.012685  19000.50c -0.000865
        8016.50c -0.562924  $ 7740 PYREX Type I Glass [CALCINE1.WQ1]
m16     6000.50c -0.755751  1001.50c -0.055491  8016.50c -0.188758 $ Lexan
mt16     poly.01t    grph.01t    $ hydrogen in solid (1.2   g/cm3) Lexan
c      Photon dose conversion factors from ANS 6.1.1 1991
de4     log  .01    .015  .02    .03    .04    .05
              .06    .08   .10    .15    .20    .30
              .40    .50   .60    .80   1.0    1.5
             2.0    3.0   4.0    5.0    6.0    8.0
            10.0   12.0
df4     log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
              1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
              7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
              2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
              8.892e-3 1.040e-2
fc4    Photon Dose behind Neutron Shield, Right Side Leak Around
f4:p   37                 $ Operator behind Neutron Shield
cf4    18                                    $ Flagging Cells for leak-through,
skyshine
c      Photon dose conversion factors from ANS 6.1.1 1991
de14    log  .01    .015  .02    .03    .04    .05
              .06    .08   .10    .15    .20    .30
              .40    .50   .60    .80   1.0    1.5
             2.0    3.0   4.0    5.0    6.0    8.0
            10.0   12.0
df14    log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
              1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
              7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
              2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
              8.892e-3 1.040e-2
fc14   Photon Dose behind Neutron Shield, Front Lower n Shield Leak Through
f14:p  37                 $ Operator behind Neutron Shield
cf14      23                                 $ Flagging Cells for leak-through,
skyshine
c      Photon dose conversion factors from ANS 6.1.1 1991
de24    log  .01    .015  .02    .03    .04    .05
              .06    .08   .10    .15    .20    .30
              .40    .50   .60    .80   1.0    1.5
             2.0    3.0   4.0    5.0    6.0    8.0
            10.0   12.0
df24    log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
              1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
              7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
              2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
              8.892e-3 1.040e-2
fc24   Photon Dose behind Neutron Shield, Front Upper n Shield Leak Through
f24:p  37                 $ Operator behind Neutron Shield
cf24       26                                $ Flagging Cells for leak-through,
skyshine
c      Photon dose conversion factors from ANS 6.1.1 1991
de34    log  .01    .015  .02    .03    .04    .05
              .06    .08   .10    .15    .20    .30
              .40    .50   .60    .80   1.0    1.5
             2.0    3.0   4.0    5.0    6.0    8.0
            10.0   12.0
df34    log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
              1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
              7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
              2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
              8.892e-3 1.040e-2
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fc34    Photon Dose behind Neutron Shield, Left Lower n Shield Leak Through
f34:p  37              $ Operator behind Neutron Shield
cf34              32                $ Flagging Cells for leak-through,
skyshine
c       Photon dose conversion factors from ANS 6.1.1 1991
de44    log  .01    .015   .02    .03    .04    .05
             .06    .08    .10    .15    .20    .30
             .40    .50    .60    .80   1.0    1.5
            2.0    3.0    4.0    5.0    6.0    8.0
           10.0   12.0
df44     log    2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
                1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
                7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
                2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
                8.892e-3 1.040e-2
fc44    Photon Dose behind Neutron Shield, Left Upper n Shield Leak Through
f44:p  37              $ Operator behind Neutron Shield
cf44                   35           $ Flagging Cells for leak-through,
skyshine
c       Photon dose conversion factors from ANS 6.1.1 1991
de54    log  .01    .015   .02    .03    .04    .05
             .06    .08    .10    .15    .20    .30
             .40    .50    .60    .80   1.0    1.5
            2.0    3.0    4.0    5.0    6.0    8.0
           10.0   12.0
df54     log    2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
                1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
                7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
                2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
                8.892e-3 1.040e-2
fc54    Photon Dose behind Neutron Shield, Roof Reflection
f54:p  37              $ Operator behind Neutron Shield
cf54                      38        $ Flagging Cells for leak-through,
skyshine
c       Photon dose conversion factors from ANS 6.1.1 1991
de64    log  .01    .015   .02    .03    .04    .05
             .06    .08    .10    .15    .20    .30
             .40    .50    .60    .80   1.0    1.5
            2.0    3.0    4.0    5.0    6.0    8.0
           10.0   12.0
df64     log    2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
                1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
                7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
                2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
                8.892e-3 1.040e-2
fc64    Photon Dose behind Neutron Shield, Steel Wall Back Reflection
f64:p  37              $ Operator behind Neutron Shield
cf64                         43     $ Flagging Cells for leak-through,
skyshine
c       Photon dose conversion factors from ANS 6.1.1 1991
de74    log  .01    .015   .02    .03    .04    .05
             .06    .08    .10    .15    .20    .30
             .40    .50    .60    .80   1.0    1.5
            2.0    3.0    4.0    5.0    6.0    8.0
           10.0   12.0
df74     log    2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
                1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
                7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
                2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
                8.892e-3 1.040e-2
fc74    Photon Dose behind Neutron Shield, Concrete Floor Effect
f74:p  37              $ Operator behind Neutron Shield
cf74                          48 $ Flagging Cells for leak-through,
skyshine
c       Photon dose conversion factors from ANS 6.1.1 1991
de84    log  .01    .015   .02    .03    .04    .05
             .06    .08    .10    .15    .20    .30
             .40    .50    .60    .80   1.0    1.5
            2.0    3.0    4.0    5.0    6.0    8.0
           10.0   12.0
df84     log    2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
                1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
                7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
                2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
                8.892e-3 1.040e-2
fc84    Photon Dose behind Neutron Shield, Sum of All Cells FLAGGING!!
f84:p  37              $ Operator behind Neutron Shield
cf84    18  23  26  32  35  38  43  48 $ Flagging Cells
c       Neutron dose conversion factors from ANS 6.1.1 1991
de0     2.50e-08  1.00e-07  1.00e-06  1.00e-05  1.00e-04  1.00e-03
        1.00e-02  2.00e-02  5.00e-02  1.00e-01  2.00e-01  5.00e-01
        1.00e+00  1.50e+00  2.00e+00  3.00e+00  4.00e+00  5.00e+00
        6.00e+00  7.00e+00  8.00e+00  1.00e+01  1.40e+01
df0     1.440e-03 1.584e-03 1.735e-03 1.606e-03 1.490e-03 1.379e-03
        1.631e-03 2.113e-03 3.924e-03 7.128e-03 1.390e-02 3.132e-02
        5.148e-02 6.588e-02 7.704e-02 9.504e-02 1.080e-01 1.177e-01
        1.249e-01 1.314e-01 1.368e-01 1.476e-01 1.728e-01
fc204    Neutron Dose behind Neutron Shield, Right Side Leak Around
f204:n  37             $ Operator behind Neutron Shield
fm204    2.0           $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf204    18                    $ Flagging Cells for leak-through,
skyshine
fc214    Neutron Dose behind Neutron Shield, Front Lower n Shield Leak
Through
f214:n  37             $ Operator behind Neutron Shield
fm214    2.0           $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf214       23                 $ Flagging Cells for leak-through,
skyshine
fc224    Neutron Dose behind Neutron Shield, Front Upper n Shield Leak
Through
f224:n  37             $ Operator behind Neutron Shield
fm224    2.0           $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf224           26             $ Flagging Cells for leak-through,
 skyshine
fc234    Neutron Dose behind Neutron Shield, Left Lower n Shield Leak
Through
f234:n  37             $ Operator behind Neutron Shield
fm234    2.0           $ Factor of 2 times the ANS 6.1.1 1991 Standard.
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cf234             32                  $ Flagging Cells for leak-through,
skyshine
fc244   Neutron Dose behind Neutron Shield, Left Upper n Shield Leak
Through
f244:n  37              $ Operator behind Neutron Shield
fm244    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf244                    35             $ Flagging Cells for leak-through,
skyshine
fc254   Neutron Dose behind Neutron Shield, Roof Reflection
f254:n  37              $ Operator behind Neutron Shield
fm254    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf254                      38           $ Flagging Cells for leak-through,
skyshine
fc264   Neutron Dose behind Neutron Shield, Steel Wall Back Reflection
f264:n  37              $ Operator behind Neutron Shield
fm264    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf264                         43        $ Flagging Cells for leak-through,
skyshine
fc274   Neutron Dose behind Neutron Shield, Concrete Floor Effect
f274:n  37              $ Operator behind Neutron Shield
fm274    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf274                            48 $ Flagging Cells for leak-through,
skyshine
fc284   Neutron Dose behind Neutron Shield, Sum of All Cells FLAGGING!!
f284:n  37              $ Operator behind Neutron Shield
fm284    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
cf284   18  23  26  32  35  38  43  48 $ Flagging Cells for leak-through,
skyshine
fc5     dose at 30 cm from outside surface of 6 in. pipe
c       Total Dist from outside = 30.0 + 50.80 +  5.08 =  85.88 cm
f5:n     -126.6933  85.88   93.1068   0
fm5      2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc15    dose at 30 cm from outside surface of Glovebox
c       Total Dist from outside = 30.0 + 83.5025 = 113.5025 cm
f15:n    -126.6933 113.5025 93.1068   0
fm15     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc25    dose at 5 feet from outside surface of Glovebox
c       Total Dist from outside = 152.8 + 83.5025 = 235.9025 cm
f25:n    -126.6933 235.9025 93.1068   0
fm25     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc35    Neutron dose at  6 in. in front of lower n Shield
c       Total Dist from outside = 191.4525 - 6*2.54 = 176.2125 cm
f35:n    0 176.2125  91.44  0
fm35     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc45    Neutron dose in middle of outer 1/8" SST n Shield
c       Total Dist from outside = (191.7700 + 192.0875)/2 = 191.9288 cm
f45:n    0 191.9288  91.44  0
fm45     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc55    Neutron dose in middle of 5.0" lower n Shield
c       Total Dist from outside = (192.0875 + 204.7875)/2 = 198.4375 cm
f55:n    0 198.4375  91.44  0
fm55     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc65    Neutron dose in middle of inner 1/8" Stainless Steel n Shield
c       Total Dist from outside = (204.7875 + 205.1050)/2 = 204.9462 cm
f65:n    0 204.9462  91.44  0
fm65     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc75    Neutron dose at 6 in. behind inside lower n Shield
c       Total Dist from outside = 205.4225 + 6*2.54 = 220.6225 cm
f75:n    0 220.6625  91.44  0
fm75     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc85    Neutron dose at  6 in. in front of upper n Shield
c       Total Dist from outside = 191.4525 - 6*2.54 = 176.2125 cm
f85:n    0 176.2125 182.88  0
fm85     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc95    Neutron dose in middle of outer 3/4" glass n Shield
c       Total Dist from outside = (191.4525 + 193.3575)/2 = 192.4050 cm
f95:n    0 192.4050 182.88  0
fm95     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc105    Neutron dose in middle of 4.0" upper n Shield
c       Total Dist from outside = (193.3575 + 203.5175)/2 = 198.4375 cm
f105:n    0 198.4375 182.88  0
fm105     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc115    Neutron dose in middle of inner 3/4" glass n Shield
c       Total Dist from outside = (203.5175 + 205.4225)/2 = 204.4700 cm
f115:n    0 204.4700 182.88  0
fm115     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc125    Neutron dose at 6 in. behind inside upper n Shield
c       Total Dist from outside = 205.4225 + 6*2.54 = 220.6225 cm
f125:n    0 220.6625 182.88  0
fm125     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
print   10  110  120
ctme    180.0
nps     1.0e5
```

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CSC08AP.INP   Storage Can, 3.6 kg Pu, gamma ray calculation

PHOTON  Dose Rate Calcs for calciner - CSC08AP
c       Hi 240Pu PuO2 Storage Can Photon Source is in Cell 1
c       N Shield Lucite - 1.185 g/cm3 - 4 inches top, 5 inches bottom
c       Lower Shields are 1/8 inch of Stainless Steel (both sides)
c       Upper Shields are 3/4 inch of Glass (no Boron)(both sides)
c       Full Room Model with Concrete Walls, Roof, and Metal Partitions
c                  xx -xx  yy -yy  zz -zz  rr -rr imp:n= $
   1  4 -5.438                     68 -69     -65 $ Hi 240PuO2
   2  9 -7.84                       9 -68     -65 $ Can SS Bot
   3  9 -7.84                       9 -69  65 -66 $ Can SS Walls
   4  8 -11.34                      9 -69  66 -67 $ Can Lead Shield
   5 10 -1.29e-3 24 -25  34 -35 9 -15 (69:67)   $ Inside Glovebox
   6  7 -7.84 23 -26 33 -36 8 -16(-24:25:-34:35:-9:15) $ SS Inside
   7 8 -11.34 22 -27 32 -37 7 -17(-23:26:-33:36:-8:16) $ Lead Shield
   8  7 -7.84 21 -28 31 -38 6 -18(-22:27:-32:37:-7:17) $ SS Outside
   9 10 -1.29e-3 21 -28  31 -38   5  -6          $ Under  Glovebox
  10 10 -1.29e-3 21 -28  31 -38  18 -19          $ Over   Glovebox
  11 10 -1.29e-3 20 -21  31 -38   5 -19          $ Left   Glovebox
  12 10 -1.29e-3 20 -21  30 -31   5 -19          $ L-B    Glovebox
  13 10 -1.29e-3 21 -28  30 -31   5 -19          $ Behind Glovebox
```

```
14 10 -1.29e-3 28 -29  30 -31   5 -19         $ R-B    Glovebox
15 10 -1.29e-3 28 -29  31 -38   5 -19         $ Right  Glovebox
16 10 -1.29e-3 20 -42  38 -39   5 -19         $ Front  Glovebox
17 10 -1.29e-3 42 -43  38 -44   5 -19         $ Front  Glovebox
18 10 -1.29e-3 43 -29  38 -39   5 -19         $ Front  Glovebox
19 10 -1.29e-3 42 -43  44 -48   5 -40         $ Bot Fr Outside air
20  7 -7.84    55 -43  48 -49   5 -40         $ Bot Fr Outer  1/8"
21 14 -1.185   52 -43  49 -50   5 -40         $ Bot Fr Middle 5.0"
22  7 -7.84    53 -43  50 -51   5 -40         $ Bot Fr Inside 1/8"
23 10 -1.29e-3 56 -43  51 -47   5 -40         $ Bot Fr Inside air
24 15 -2.14    42 -43  44 -45  40 -41         $ Top Fr Outer  3/4"
25 14 -1.185   52 -43  45 -46  40 -41         $ Top Fr Middle 4.0"
26 15 -2.14    53 -43  46 -47  40 -41         $ Top Fr Inside 3/4"
27 10 -1.29e-3 42 -43  44 -47  41 -19         $ Above Shield
28 10 -1.29e-3 42 -55  48 -39   5 -40         $ Bot L  Outside air
29  7 -7.84    55 -52  49 -39   5 -40         $ Bot L  Outer  1/8"
30 14 -1.185   52 -53  50 -39   5 -40         $ Bot L  Middle 1.0"
31  7 -7.84    53 -56  51 -39   5 -40         $ Bot L  Inside 1/8"
32 10 -1.29e-3 56 -54  47 -39   5 -40         $ Bot L  Inside air
33 15 -2.14    42 -52  45 -39  40 -41         $ Top L  Outer  3/4"
34 14 -1.185   52 -53  46 -39  40 -41         $ Top L  Middle 1.0"
35 15 -2.14    53 -54  47 -39  40 -41         $ Top L  Inside 3/4"
36 10 -1.29e-3 42 -54  47 -39  41 -19         $ Above Shield
37 10 -1.29e-3 54 -43  47 -39   5 -41         $ Behind n Shield
38 10 -1.29e-3 54 -43  47 -39  41 -19         $ Behind n Shield
39 10 -1.29e-3 60 -20  30 -39   5 -19         $ Room, Left Side
40 10 -1.29e-3 60 -20  63 -30   5 -19         $ Room, Left Back
41 10 -1.29e-3 20 -29  63 -30   5 -19         $ Room, Back Part
42 10 -1.29e-3 60 -29  63 -39  19 -57         $ Room to Ceiling
43  7 -7.84    60 -29  62 -63   5 -57         $ SS Wall Back
44  7 -7.84    60 -29  39 -64   5 -57         $ SS Wall Front
45 11 -2.30    59 -60  62 -64   5 -57         $ Concrete Wall Left
46 11 -2.30    29 -61  62 -64   5 -57         $ Concrete Wall Right
47 11 -2.30    59 -61  62 -64  57 -58         $ Concrete Roof
48 11 -2.30    59 -61  62 -64   4  -5         $ Concrete Floor
49  0          61:-59: 64:-62: -4: 58         $ OUTSIDE WORLD

 1        cz    7.7610     $ FEED TANK O.R. - (5/16"-0.040")
 2        cz    8.4534     $ FEED TANK O.R.
 3        cz   14.2875     $ FEED TANK FLANGE O.R.
 4        pz  -60.9600     $ CONCRETE FLOOR bottom (24" thick)
 5        pz    0.0000     $ CONCRETE FLOOR surface
 6        pz   86.3600     $ GLOVEBOX bottom surface
 7        pz   86.5981     $ GLOVEBOX Stainless Steel (3/32")
 8        pz   87.0744     $ GLOVEBOX Lead Shield (3/16")
 9        pz   87.3125     $ GLOVEBOX Stainless Steel (3/32")
10        pz  171.4500     $ FEED TANK Bottom Flange bottom
11        pz  171.7200     $ FEED TANK Bottom Flange top
12        pz  224.5663     $ FEED TANK Solution level (10 L)
13        pz  233.6800     $ FEED TANK Top    Flange bottom
14        pz  234.9500     $ FEED TANK Top    Flange top
15        pz  265.7475     $ GLOVEBOX top inside surface
16        pz  265.9856     $ GLOVEBOX Stainless Steel (3/32")
17        pz  266.4619     $ GLOVEBOX Lead Shield (3/16")
   18          pz  266.7000     $ GLOVEBOX Stainless Steel (3/32")
   19          pz  366.7000     $ MODEL TOP (GB roof +100 cm)
   20          px -321.6150     $ MODEL LEFT SIDE (GB side +100 cm)
   21          px -221.6150     $ GLOVEBOX left   surface
   22          px -221.3769     $ GLOVEBOX Stainless Steel (3/32")
   23          px -220.9006     $ GLOVEBOX Lead Shield (3/16")
   24          px -220.6625     $ GLOVEBOX Stainless Steel (3/32")
   25          px   39.6875     $ GLOVEBOX right inside surface
   26          px   39.9256     $ GLOVEBOX Stainless Steel (3/32")
   27          px   40.4019     $ GLOVEBOX Lead Shield (3/16")
   28          px   40.6400     $ GLOVEBOX Stainless Steel (3/32")
   29          px  231.1400     $ MODEL RIGHT SIDE (GB side +75")
   30          py -122.2250     $ MODEL BACK SIDE (GB back +100 cm)
   31          py  -22.2250     $ GLOVEBOX back   surface
   32          py  -21.9869     $ GLOVEBOX Stainless Steel (3/32")
   33          py  -21.5106     $ GLOVEBOX Lead Shield (3/16")
   34          py  -21.2725     $ GLOVEBOX Stainless Steel (3/32")
   35          py   82.5500     $ GLOVEBOX front inside surface
   36          py   82.7881     $ GLOVEBOX Stainless Steel (3/32")
   37          py   83.2644     $ GLOVEBOX Lead Shield (3/16")
   38          py   83.5025     $ GLOVEBOX Stainless Steel (3/32")
   39          py  327.3425     $ MODEL FRONT SIDE (GB front +96")
   40          pz  137.16       $ 4.5' High  n Shield
   41          pz  213.36       $ +2.5' Top  n Shield
   42          px -125.00       $ Left End  n Shield
   43          px  175.00       $ Right End n Shield
   44          py  191.4525     $ 3/4" n Shield Material outside
   45          py  193.3575     $ 4.0" n Shield Material outside
   46          py  203.5175     $ 3/4" n Shield Material outside
   47          py  205.4225     $ Operator Side n Shield
c  44          py  191.4525     $ 3/4" n Shield Material outside
   48          py  191.7700     $ 1/8" n Shield Material outside
   49          py  192.0875     $ 5.0" n Shield Material outside
   50          py  204.7875     $ 1/8" n Shield Material outside
   51          py  205.1050     $ 1/8" n Shield Material inside
c  47          py  205.4225     $ Operator Side n Shield
c  42          px -125.00       $ 3/4" n Shield Material outside
   52          px -123.0950     $ 1.0" n Shield Material outside
   53          px -120.5550     $ 3/4" n Shield Material outside
   54          px -118.6500     $ Operator Side n Shield
c  42          px -125.00       $ 3/4" n Shield Material outside
   55          px -123.4125     $ 1/8" n Shield Material outside
c  52          px -123.0950     $ 1.0" n Shield Material outside
c  53          px -120.5550     $ 3/4" n Shield Material outside
   56          px -120.2375     $ 1/8" n Shield Material inside
c  54          px -118.6500     $ Operator Side n Shield
   57          pz  949.96       $ Ceiling Surface [H-2-16174]
   58          pz  960.12       $ 4 inch concrete roof [H-2-16174]
   59          px -561.34       $ 8 inch concrete wall left side
   60          px -541.02       $ Left Wall Surface [H-2-16140]
   61          px  251.46       $ 8 inch concrete wall right side
   62          py -735.3078     $ 18 Gauge Metal (.0516"*(4.0/1.8)=>.2913 cm)
   63          py -735.0125     $ Back Wall Surface [H-2-16140]
   64          py  327.6338     $ 18 Gauge Metal (.0516"*(4.0/1.8)=>.2913 cm)
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```
 65       c/z  -126.6933  50.8000  4.6038 $ Storage Can Inside Radius
 66       c/z  -126.6933  50.8000  4.7625 $ Storage Can Outside Radius
 67       c/z  -126.6933  50.8000  5.0800 $ 1/8" Lead   Outside Radius
 68       pz   87.4712       $ Storage Can Stainless Steel Floor
 69       pz   98.7425       $ Storage Can Height

mode    p
imp:p   1 47r 0
c   wgt =  3600*3.169E+8 = 1.141E+12  Low  240 Pu
c   wgt =  3600*1.115E+9 = 4.014E+12  Mid  240 Pu
c   wgt =  3600*1.682E+9 = 6.055E+12  High 240 Pu
sdef    cel=1   erg= d5   pos = -126.6933 50.8000 0
        rad= d3   ext= d4   axs = 0 0 1  wgt=6.055E+12
sc2    (alpha,n) and fission spectrum
si2     s     35     36
sp2       0.504 0.496
sc3     radius
si3     4.6038
sp3     -21 1
sc4     extent
si4      87.4712   98.7425
sp4     -21 0
sc5     photon source from ORIGEN2
c         TOTAL PHOTON SPECTRUM
#          si5          sp5        sb5
        0.0           0.0           0
        1.5000e-02    8.9240e+08    200790
        2.5000e-02    4.9830e+07    31144
        3.7500e-02    4.6240e+06    6503
        5.7500e-02    7.3350e+08    2425134
        8.5000e-02    6.1780e+05    4464
        1.2500e-01    7.0030e+05    10942
        2.2500e-01    7.9320e+04    4016
        3.7500e-01    1.2800e+05    18000
        5.7500e-01    1.7600e+04    5819
        8.5000e-01    5.1220e+03    3701
        1.2500e+00    1.6370e+02    256
        1.7500e+00    7.2840e+01    223
        2.2500e+00    4.1830e+01    212
        2.7500e+00    2.4080e+01    182
        3.5000e+00    2.1360e+01    262
        5.0000e+00    9.0380e+00    226
        7.0000e+00    1.0250e+00    50
        1.1000e+01    1.1690e-01    14
c        TOTAL        1.6820e+09
sc35    (alpha,n) neutron source on OXYGEN from Jacom and Liskien
c        Energy of the alpha particles = 5.5 MeV
#          si35        sp35
            0.0        0.00
            0.1        0.68
            0.2        0.76
            0.3        0.74
            0.4        0.88
            0.5        1.20
            0.6        1.35
            0.7        1.48
            0.8        1.62
            0.9        1.55
            1.0        1.28
            1.1        1.34
            1.2        1.45
            1.3        1.63
            1.4        1.76
            1.5        1.80
            1.6        1.89
            1.7        2.05
            1.8        2.28
            1.9        2.37
            2.0        2.49
            2.1        2.50
            2.2        2.61
            2.3        2.65
            2.4        2.54
            2.5        2.43
            2.6        2.34
            2.7        2.73
            2.8        2.06
            2.9        2.00
            3.0        1.88
            3.1        1.66
            3.2        1.56
            3.3        1.34
            3.4        1.09
            3.5        0.92
            3.6        0.79
            3.7        0.64
            3.8        0.55
            3.9        0.48
            4.0        0.39
            4.1        0.35
            4.2        0.23
            4.3        0.18
            4.4        0.11
            4.5        0.07
sc36    spontaneous fission source spectrum (Pu240)
sp36     -3  0.799  4.903   $ Watt Fisson Spectrum
m1      94239. -0.197551   7014. -0.047731   8016. -0.682422
          1001. -0.065371  $ Pu(NO3)4 711.69 g/L, H2O 1000 g/L.
c       mt1      lwtr.01t                   $ hydrogen in liquid
m2      94238. -0.000089  94239. -0.823090  94240. -0.054516
        94241. -0.002316  94242. -0.000356  95241. -0.001603
         8016. -0.118030  $ PuO2 for Low 240 Weight % [CALCINE2.WQ1]
m3      94238. -0.001312  94239. -0.748841  94240. -0.108876
        94241. -0.010494  94242. -0.003236  95241. -0.009270
         8016. -0.117971  $ PuO2 for Med 240 Weight % [CALCINE2.WQ1]
m4      94238. -0.001559  94239. -0.693581  94240. -0.154553
        94241. -0.010569  94242. -0.006324  95241. -0.015507
         8016. -0.117907  $ PuO2 for High 240 Weight % [CALCINE2.WQ1]
```

```
m5     14000. -0.376753   5010. -0.007986   5011. -0.032386
        11023. -0.029674  13027. -0.012173  19000. -0.000830
         8016. -0.540198  $ 7740 PYREX Type I Glass [CALCINE1.WQ1]
m6     26000. -0.74  24000. -0.18  28000. -0.08  $ SS 304L Flanges
m7     26000. -0.98  28000. -0.02  $ Stainless Steel Glovebox
m8     82000. -1.00                  $ Lead Glovebox Shield
m9     26000.     -1                 $ SS 310S
m10     7014. -.78084  8016. -0.20946  18000.35c -0.00934
         1001. -.00036  $ Air
c      mt10      lwtr.01t                 $ hydrogen in liquid, gas
m11    13027. -.034   20000. -0.044    26000. -0.014
         1001. -.001    8016. -0.532    14000. -0.337
        11023. -.029   $ Concrete (common Portland) ARH-600 II.F.1-3
c      mt11      poly.01t                 $ hydrogen in solid
m12     6000. -0.5925   5010. -0.0590   5011. -0.2410 $ Neutron
         1001. -0.0854  14000. -0.0101   8016. -0.0076 $ Shield
        26000. -0.0038  13027. -0.0004  25055. -0.0002 $ 210
c      mt12     poly.01t    grph.01t    $ hydrogen, carbon in solid (1.19
g/cm3)
m13     8016. -0.3649    6000. -0.3439  13027. -0.1906 $ Neutron
         1001. -0.0784  20000. -0.0123  14000. -0.0009 $ Shield
         5010. -0.00138  5011. -0.00562 12000. -0.0006 $ 207
        11023. -0.0006  39089. -0.0005  26000. -0.0001
        19000. -0.0001  16032. -0.0001 $ Y89 substituted for Sr.
c      mt13     poly.01t    grph.01t    $ hydrogen, carbon in solid (1.4
g/cm3)
m14     6000. -0.599848  1001. -0.080538  8016. -0.319614 $ Lucite
c      mt14     poly.01t    grph.01t    $ hydrogen in solid (1.185 g/cm3)
Lucite
m15    14000. -0.392603  $ 7740 PYREX Type I Glass [no Boron, 2.14 g/cm3]
        11023. -0.030923  13027. -0.012685  19000. -0.000865
         8016. -0.562924  $ 7740 PYREX Type I Glass [CALCINE1.WQ1]
m16     6000. -0.755751  1001. -0.055491  8016. -0.188758 $ Lexan
c      mt16     poly.01t    grph.01t    $ hydrogen in solid (1.2   g/cm3)
Lexan
c      Photon dose conversion factors from ANS 6.1.1 1991
de0    log  .01    .015  .02    .03    .04    .05
            .06    .08   .10    .15    .20    .30
            .40    .50   .60    .80   1.0    1.5
           2.0    3.0   4.0    5.0    6.0    8.0
          10.0   12.0
df0     log   2.232e-5 5.652e-5 8.568e-5 1.184e-4 1.314e-4 1.382e-4
              1.440e-4 1.624e-4 1.919e-4 2.797e-4 3.708e-4 5.616e-4
              7.416e-4 9.144e-4 1.076e-3 1.379e-3 1.656e-3 2.246e-3
              2.758e-3 3.672e-3 4.500e-3 5.292e-3 6.012e-3 7.488e-3
              8.892e-3 1.040e-2
fc4    Photon Dose behind Neutron Shield, Right Side Leak Around
f4:p   37            $ Operator behind Neutron Shield
cf4    18                          $ Flagging Cells for leak-through,
skyshine
fc14   Photon Dose behind Neutron Shield, Front Lower n Shield Leak Through
f14:p  37            $ Operator behind Neutron Shield
cf14      23                       $ Flagging Cells for leak-through,
skyshine
```

```
fc24   Photon Dose behind Neutron Shield, Front Upper n Shield Leak Through
f24:p  37             $ Operator behind Neutron Shield
cf24         26                  $ Flagging Cells for leak-through,
skyshine
fc34   Photon Dose behind Neutron Shield, Left Lower n Shield Leak Through
f34:p  37             $ Operator behind Neutron Shield
cf34             32              $ Flagging Cells for leak-through,
skyshine
fc44   Photon Dose behind Neutron Shield, Left Upper n Shield Leak Through
f44:p  37             $ Operator behind Neutron Shield
cf44                35           $ Flagging Cells for leak-through,
skyshine
fc54   Photon Dose behind Neutron Shield, Roof Reflection
f54:p  37             $ Operator behind Neutron Shield
cf54                    38       $ Flagging Cells for leak-through,
skyshine
fc64   Photon Dose behind Neutron Shield, Steel Wall Back Reflection
f64:p  37             $ Operator behind Neutron Shield
cf64                        43   $ Flagging Cells for leak-through,
skyshine
fc74   Photon Dose behind Neutron Shield, Concrete Floor Effect
f74:p  37             $ Operator behind Neutron Shield
cf74                          48 $ Flagging Cells for leak-through,
skyshine
fc84   Photon Dose behind Neutron Shield, Sum of All Cells FLAGGING!!
f84:p  37             $ Operator behind Neutron Shield
cf84   18  23  26  32  35  38  43  48 $ Flagging Cells
fc5    Photon dose at 30 cm from outside surface of 6 in. pipe
c      Total Dist from outside = 30.0 + 50.80 +  5.08 =  85.88 cm
f5:p     -126.6933  85.88   93.1068   0
fc15   Photon dose at 30 cm from outside surface of Glovebox
c      Total Dist from outside = 30.0 + 83.5025 = 113.5025 cm
f15:p    -126.6933 113.5025 93.1068   0
fc25   Photon dose at 5 feet from outside surface of Glovebox
c      Total Dist from outside = 152.8 + 83.5025 = 235.9025 cm
f25:p    -126.6933 235.9025 93.1068   0
fc35   Photon dose at  6 in. in front of lower n Shield
c      Total Dist from outside = 191.4525 - 6*2.54 = 176.2125 cm
f35:p    0 176.2125  91.44  0
fc45   Photon dose in middle of outer 1/8" SST n Shield
c      Total Dist from outside = (191.7700 + 192.0875)/2 = 191.9288 cm
f45:p    0 191.9288  91.44  0
fc55   Photon dose in middle of 5.0" lower n Shield
c      Total Dist from outside = (192.0875 + 204.7875)/2 = 198.4375 cm
f55:p    0 198.4375  91.44  0
fc65   Photon dose in middle of inner 1/8" Stainless Steel n Shield
c      Total Dist from outside = (204.7875 + 205.1050)/2 = 204.9462 cm
f65:p    0 204.9462  91.44  0
fc75   Photon dose at 6 in. behind inside lower n Shield
c      Total Dist from outside = 205.4225 + 6*2.54 = 220.6225 cm
f75:p    0 220.6625  91.44  0
fc85   Photon dose at  6 in. in front of upper n Shield
c      Total Dist from outside = 191.4525 - 6*2.54 = 176.2125 cm
f85:p    0 176.2125 182.88  0
```

```
fc95    Photon dose in middle of outer 3/4" glass n Shield
c       Total Dist from outside = (191.4525 + 193.3575)/2 = 192.4050 cm
f95:p     0 192.4050 182.88  0
fc105    Photon dose in middle of 4.0" upper n Shield
c       Total Dist from outside = (193.3575 + 203.5175)/2 = 198.4375 cm
f105:p    0 198.4375 182.88  0
fc115    Photon dose in middle of inner 3/4" glass n Shield
c       Total Dist from outside = (203.5175 + 205.4225)/2 = 204.4700 cm
f115:p    0 204.4700 182.88  0
fc125    Photon dose at 6 in. behind inside upper n Shield
c       Total Dist from outside = 205.4225 + 6*2.54 = 220.6225 cm
f125:p    0 220.6625 182.88  0
print    10  110  120
ctme     180.0
nps      1.0e7
```

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APPENDIX D

HAND DOSE RATE MCNP INPUT FILES

CRCH02NP.INP 3.6 kg Pu Receipt Can with Hands, neutron and capture gammas

CRCH02P.INP 3.6 kg Pu Receipt Can with Hands, gamma ray calculation

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HAND DOSE RATE MCNP INPUT FILES

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CRCHO2NP.INP   3.6 kg Pu Receipt Can with Hands, neutron and capture gammas

NEUTRON Dose Rate Calcs for calciner - CRCHO2NP.INP
c      Hi 240Pu PuO2 Receipt Can Neutron Source is in Cell 1
c               xx -xx  yy -yy  zz -zz  rr -rr $
  1  4 -5.438                   51 -52     -49 $ Hi 240PuO2
  2  9 -7.84                     9 -51     -49 $ Can SS Bot
  3  9 -7.84                     9 -52  49 -50 $ Can SS Walls
  4 15 -1.10                     9 -52  50 -53 $ Latex layer
  5 16 -1.00                     9 -52  53 -54 $ Water Hands
  6 15 -1.10                     9 -52  54 -55 $ Latex layer
  7 10 -1.29e-3 24 -25  34 -35 9 -15 (52:55)   $ Inside Glovebox
  8  7 -7.84 23 -26 33 -36 8 -16(-24:25:-34:35:-9:15) $ SS Inside
  9 8 -11.34 22 -27 32 -37 7 -17(-23:26:-33:36:-8:16) $ Lead Shield
 10  7 -7.84 21 -28 31 -38 6 -18(-22:27:-32:37:-7:17) $ SS Outside
 11 10 -1.29e-3 21 -28  31 -38   5  -6         $ Under  Glovebox
 12 10 -1.29e-3 21 -28  31 -38  18 -19         $ Over   Glovebox
 13 10 -1.29e-3 20 -21  31 -38   5 -19         $ Left   Glovebox
 14 10 -1.29e-3 20 -21  30 -31   5 -19         $ L-B    Glovebox
 15 10 -1.29e-3 21 -28  30 -31   5 -19         $ Behind Glovebox
 16 10 -1.29e-3 28 -29  30 -31   5 -19         $ R-B    Glovebox
 17 10 -1.29e-3 28 -29  31 -38   5 -19         $ Right  Glovebox
 18 10 -1.29e-3 20 -42  38 -39   5 -19         $ Front  Glovebox
 19 10 -1.29e-3 42 -43  38 -44   5 -19         $ Front  Glovebox
 20 10 -1.29e-3 43 -29  38 -39   5 -19         $ Front  Glovebox
 21 10 -1.29e-3 42 -43  44 -45   5 -40         $ Bot Outer  3/4"
 22 10 -1.29e-3 42 -43  45 -46   5 -40         $ Bot Middle 1.0"
 23 10 -1.29e-3 42 -43  46 -47   5 -40         $ Bot Inner  3/4"
 24 10 -1.29e-3 42 -43  47 -48   5 -40         $ Bot Inside 1/4"
 25 10 -1.29e-3 42 -43  44 -45  40 -41         $ Top Outer  3/4"
 26 10 -1.29e-3 42 -43  45 -46  40 -41         $ Top Middle 1.0"
 27 10 -1.29e-3 42 -43  46 -47  40 -41         $ Top Inner  3/4"
 28 10 -1.29e-3 42 -43  47 -48  40 -41         $ Top Inside 1/4"
 29 10 -1.29e-3 42 -43  44 -48  41 -19         $ Above Shield
 30 10 -1.29e-3 42 -43  48 -39   5 -41         $ Behind n Shield
 31 10 -1.29e-3 42 -43  48 -39  41 -19         $ Behind n Shield
 32 11 -2.30    20 -29  30 -39   4  -5         $ Concrete Floor
 33  0          29:-20: 39:-30: -4: 19         $ OUTSIDE WORLD

  1       cz    7.7610      $ FEED TANK O.R. - (5/16"-0.040")
  2       cz    8.4534      $ FEED TANK O.R.
  3       cz   14.2875      $ FEED TANK FLANGE O.R.
  4       pz  -60.9600      $ CONCRETE FLOOR bottom (24" thick)
  5       pz    0.0000      $ CONCRETE FLOOR surface
  6       pz   86.3600      $ GLOVEBOX bottom surface
  7       pz   86.5981      $ GLOVEBOX Stainless Steel (3/32")
  8       pz   87.0744      $ GLOVEBOX Lead Shield (3/16")
  9       pz   87.3125      $ GLOVEBOX Stainless Steel (3/32")
 10       pz  171.4500      $ FEED TANK Bottom Flange bottom
 11       pz  171.7200      $ FEED TANK Bottom Flange top
 12       pz  224.5663      $ FEED TANK Solution level (10 L)
 13       pz  233.6800      $ FEED TANK Top    Flange bottom
 14       pz  234.9500      $ FEED TANK Top    Flange top
 15       pz  265.7475      $ GLOVEBOX top inside surface
 16       pz  265.9856      $ GLOVEBOX Stainless Steel (3/32")
 17       pz  266.4619      $ GLOVEBOX Lead Shield (3/16")
 18       pz  266.7000      $ GLOVEBOX Stainless Steel (3/32")
 19       pz  366.7000      $ MODEL TOP (GB roof +100 cm)
 20       px -321.6150      $ MODEL LEFT SIDE (GB side +100 cm)
 21       px -221.6150      $ GLOVEBOX left   surface
 22       px -221.3769      $ GLOVEBOX Stainless Steel (3/32")
 23       px -220.9006      $ GLOVEBOX Lead Shield (3/16")
 24       px -220.6625      $ GLOVEBOX Stainless Steel (3/32")
 25       px   39.6875      $ GLOVEBOX right inside surface
 26       px   39.9256      $ GLOVEBOX Stainless Steel (3/32")
 27       px   40.4019      $ GLOVEBOX Lead Shield (3/16")
 28       px   40.6400      $ GLOVEBOX Stainless Steel (3/32")
 29       px  231.1400      $ MODEL RIGHT SIDE (GB side +75")
 30       py -122.2250      $ MODEL BACK SIDE (GB back +100 cm)
 31       py  -22.2250      $ GLOVEBOX back   surface
 32       py  -21.9869      $ GLOVEBOX Stainless Steel (3/32")
 33       py  -21.5106      $ GLOVEBOX Lead Shield (3/16")
 34       py  -21.2725      $ GLOVEBOX Stainless Steel (3/32")
 35       py   82.5500      $ GLOVEBOX front inside surface
 36       py   82.7881      $ GLOVEBOX Stainless Steel (3/32")
 37       py   83.2644      $ GLOVEBOX Lead Shield (3/16")
 38       py   83.5025      $ GLOVEBOX Stainless Steel (3/32")
 39       py  327.3425      $ MODEL FRONT SIDE (GB front +96")
 40       pz  152.40        $ 5' High  n Shield
 41       pz  213.36        $ +2' Top  n Shield
 42       px -125.00        $ Left End  n Shield
 43       px  175.00        $ Right End n Shield
 44       py  198.4375      $ 3/4" n Shield Material
 45       py  200.3425      $ 1.0" n Shield Material
 46       py  202.8825      $ 3/4" n Shield Material
 47       py  204.7875      $ 1/4" n Shield Material
 48       py  205.4225      $ Operator Side n Shield
 49       c/z  -168.5925  29.8450  4.6038 $ Receipt Can Inside Radius
 50       c/z  -168.5925  29.8450  4.7625 $ Receipt Can Outside Radius
 51       pz    87.4712     $ Receipt Can Stainless Steel Floor
 52       pz    98.7425     $ Receipt Can Height
 53       c/z  -168.5925  29.8450  5.0006 $ Latex Glove Inside Radius
 54       c/z  -168.5925  29.8450  7.5406 $ Water Hand  Outside Radius
 55       c/z  -168.5925  29.8450  7.7788 $ Latex Glove Outside Radius

mode     n p
imp:n    1 31r 0
imp:p    1 31r 0
c   wgt =  3600*105      =  378000 Low  240 Pu
c   wgt =  3600*215      =  774000 Mid  240 Pu
c   wgt =  3600*295      = 1062000 High 240 Pu
sdef      cel=1    erg= d2   pos = -168.5925 29.8450 0
          rad= d3  ext= d4   axs = 0 0 1  wgt=1062000.
sc2    (alpha,n) and fission spectrum
```

```
si2     s     35     36
sp2       0.504 0.496
sc3     radius
si3     4.6038
sp3     -21 1
sc4     extent
si4      87.4712   98.7425
sp4     -21 0
sc35    (alpha,n) neutron source on OXYGEN from Jacom and Liskien
c        Energy of the alpha particles = 5.5 MeV
#         si35        sp35
            0.0         0.00
            0.1         0.68
            0.2         0.76
            0.3         0.74
            0.4         0.88
            0.5         1.20
            0.6         1.35
            0.7         1.48
            0.8         1.62
            0.9         1.55
            1.0         1.28
            1.1         1.34
            1.2         1.45
            1.3         1.63
            1.4         1.76
            1.5         1.80
            1.6         1.89
            1.7         2.05
            1.8         2.28
            1.9         2.37
            2.0         2.49
            2.1         2.50
            2.2         2.61
            2.3         2.65
            2.4         2.54
            2.5         2.43
            2.6         2.34
            2.7         2.73
            2.8         2.06
            2.9         2.00
            3.0         1.88
            3.1         1.66
            3.2         1.56
            3.3         1.34
            3.4         1.09
            3.5         0.92
            3.6         0.79
            3.7         0.64
            3.8         0.55
            3.9         0.48
            4.0         0.39
            4.1         0.35
            4.2         0.23
            4.3         0.18
            4.4         0.11
            4.5         0.07
sc36    spontaneous fission source spectrum (Pu240)
sp36     -3  0.799  4.903   $ Watt Fisson Spectrum
m1     94239.55c -0.197551   7014.50c -0.047731   8016.50c -0.682422
        1001.50c -0.065371  $ Pu(NO3)4 711.69 g/L, H2O 1000 g/L.
mt1      lwtr.01t                    $ hydrogen in liquid
m2     94238.50c -0.000089  94239.55c -0.823090  94240.50c -0.054516
       94241.50c -0.002316  94242.50c -0.000356  95241.50c -0.001603
        8016.50c -0.118030  $ PuO2 for Low 240 Weight % [CALCINE2.WQ1]
m3     94238.50c -0.001312  94239.55c -0.748841  94240.50c -0.108876
       94241.50c -0.010494  94242.50c -0.003236  95241.50c -0.009270
        8016.50c -0.117971  $ PuO2 for Med 240 Weight % [CALCINE2.WQ1]
m4     94238.50c -0.001559  94239.55c -0.693581  94240.50c -0.154553
       94241.50c -0.010569  94242.50c -0.006324  95241.50c -0.015507
        8016.50c -0.117907  $ PuO2 for High 240 Weight % [CALCINE2.WQ1]
m5     14000.50c -0.376753   5010.50c -0.007986   5011.55c -0.032386
       11023.50c -0.029674  13027.50c -0.012173  19000.50c -0.000830
        8016.50c -0.540198  $ 7740 PYREX Type I Glass [CALCINE1.WQ1]
m6     26000.55c -0.74  24000.50c -0.18  28000.50c -0.08  $ SS 304L Flanges
m7     26000.55c -0.98  28000.50c -0.02  $ Stainless Steel Glovebox
m8     82000.50c -1.00                    $ Lead Glovebox Shield
m9     26000.55c      -1                  $ SS 310S
m10     7014.50c -.78084  8016.50c -0.20946  18000.35c -0.00934
        1001.50c -.00036  $ Air
mt10      lwtr.01t                   $ hydrogen in liquid, gas
m11    13027.50c -.034   20000.50c -0.044    26000.55c -0.014
        1001.50c -.001    8016.50c -0.532    14000.50c -0.337
       11023.50c -.029   $ Concrete (common Portland) ARH-600 II.F.1-3
mt11      poly.01t                   $ hydrogen in solid
m12     6000.50c -0.5925   5010.50c -0.0590   5011.55c -0.2410 $ Neutron
        1001.50c -0.0854  14000.50c -0.0101   8016.50c -0.0076 $ Shield
       26000.55c -0.0038  13027.50c -0.0004  25055.50c -0.0002 $ 210
mt12     poly.01t     grph.01t    $ hydrogen, carbon in solid (1.19 g/cm3)
m13     8016.50c -0.3649   6000.50c -0.3439  13027.50c -0.1906 $ Neutron
        1001.50c -0.0784  20000.50c -0.0123  14000.50c -0.0009 $ Shield
        5010.50c -0.00138  5011.55c -0.00562 12000.50c -0.0006 $ 207
       11023.50c -0.0006  39089.50c -0.0005  26000.55c -0.0001
       19000.50c -0.0001  16032.50c -0.0001 $ Y89 substituted for Sr.
mt13     poly.01t     grph.01t    $ hydrogen, carbon in solid (1.4 g/cm3)
m14     6000.50c -0.5999   8016.50c -0.3196   1001.50c -0.0805 $ Lucite
mt14     poly.01t                 $ hydrogen in solid (1.2 g/cm3)
m15     6000.50c -0.64  1001.50c -0.07  8016.50c -0.29 $ LATEX 1.1 g/cm3
mt15     poly.01t     grph.01t    $ hydrogen, carbon in solid (1.1 g/cm3)
m16     1001.50c 0.333333  8016.50c 0.666667   $ Water Hands (1.00 g/cm3)
mt16      lwtr.01t                   $ hydrogen in liquid, gas
c      Neutron dose conversion factors from ANS 6.1.1 1991
de0     2.50e-08  1.00e-07  1.00e-06  1.00e-05  1.00e-04  1.00e-03
        1.00e-02  2.00e-02  5.00e-02  1.00e-01  2.00e-01  5.00e-01
        1.00e+00  1.50e+00  2.00e+00  3.00e+00  4.00e+00  5.00e+00
        6.00e+00  7.00e+00  8.00e+00  1.00e+01  1.40e+01
df0     1.440e-03 1.584e-03 1.735e-03 1.606e-03 1.490e-03 1.379e-03
        1.631e-03 2.113e-03 3.924e-03 7.128e-03 1.390e-02 3.132e-02
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         5.148e-02 6.588e-02 7.704e-02 9.504e-02 1.080e-01 1.177e-01
         1.249e-01 1.314e-01 1.368e-01 1.476e-01 1.728e-01
c      Neutron dose conversion factors from ANS 6.1.1 1977
de4      2.5e-08   1.0e-07   1.0e-06   1.0e-05   1.0e-04   1.0e-03
         1.0e-02   1.0e-01   5.0e-01   1.0       2.5       5.0
         7.0       10.0      14.0      20.0
df4      3.670e-03 3.670e-03 4.460e-03 4.540e-03 4.180e-03 3.760e-03
         3.560e-03 2.170e-02 9.260e-02 1.320e-01 1.250e-01 1.560e-01
         1.470e-01 1.470e-01 2.080e-01 2.270e-01
fc4      dose in hands modeled by water 1 inch thick  (Cell 5)
f4:n     5
c      Photon dose conversion factors from ANS 6.1.1 1977
de14  log 0.01      0.03      0.05      0.07      0.10      0.15
          0.20      0.25      0.30      0.35      0.40      0.45
          0.50      0.55      0.60      0.65      0.70      0.80
          1.00      1.40      1.80      2.20      2.60      2.80
          3.25      3.75      4.25      4.75      5.00      5.25
          5.75      6.25      6.75      7.50      9.00      11.00
          13.00     15.00
df14  log 3.960e-03 5.820e-04 2.900e-04 2.580e-04 2.830e-04 3.790e-04
          5.010e-04 6.310e-04 7.590e-04 8.780e-04 9.850e-04 1.080e-03
          1.170e-03 1.270e-03 1.360e-03 1.440e-03 1.520e-03 1.680e-03
          1.980e-03 2.510e-03 2.990e-03 3.420e-03 3.820e-03 4.010e-03
          4.410e-03 4.830e-03 5.230e-03 5.600e-03 5.800e-03 6.010e-03
          6.370e-03 6.740e-03 7.110e-03 7.660e-03 8.770e-03 1.030e-02
          1.180e-02 1.330e-02
fc14     dose in hands modeled by water 1 inch thick  (Cell 5)
f14:p    5
fc15     dose at 30 cm from outside surface of Receipt Can
c        Y Dist = 30.0 + 4.6038 + 29.8450 = 64.4488 cm
f15:n    -168.5925  64.4488  93.10685    0
fm15     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc25     dose at 30 cm from outside surface of Glovebox
c        Y Dist = 30.0 + 83.5025 = 113.5025 cm
f25:n    -168.5925  113.5025  93.10685   0
fm25     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc35     dose at 5 feet from outside surface of Glovebox
c        Y Dist = 152.8 + 83.5025 = 235.9025 cm
f35:n    -168.5925  235.9025  93.10685   0
fm35     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc45     dose at  6 in. in front of lower n Shield
c        Total Dist from outside = 198.4375 - 6*2.54 = 183.1975 cm
f45:n     0 183.1975 135.0   0
fm45     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc55     dose in middle of outer 3/4" PYREX n Shield
c        Total Dist from outside = (198.4375 + 200.3425)/2 = 199.3900 cm
f55:n     0 199.3900 135.0   0
fm55     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc65     dose in middle of 1.0" n Shield
c        Total Dist from outside = (200.3425 + 202.8825)/2 = 201.6125 cm
f65:n     0 201.6125 135.0   0
fm65     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc75     dose in middle of inner 3/4" PYREX n Shield
c        Total Dist from outside = (202.8825 + 204.7875)/2 = 203.8350 cm
f75:n     0 203.8350 135.0   0
fm75     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc85     dose in middle of inside 1/4" n Shield
c        Total Dist from outside = (204.7875 + 205.4225)/2 = 205.1050 cm
f85:n     0 205.1050 135.0   0
fm85     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc95     dose at 6 in. behind inside n Shield
c        Total Dist from outside = 205.4225 + 6*2.54 = 220.6225 cm
f95:n     0 220.6625 135.0   0
fm95     2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc105    dose at  6 in. in front of upper n Shield
c        Total Dist from outside = 198.4375 - 6*2.54 = 183.1975 cm
f105:n    0 183.1975 200.0   0
fm105    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc115    dose in middle of outer 3/4" PYREX n Shield
c        Total Dist from outside = (198.4375 + 200.3425)/2 = 199.3900 cm
f115:n    0 199.3900 200.0   0
fm115    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc125    dose in middle of 1.0" n Shield
c        Total Dist from outside = (200.3425 + 202.8825)/2 = 201.6125 cm
f125:n    0 201.6125 200.0   0
fm125    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc135    dose in middle of inner 3/4" PYREX n Shield
c        Total Dist from outside = (202.8825 + 204.7875)/2 = 203.8350 cm
f135:n    0 203.8350 200.0   0
fm135    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc145    dose in middle of inside 1/4" n Shield
c        Total Dist from outside = (204.7875 + 205.4225)/2 = 205.1050 cm
f145:n    0 205.1050 200.0   0
fm145    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
fc155    dose at 6 in. behind inside n Shield
c        Total Dist from outside = 205.4225 + 6*2.54 = 220.6225 cm
f155:n    0 220.6625 200.0   0
fm155    2.0            $ Factor of 2 times the ANS 6.1.1 1991 Standard.
print    10 110 120
ctme     90.0
nps      1.0e5
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CRCHO2P.INP   3.6 kg Pu Receipt Can with Hands, gamma ray calculation

PHOTON  Dose Rate Calcs for calciner
c      Hi 240Pu PuO2 Receipt Can Neutron Source is in Cell 1
c               xx -xx  yy -yy  zz -zz  rr -rr imp:p=  $
   1  4 -5.438                  51 -52     -49 imp:p=1 $ Hi 240PuO2
   2  9 -7.84                    9 -51     -49 imp:p=1 $ Can SS Bot
   3  9 -7.84                    9 -52  49 -50 imp:p=1 $ Can SS Walls
   4 15 -1.10                    9 -52  50 -53 imp:p=1 $ Latex layer
   5 16 -1.00                    9 -52  53 -54 imp:p=1 $ Water Hands
   6 15 -1.10                    9 -52  54 -55 imp:p=1 $ Latex layer
   7 10 -1.29e-3 24 -25  34 -35 9 -15 (52:55)   imp:p=1 $ Inside Glovebox
   8  7 -7.84 23 -26 33 -36 8 -16(-24:25:-34:35:-9:15) imp:p=1 $ SS Inside
   9 8 -11.34 22 -27 32 -37 7 -17(-23:26:-33:36:-8:16) imp:p=1 $ Lead
Shield
  10  7 -7.84 21 -28 31 -38 6 -18(-22:27:-32:37:-7:17) imp:p=1 $ SS Outside
  11 10 -1.29e-3 21 -28  31 -38   5  -6        imp:p=1 $ Under  Glovebox
  12 10 -1.29e-3 21 -28  31 -38  18 -19        imp:p=1 $ Over   Glovebox
  13 10 -1.29e-3 20 -21  31 -38   5 -19        imp:p=1 $ Left   Glovebox
  14 10 -1.29e-3 20 -21  30 -31   5 -19        imp:p=1 $ L-B    Glovebox
  15 10 -1.29e-3 21 -28  30 -31   5 -19        imp:p=1 $ Behind Glovebox
  16 10 -1.29e-3 28 -29  30 -31   5 -19        imp:p=1 $ R-B    Glovebox
  17 10 -1.29e-3 28 -29  31 -38   5 -19        imp:p=1 $ Right  Glovebox
  18 10 -1.29e-3 20 -42  38 -39   5 -19        imp:p=1 $ Front  Glovebox
  19 10 -1.29e-3 42 -43  38 -44   5 -19        imp:p=1 $ Front  Glovebox
  20 10 -1.29e-3 43 -29  38 -39   5 -19        imp:p=1 $ Front  Glovebox
  21 10 -1.29e-3 42 -43  44 -45   5 -40        imp:p=1 $ Bot Outer  3/4"
  22 10 -1.29e-3 42 -43  45 -46   5 -40        imp:p=1 $ Bot Middle 1.0"
  23 10 -1.29e-3 42 -43  46 -47   5 -40        imp:p=1 $ Bot Inner  3/4"
  24 10 -1.29e-3 42 -43  47 -48   5 -40        imp:p=1 $ Bot Inside 1/4"
  25 10 -1.29e-3 42 -43  44 -45  40 -41        imp:p=1 $ Top Outer  3/4"
  26 10 -1.29e-3 42 -43  45 -46  40 -41        imp:p=1 $ Top Middle 1.0"
  27 10 -1.29e-3 42 -43  46 -47  40 -41        imp:p=1 $ Top Inner  3/4"
  28 10 -1.29e-3 42 -43  47 -48  40 -41        imp:p=1 $ Top Inside 1/4"
  29 10 -1.29e-3 42 -43  44 -48  41 -19        imp:p=1 $ Above Shield
  30 10 -1.29e-3 42 -43  48 -39   5 -41        imp:p=1 $ Behind n Shield
  31 10 -1.29e-3 42 -43  48 -39  41 -19        imp:p=1 $ Behind n Shield
  32 11 -2.30      20 -29  30 -39   4  -5        imp:p=1 $ Concrete Floor
  33  0            29:-20: 39:-30: -4: 19        imp:p=0 $ OUTSIDE WORLD

   1       cz     7.7610      $ FEED TANK O.R. - (5/16"-0.040")
   2       cz     8.4534      $ FEED TANK O.R.
   3       cz    14.2875      $ FEED TANK FLANGE O.R.
   4       pz   -60.9600      $ CONCRETE FLOOR bottom (24" thick)
   5       pz     0.0000      $ CONCRETE FLOOR surface
   6       pz    86.3600      $ GLOVEBOX bottom surface
   7       pz    86.5981      $ GLOVEBOX Stainless Steel (3/32")
   8       pz    87.0744      $ GLOVEBOX Lead Shield (3/16")
   9       pz    87.3125      $ GLOVEBOX Stainless Steel (3/32")
  10       pz   171.4500      $ FEED TANK Bottom Flange bottom
  11       pz   171.7200      $ FEED TANK Bottom Flange top
  12       pz   224.5663      $ FEED TANK Solution level (10 L)
  13       pz   233.6800      $ FEED TANK Top    Flange bottom
  14       pz   234.9500      $ FEED TANK Top    Flange top
  15       pz   265.7475      $ GLOVEBOX top inside surface
  16       pz   265.9856      $ GLOVEBOX Stainless Steel (3/32")
  17       pz   266.4619      $ GLOVEBOX Lead Shield (3/16")
  18       pz   266.7000      $ GLOVEBOX Stainless Steel (3/32")
  19       pz   366.7000      $ MODEL TOP (GB roof +100 cm)
  20       px  -321.6150      $ MODEL LEFT SIDE (GB side +100 cm)
  21       px  -221.6150      $ GLOVEBOX left   surface
  22       px  -221.3769      $ GLOVEBOX Stainless Steel (3/32")
  23       px  -220.9006      $ GLOVEBOX Lead Shield (3/16")
  24       px  -220.6625      $ GLOVEBOX Stainless Steel (3/32")
  25       px    39.6875      $ GLOVEBOX right inside surface
  26       px    39.9256      $ GLOVEBOX Stainless Steel (3/32")
  27       px    40.4019      $ GLOVEBOX Lead Shield (3/16")
  28       px    40.6400      $ GLOVEBOX Stainless Steel (3/32")
  29       px   231.1400      $ MODEL RIGHT SIDE (GB side +75")
  30       py  -122.2250      $ MODEL BACK SIDE (GB back +100 cm)
  31       py   -22.2250      $ GLOVEBOX back   surface
  32       py   -21.9869      $ GLOVEBOX Stainless Steel (3/32")
  33       py   -21.5106      $ GLOVEBOX Lead Shield (3/16")
  34       py   -21.2725      $ GLOVEBOX Stainless Steel (3/32")
  35       py    82.5500      $ GLOVEBOX front inside surface
  36       py    82.7881      $ GLOVEBOX Stainless Steel (3/32")
  37       py    83.2644      $ GLOVEBOX Lead Shield (3/16")
  38       py    83.5025      $ GLOVEBOX Stainless Steel (3/32")
  39       py   327.3425      $ MODEL FRONT SIDE (GB front +96")
  40       pz   152.40        $ 5' High  n Shield
  41       pz   213.36        $ +2' Top  n Shield
  42       px  -125.00        $ Left End  n Shield
  43       px   175.00        $ Right End n Shield
  44       py   198.4375      $ 3/4" n Shield Material
  45       py   200.3425      $ 1.0" n Shield Material
  46       py   202.8825      $ 3/4" n Shield Material
  47       py   204.7875      $ 1/4" n Shield Material
  48       py   205.4225      $ Operator Side n Shield
  49       c/z  -168.5925  29.8450  4.6038 $ Receipt Can Inside Radius
  50       c/z  -168.5925  29.8450  4.7625 $ Receipt Can Outside Radius
  51       pz    87.4712      $ Receipt Can Stainless Steel Floor
  52       pz    98.7425      $ Receipt Can Height
  53       c/z  -168.5925  29.8450  5.0006 $ Latex Glove Inside Radius
  54       c/z  -168.5925  29.8450  7.5406 $ Water Hand  Outside Radius
  55       c/z  -168.5925  29.8450  7.7788 $ Latex Glove Outside Radius

mode    p
c   wgt =  3600*3.169E+8 = 1.141E+12  Low  240 Pu
c   wgt =  3600*1.115E+9 = 4.014E+12  Mid  240 Pu
c   wgt =  3600*1.682E+9 = 6.055E+12  High 240 Pu
sdef     cel=1   erg= d5   pos = -168.5925 29.8450 0
         rad= d3   ext= d4   axs = 0 0 1  wgt=6.055E+12
sc2     (alpha,n) and fission spectrum
si2      s     35      36
sp2        0.504 0.496
sc3      radius
si3      4.6038
sp3      -21 1
```

```
sc4    extent
si4     87.4712   98.7425
sp4    -21 0
sc5    photon source from ORIGEN2
c        TOTAL PHOTON SPECTRUM
#         si5            sp5         sb5
       0.0            0.0            0
       1.5000e-02     8.9240e+08     200790
       2.5000e-02     4.9830e+07     31144
       3.7500e-02     4.6240e+06     6503
       5.7500e-02     7.3350e+08     2425134
       8.5000e-02     6.1780e+05     4464
       1.2500e-01     7.0030e+05     10942
       2.2500e-01     7.9320e+04     4016
       3.7500e-01     1.2800e+05     18000
       5.7500e-01     1.7600e+04     5819
       8.5000e-01     5.1220e+03     3701
       1.2500e+00     1.6370e+02     256
       1.7500e+00     7.2840e+01     223
       2.2500e+00     4.1830e+01     212
       2.7500e+00     2.4080e+01     182
       3.5000e+00     2.1360e+01     262
       5.0000e+00     9.0380e+00     226
       7.0000e+00     1.0250e+00     50
       1.1000e+01     1.1690e-01     14
c        TOTAL        1.6820e+09
sc35   (alpha,n) neutron source on OXYGEN from Jacom and Liskien
c       Energy of the alpha particles = 5.5 MeV
#         si35         sp35
           0.0         0.00
           0.1         0.68
           0.2         0.76
           0.3         0.74
           0.4         0.88
           0.5         1.20
           0.6         1.35
           0.7         1.48
           0.8         1.62
           0.9         1.55
           1.0         1.28
           1.1         1.34
           1.2         1.45
           1.3         1.63
           1.4         1.76
           1.5         1.80
           1.6         1.89
           1.7         2.05
           1.8         2.28
           1.9         2.37
           2.0         2.49
           2.1         2.50
           2.2         2.61
           2.3         2.65
           2.4         2.54
           2.5         2.43
           2.6         2.34
           2.7         2.73
           2.8         2.06
           2.9         2.00
           3.0         1.88
           3.1         1.66
           3.2         1.56
           3.3         1.34
           3.4         1.09
           3.5         0.92
           3.6         0.79
           3.7         0.64
           3.8         0.55
           3.9         0.48
           4.0         0.39
           4.1         0.35
           4.2         0.23
           4.3         0.18
           4.4         0.11
           4.5         0.07
sc36    spontaneous fission source spectrum (Pu240)
sp36     -3  0.799  4.903   $ Watt Fisson Spectrum
m1     94239. -0.197551   7014. -0.047731   8016. -0.682422
        1001. -0.065371  $ Pu(NO3)4 711.69 g/L, H20 1000 g/L.
m2     94238. -0.000089  94239. -0.823090  94240. -0.054516
       94241. -0.002316  94242. -0.000356  95241. -0.001603
        8016. -0.118030  $ PuO2 for Low 240 Weight % [CALCINE2.WQ1]
m3     94238. -0.001312  94239. -0.748841  94240. -0.108876
       94241. -0.010494  94242. -0.003236  95241. -0.009270
        8016. -0.117971  $ PuO2 for Med 240 Weight % [CALCINE2.WQ1]
m4     94238. -0.001559  94239. -0.693581  94240. -0.154553
       94241. -0.010569  94242. -0.006324  95241. -0.015507
        8016. -0.117907  $ PuO2 for High 240 Weight % [CALCINE2.WQ1]
m5     14000. -0.376753   5010. -0.007986   5011. -0.032386
       11023. -0.029674  13027. -0.012173  19000. -0.000830
        8016. -0.540198  $ 7740 PYREX Type I Glass [CALCINE1.WQ1]
m6     26000. -0.74  24000. -0.18  28000. -0.08  $ SS 304L Flanges
m7     26000. -0.98  28000. -0.02  $ Stainless Steel Glovebox
m8     82000. -1.00                 $ Lead Glovebox Shield
m9     26000.      -1               $ SS 310S
m10     7014. -.78084  8016. -0.20946  18000. -0.00934
        1001. -.00036  $ Air
m11    13027. -.034    20000. -0.044    26000. -0.014
        1001. -.001     8016. -0.532    14000. -0.337
       11023. -.029    $ Concrete (common Portland) ARH-600 II.F.1-3
m12     6000. -0.5925    5010. -0.0590    5011. -0.2410 $ Neutron
        1001. -0.0854  14000. -0.0101    8016. -0.0076 $ Shield
       26000. -0.0038  13027. -0.0004  25055. -0.0002 $ 210
m13     8016. -0.3649    6000. -0.3439  13027. -0.1906 $ Neutron
        1001. -0.0784  20000. -0.0123  14000. -0.0009 $ Shield
        5010. -0.00138  5011. -0.00562 12000. -0.0006 $ 207
       11023. -0.0006  39089. -0.0005  26000. -0.0001
       19000. -0.0001  16032. -0.0001 $ Y89 substituted for Sr.
```

```
m14     6000. -0.5999   8016. -0.3196   1001. -0.0805 $ Lucite
m15     6000. -0.64  1001. -0.07  8016. -0.29 $ LATEX 1.1 g/cm3
m16     1001. 0.333333  8016. 0.666667   $ Water Hands (1.00 g/cm3)
c      Photon dose conversion factors from ANS 6.1.1 1991
de0     log 0.010     0.015      0.02       0.03       0.04       0.05
            0.06      0.08       0.10       0.15       0.2        0.3
            0.4       0.5        0.6        0.8        1.0        1.5
            2.0       3.0        4.0        5.0        6.0        8.0
           10.0      12.0
df0     log 2.232e-05 5.652e-05 8.568e-05 1.184e-04 1.314e-04 1.382e-04
            1.440e-04 1.624e-04 1.919e-04 2.797e-04 3.708e-04 5.616e-04
            7.416e-04 9.144e-04 1.076e-03 1.379e-03 1.656e-03 2.246e-03
            2.758e-03 3.672e-03 4.500e-03 5.292e-03 6.012e-03 7.488e-03
            8.892e-03 1.040e-02
c      Photon dose conversion factors from ANS 6.1.1 1977
de4     log 0.01      0.03       0.05       0.07       0.10       0.15
            0.20      0.25       0.30       0.35       0.40       0.45
            0.50      0.55       0.60       0.65       0.70       0.80
            1.00      1.40       1.80       2.20       2.60       2.80
            3.25      3.75       4.25       4.75       5.00       5.25
            5.75      6.25       6.75       7.50       9.00      11.00
           13.00     15.00
df4     log 3.960e-03 5.820e-04 2.900e-04 2.580e-04 2.830e-04 3.790e-04
            5.010e-04 6.310e-04 7.590e-04 8.780e-04 9.850e-04 1.080e-03
            1.170e-03 1.270e-03 1.360e-03 1.440e-03 1.520e-03 1.680e-03
            1.980e-03 2.510e-03 2.990e-03 3.420e-03 3.820e-03 4.010e-03
            4.410e-03 4.830e-03 5.230e-03 5.600e-03 5.800e-03 6.010e-03
            6.370e-03 6.740e-03 7.110e-03 7.660e-03 8.770e-03 1.030e-02
            1.180e-02 1.330e-02
fc4     dose in hands modeled by water 1 inch thick  (Cell 5)
f4:p      5
fc5     dose at 30 cm from outside surface of Receipt Can
c       Y Dist = 30.0 + 4.6038 + 29.8450 = 64.4488 cm
f5:p     -168.5925  64.4488  93.10685    0
fc15    dose at 30 cm from outside surface of Glovebox
c       Y Dist = 30.0 + 83.5025 = 113.5025 cm
f15:p    -168.5925  113.5025  93.10685   0
fc25    dose at 5 feet from outside surface of Glovebox
c       Y Dist = 152.8 + 83.5025 = 235.9025 cm
f25:p    -168.5925  235.9025  93.10685   0
fc35    dose at  6 in. in front of lower n Shield
c       Total Dist from outside = 198.4375 - 6*2.54 = 183.1975 cm
f35:p     0 183.1975 135.0   0
fc45    dose in middle of outer 3/4" PYREX n Shield
c       Total Dist from outside = (198.4375 + 200.3425)/2 = 199.3900 cm
f45:p     0 199.3900 135.0   0
fc55    dose in middle of 1.0" n Shield
c       Total Dist from outside = (200.3425 + 202.8825)/2 = 201.6125 cm
f55:p     0 201.6125 135.0   0
fc65    dose in middle of inner 3/4" PYREX n Shield
c       Total Dist from outside = (202.8825 + 204.7875)/2 = 203.8350 cm
f65:p     0 203.8350 135.0   0
fc75    dose in middle of inside 1/4" n Shield
c       Total Dist from outside = (204.7875 + 205.4225)/2 = 205.1050 cm
f75:p     0 205.1050 135.0   0
fc85    dose at 6 in. behind inside n Shield
c       Total Dist from outside = 205.4225 + 6*2.54 = 220.6225 cm
f85:p     0 220.6625 135.0   0
fc95    dose at  6 in. in front of upper n Shield
c       Total Dist from outside = 198.4375 - 6*2.54 = 183.1975 cm
f95:p     0 183.1975 200.0   0
fc105    dose in middle of outer 3/4" PYREX n Shield
c       Total Dist from outside = (198.4375 + 200.3425)/2 = 199.3900 cm
f105:p    0 199.3900 200.0   0
fc115    dose in middle of 1.0" n Shield
c       Total Dist from outside = (200.3425 + 202.8825)/2 = 201.6125 cm
f115:p    0 201.6125 200.0   0
fc125    dose in middle of inner 3/4" PYREX n Shield
c       Total Dist from outside = (202.8825 + 204.7875)/2 = 203.8350 cm
f125:p    0 203.8350 200.0   0
fc135    dose in middle of inside 1/4" n Shield
c       Total Dist from outside = (204.7875 + 205.4225)/2 = 205.1050 cm
f135:p    0 205.1050 200.0   0
fc145    dose at 6 in. behind inside n Shield
c       Total Dist from outside = 205.4225 + 6*2.54 = 220.6225 cm
f145:p    0 220.6625 200.0   0
print   10 110 120
ctme  90.0
nps    3.e6
```

APPENDIX E

MISCELLANEOUS REFERENCE PAGES

Calciner Shield Wall Specifications

7740 Corning Trademark PYREX®[5] Composition for Feed Tank Glass

Physical Properties Glass Composition of Code 7740 Glass

Physical Dimensions of Glass Pipe Straight Lengths

Plutonium Nitrate Feed material composition by Jerome F. Durnil

Material Data for Borated Polyethylene products 210, 207 by Scott Huneycutt

[5]PYREX is a registered trademark of the Corning Company.

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Calciner Shield Wall Specifications.

Scope
A shield wall will need to be constructed to minimize the dose from the calciner components to the worker located at the calciner control panel. The upper portion of this wall will need to be transparent for security purposes.

Design Criteria
The optimum design for a shield to reduce exposure from neutron radiation should consist of three layers. The first layer, the layer closest to the neutron source, should be a hydrogenous material to thermalize the neutron energy spectra. The second layer should be a Borated material to capture the thermal neutrons. The third layer, the layer most distant from the neutron source, should be a high Z material, such as steel or lead, to attenuate the gamma rays produced from the capture of the neutrons in the Borated material.

Note:
The suggested shield design is one possible configuration based on preliminary dose-rate calculations. Further analysis is being conducted.

Due to security and fire safety requirements, this shield wall will have a slightly different layer configuration.
Lower Portion (approximately 5 feet)
The first layer of the lower portion of the shield wall, the layer closest to the calciner glovebox, should have a 19.0 mm (¾") layer of 7740 PYREX® glass. The second layer should have a 25.4 mm (1") layer of Borated Polyethylene #210 which has a 30% Boron content. The third layer should be a 6.4 mm (¼") layer of Stainless Steel.
Upper Portion (approximately 2 feet)
The first layer of the upper portion of the shield wall, the layer closest to the calciner glovebox, should have a 19.0 mm (¾") layer of 7740 PYREX® glass. The second layer should have a 25.4 mm (1") layer of clear Acrylic, Lexan, or Plexiglas. The third layer should be another layer of 19.0 mm (¾") layer of 7740 PYREX® glass. A fourth layer will be required. The fourth layer should be a 6.4 mm (¼") layer of 2.0 mm equivalent Leaded Glass.

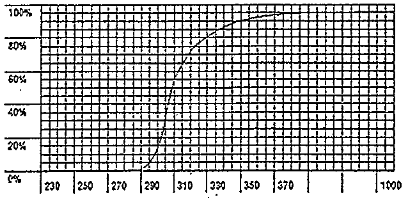
These sandwiched materials will need to be fit together in a way that no two seams line-up to produce a gap in the shield.

Materials
Listed below are some possible Vendors, their contacts and latest cost estimate, for the required materials.

Vendor	Thickness	Sheet size	Est. Price
PYREX® 7740 ABRISA Industrial Glass, Inc. John Kolinke 1456 Fleet Ave. PO Box 3053 Ventura, CA 93003 (800) 350-5000	19.0 mm (0.75")	305 mm x 610 mm (12" x 24") 845 mm x 1150 mm (33.25" x 45.25") [sheet edges are unfinished] [comes in various thicknesses (3/32" to 2 ¼")]	255.00 768.00
Borated Polyethylene Catalog # 210 Reactor Experiments, Inc. Dean White, ext. 352 1275 Hammerwood Ave. Sunnyvale, CA 94088-2231 (408) 745-6770	25.0 mm (1.0")	610 mm x 610 mm (24" x 24") 1219 mm x 1219 mm (48" x 48")	
Leaded Glass (= 2.0 mm Pb) Shielding International Bill Chisolm 182 NW Earl Street PO Box Z Madras, OR 97741-0069 (800) 292-2247	6.4 mm (0.25")	305 mm x 305 mm (12" x 12") to 914 mm x 1220 mm (36" x 48")	
Leaded Glass Hot Cell Services 22626 85th Place South Kent, WA 98031 Mike Caulkworth (206) 854-4945	6.4 mm (0.25")		

7740 Corning Trademark PYREX®[6] Composition for Feed Tank Glass

Warnings
1. Do not use in heat applications.



Wavelength (Nanometers)
Transmittance in Percent

0211 Transmittance
Approx 1 mm thick

7740
Corning Trademark:
PYREX®

Common Names
Borosilicate - Low Expansion - Type I Glass

Standards
Type I, Class A Borosilicate conforming to federal specification DD-G-54 lb and ASTM E-438. Also meets the U.S. Pharmacopoeia specs for Type I Borosilicate Glass.

Composition	(percent approx.)
SiO2	80.6%
B2O3	13.0%
Na2O	4.0%
A12O3	2.3%
K_2O → Na2O	0.1%

Properties

Coeff. of Exp.	32.5 3 1027cm/cm/°C
Strain Point	510°C
Anneal Point	560°C
Soften Point	821°C
Density	2.53 g/cm³ ← 2.23
Youngs Mod.	76 x 10³ Kg/mm2
Refract. Index	1.474 @ Sodium D Line
Temp. Limits	490°C (Extreme Service)
	230°C (Normal Service)
Max. Thermal Shock	160°C

Applications

Designed for use in all products requiring very high resistance to strong acids, alkalis and products intended for use in heat applications such as

[6]PYREX is a registered trademark of the Corning Company.

Physical Properties Glass Composition of Code 7740 Glass

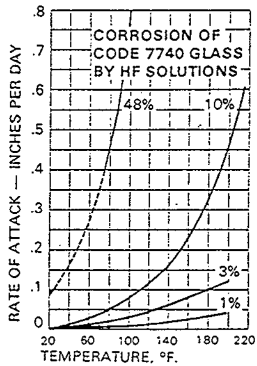
BASIC ENGINEERING DATA

CHEMICAL PROPERTIES

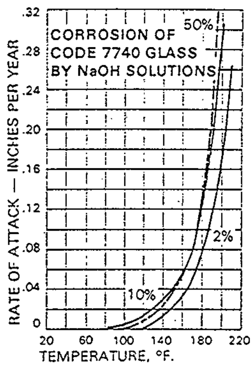
Chemical Durability

All of Corning's piping systems are resistant to more acids and acidic materials than any other pipe.

By exception there are only these chemicals to avoid: hydrofluoric acid and hot alkalies. See the two graphs for more specific data. The graphs apply only to Corning's Code 7740 glass and show order-of-magnitude data, since operating conditions greatly affect performance.



Concentrated hydrofluoric acid attacks Code 7740 glass at all temperatures. Mild solutions dumped into drainlines can be tolerated at room temperatures.



Alkaline solutions attack glass very slowly at room temperatures, but as temperature is increased over 100°F, the corrosion rate rises rapidly.

PHYSICAL PROPERTIES

Glass Composition

Physical Properties Of Code 7740 Glass

4.04 wt % B

Mole %

B 9.39
Al 0.98
K 0.28
Na ~~3~~3.25
Si 33.73
O 52.38
100.01

Composition

Corning's code 7740 low-expansion borosilicate glass has the following approximate chemical composition:

SiO_2	80.5%
Na_2O	4.0%
K_2O	0.5%
B_2O_3	13.0%
Al_2O_3	2.0%

For further details please refer to ASTM C 599, "Standard Specification for Process Glass Pipe and Fittings."

Linear Coefficient of Expansion:
(between 32°F and 572°F [0°C and 300°C], per ASTM Method E 228)

18.1×10^{-7} in/in/°F
32.5×10^{-7} cm/cm/°C

Annealing
All fittings and all straight lengths under 60" in length are annealed to reduce internal stress. This also makes the pipe under 60" easier to field fabricate.

Tempering
All pipe ends on lengths 60" and longer are tempered, the distance varying between 4" and 8" depending on the pipe system. The tempered area blends gradually into the center portion of the straight length. This is to permit pipe lengths to be cut in the central portion.

Thermal Conductivity:
0.73 Btu/hr-ft²-°F/ft
0.0035 cal/sec-cm²-°C/cm

Specific Heat:
0.20 Btu/lb-°F
0.20 cal/gm-°C

Dielectric Constant:
at 23°C and 1 M Hz, per ASTM Method D 150: 4.6 ± 0.2.

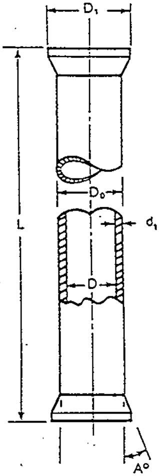
Density:
Approximately 139 lb/ft³ (2.23 gm/cm³).

Young's Modulus:
per ASTM Method C215: in the range of. 9×10^6 to 10×10^6 psi.

Physical Dimensions of Glass Pipe Straight Lengths

CONICAL SYSTEM PYREX™

PIPE



Straight Length

Pipe Size D	Pipe O.D. D₀	Cone O.D. D₁	Wall Thickness* d₁	Cone Angle A	Approx. Weight Per Foot
1" (25mm)	1⁵⁄₁₆" ±.016" (33mm ±0.4mm)	1⁹⁄₁₆" ±.016" (40mm ±0.4mm)	⁵⁄₃₂" ±.016" (4.0mm ±0.4mm)	12°	0.6 lb (0.27 kg)
1½" (38mm)	1²⁷⁄₃₂" ±.020" (47mm ±0.5mm)	2⅛" ±.016" (54mm ±0.4mm)	¹¹⁄₆₄" ±.016" (4.4mm ±0.4mm)	12°	1.0 lb (0.45 kg)
2" (51mm)	2¹¹⁄₃₂" ±.040" (60mm ±1.0mm)	2⅝" ±.020" (67mm ±0.5mm)	¹¹⁄₆₄" ±.020" (4.4mm ±0.5mm)	12°	1.13 lb (0.51 kg)
3" (76mm)	3¹³⁄₃₂" ±.056" (87mm ±1.4mm)	3²⁵⁄₃₂" ±.031" (96mm ±0.8mm)	¹³⁄₆₄" ±.021" (5.2mm ±0.5mm)	12°	2.0 lb (0.91 kg)
4" (102mm)	4¹⁷⁄₃₂" ±.068" (115mm ±1.7mm)	5²³⁄₆₄" ±.016" (136mm ±0.4mm)	¹⁷⁄₆₄" ±.025" (6.7mm ±0.6mm)	21°	3.4 lb (1.5 kg)
6" (152mm)	6²¹⁄₃₂" ±.075" (169mm ±1.9mm)	7.553" ±.016" (192mm ±0.4mm)	⁵⁄₁₆" ±.040" (7.9mm ±1.0mm)	21°	6.3 lb (2.9 kg)

Codes

Pipe Size	Minimum Length		6" L (152mm)	12" L (305mm)	18" L (457mm)	24" L (610mm)
1" (25mm)	3" (70mm)	72-1590	72-1550	72-7010	72-7015	72-7020
1½" (38mm)	3½" (89mm)	72-1600	72-1560	72-7100	72-7105	72-7110
2" (51mm)	4" (102mm)	72-1610	72-1570	72-7190	72-7195	72-7200
3" (76mm)	5" (127mm)	72-1620	72-1580	72-7280	72-7285	72-7290
4" (102mm)	6" (152mm)	72-2560	72-2560	72-7370	72-7375	72-7380
6" (152mm)	6" (152mm)	72-2610	72-2610	72-1360	72-1365	72-1380

Codes

Pipe Size	30" L (762mm)	36" L (914mm)	48" L (1219mm)	60" L (1524mm)	72" L (1829mm)	84" L (2134mm)	96" L (2438mm)	108" L (2473mm)	120" L (3048mm)
1" (25mm)	72-7540	72-7030	72-7040	72-7050	72-7500	72-7070	72-7510	72-7520	72-4500
1½" (38mm)	72-7530	72-7120	72-7130	72-7140	72-7501	72-7160	72-7511	72-7521	72-4510
2" (51mm)	72-7541	72-7210	72-7220	72-7230	72-7502	72-7250	72-7512	72-7522	72-4520
3" (76mm)	72-7542	72-7300	72-7310	72-7320	72-7503	72-7340	72-7513	72-7523	72-4530
4" (102mm)	72-7543	72-7390	72-7400	72-7410	72-7504	72-7430	72-7514	72-7524	72-4540
6" (152mm)	72-7544	72-1410	72-1430	72-1450	72-7505	72-1470	72-7515	72-7525	72-1490

Plutonium Nitrate Feed material composition by Jerome F. Durnil

---

Author: Jerome F (Jerry) Durnil at ~HANFORD03B
Date: 5/12/97 1:15 PM
Priority: Normal
TO: Scott E Huneycutt at ~HANFORD03D
TO: Warren D Wittekind at ~HANFORD02A
CC: Jerome F (Jerry) Durnil
Subject: Re: Plutonium Nitrate Feed material composition
------------------------------------ Message Contents ------------------------------------

Warren: See below.

Thanks
Jerry Durnil

Hi:

Unless there is an over-riding concern, I am going to use an assumed composition from "Calcination of Plutonium Nitrate Solution" by A.M. Stubbs, document number PFD-Z-300-001 Rev A-0.

The composition is in Table I Material Balance Flow Sheet Assumptions, page 15, which is:
250.00 gPu/L
509.37 gPu(NO3)4/L
441.07 gHNO3/L
631.54 gH2O/L
1,581.98 g/L TOTAL

OK? OK!

SpG = 1 + 0.031*[H+ M] + 0.00138*[Pu g/L]

For VDC feed sol'n:
6 % 240, 250 g Pu/L, 4 M H+ (min)
12 % 240, 150 g Pu/L, 4 M H+ (min)
22.7 % 240, 190 g Pu/L, 2 M H+ (min)

Please page me at 85-3299 or call me at 373-2150 if you need additional info.

Thanks

Jerry Durnil

Material Data for Borated Polyethylene products 210, 207 by Scott Huneycutt

---

Author: Scott E Huneycutt at ~HANFORD03D
Date: 5/6/97 1:47 PM
Priority: Normal
TO: Warren D Wittekind at ~HANFORD02A
TO: Scott E Huneycutt
Subject: material data

------------------------------------ Message Contents ------------------------------------

Warren,

Here is a percent weight distribution of the elements in the 210 and 207 Borated Polyethylene products.

210	element	percent weight	density (g/cc)
	C	59.25	1.19
	B	30.0	
	H	8.54	
	Si	1.01	
	O	0.76	
	Fe	0.38	
	Al	0.04	
	Mn	0.02	
207	H	7.84	1.4
	B	0.70	
	C	34.39	
	Al	19.06	
	Ca	1.23	
	Fe	0.01	
	K	0.01	
	Mg	0.06	
	Na	0.06	
	O	36.49	
	S	0.01	
	Si	0.09	
	Sr	0.05	

I hope these are of value.

Scott

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DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Criticality and Shielding	Date 07/17/97
Project Title/Work Order		EDT No. 620293
PFP Vertical Calciner Shield Wall Dose Rate Calculations Using MCNP		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
G.G. Bergquist	T5-55	X			
E.P. Bonadie	T5-55	X			
K.D. Dobbin	H0-35	X			
D.G. Erickson	H0-35	X			
S.R. Gedeon	H0-35	X			
M.W. Gibson	T5-55	X			
J. Greenborg	H0-35	X			
K.E. Hillesland	H0-35	X			
S.E. Huneycutt	T5-57	X			
S.F. Kessler	H0-35	X			
C.M. Kronvall	T5-15	X			
J.S. Lan	H0-35	X			
W.S. Lewis	T5-55	X			
E.M. Miller	H0-35	X			
L.T. Nirider	T5-04	X			
S.E. Nunn	T5-11	X			
L.L. Pedersen (3)	H0-35	X			
A.L. Ramble	T5-54	X			
R.F. Richards	H0-35	X			
S.P. Roblyer	H0-35	X			
R.H. Ruben	H0-35	X			
K.N. Schwinkendorf	H0-35	X			
W.T. Watson	H0-31	X			
C.L. Whalen	H8-67	X			
W.D. Wittekind (2)	H0-35	X			
Central Files	A3-88	X			