3-7-97
Sta-34 #68

ENGINEERING DATA TRANSMITTAL

1. EDT 620278

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) Environmental and Nuclear Initiatives	4. Related EDT No.:
5. Proj./Prog./Dept./Div.:	6. Design Authority/ Design Agent/Cog. Engr.: WT Watson	7. Purchase Order No.:
8. Originator Remarks: For Approval and Release.		9. Equip./Component No.:
		10. System/Bldg./Facility:
11. Receiver Remarks: 11A. Design Baseline Document? [X] Yes [] No		12. Major Assm. Dwg. No.:
		13. Permit/Permit Application No.:
		14. Required Response Date:

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	[redacted]-SD-SQA-CSA-525 HNF	All	0	CSER 96-027: Storage of Cemented Plutonium Residue Containers in 55 Gallon Drums	S	1	1	1

16. KEY

Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION
(See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
		Design Authority			
		Design Agent	[signature]	01/20/97	
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18.	19.	20.	21. DOE APPROVAL (if required)
WT Watson [signature] 1/20/97 Signature of EDT Originator Date	LT Nirider [signature] 2-03-97 Authorized Representative for Receiving Organization Date	J Greenborg [signature] 3/4/97 Design Authority/ Cognizant Manager Date	Ctrl. No. [] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-2 (05/96) GEF097

UNREVIEWED SAFETY QUESTION (USQ) SCREENING AND EVALUATION

EDT 620278 Pg 2 of 2

1. Identification Number: SWMFE-USQ-97-009	USQ SCREENING	Page 1 of 1

2. Title: CSER 97-27: Storage of Cemented Plutonium Residue Containers in 55 gallon drums

INSTRUCTIONS: Respond to each question and provide justification for each response. A restatement of the question does not constitute a satisfactory justification or basis. An adequate justification provides sufficient explanation such that an independent reviewer could reach the same conclusion based on the information provided [DOE 5480.21, 10.e.1].

QUESTIONS

1. Does the proposed change or occurrence represent a change to the facility or procedures as described in the Authorization Basis?
   [] N/A [X] No [] Yes/Maybe

   BASIS: The proposed change evaluates a waste form (cemented Pu) and demonstrates that this form meets the criticality safety requirements even when the volume of waste is <20% of the drum volume. Therefore, a 200 g limit is appropriate for this packaged waste form. The analysis conforms to the section 6.2.12 criticality safety program described in the CWC authorization basis, WHC-SD-WM-SAR-049.

2. Does the proposed change or occurrence represent conditions that have not been analyzed in the Authorization Basis?
   [] N/A [X] No [] Yes/Maybe

   BASIS: The proposed change demonstrates that this waste form packaging meets the criticality safety program as analyzed in the authorization basis.

3. Does the proposed change represent a test or experiment NOT described in the Authorization Basis that may affect the safe operation of the facility?
   [] N/A [X] No [] Yes/Maybe

   BASIS: There are no tests or experiments involved in this change.

4. Does the proposed change or occurrence represent a change to the Technical Safety Requirements or a reduction in the margin of safety defined in the Technical Safety Requirements?
   [] N/A [X] No [] Yes/Maybe

   BASIS: The criticality program administrative control (2.11) from the authorization basis TSR chapter 7 is complied with completely by the CSER analysis proposed.

USQE #1 R.M. Irwin (Print Name)

USQE #2 R. Ames (Print Name)

Matt Irwin Signature Date: 2/11/97

R. Ames Signature Date: 2/11/97

If there is a YES/MAYBE response to questions 1, 2, 3, or 4, then a USQ Evaluation must be completed.

The following guidance should be considered when completing this screening. This guidance should not be considered all-inclusive; additional factors may need to be considered depending on the nature of the proposed change.

Does the proposed change:

1) Modify, add, or delete a safety class function of a structure, system or component stated in the authorization basis?
2) Alter the design of a structure, system or component as described in the authorization basis?
3) Modify, add, or delete the description of operation, operating environment, or analyses of any system or component described in the authorization basis?
4) Modify, add, delete or conflict with any of the design bases stated in the authorization basis?
5) Conflict with the principle or general design criteria stated in the authorization basis?
6) Modify, add, or delete any plant design features described in the authorization basis?
7) Modify, add, or delete a flow diagram or facility drawing provided in the authorization basis?
8) Create the potential for new system or component interactions (e.g., seismic, electrical breaker coordination)?

CSER 96-027: Storage of Cemented Plutonium Residue Containers in 55 Gallon Drums

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U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 620278 UC: 610
Org Code: 403 Charge Code: E56008
B&R Code: Total Pages: 55

Key Words: plutonium, sand, slag, crucible, 55 gallon drum, cementation, plutonium finishing plant

Abstract: A nuclear criticality safety analysis has been performed for the storage of residual plutonium cementation containers, produced at the Plutonium Finishing Plant, in 55 gallon drums. This CSER increases the limit of total plutonium stored in each 55 gallon drum from 100 to 200 grams.

Sheri Martens 3/7/97
Release Approval Date

MAR 07 1997
DATE:
STA: 34
HANFORD RELEASE
ID: 68

Release Stamp

Approved for Public Release

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CSER-96-027

Title: CSER 96-027: Storage of Cemented Plutonium Residue Containers in 55 Gallon Drums

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1.0 INTRODUCTION

A nuclear criticality safety analysis has been performed for the 55 gallon drum storage arrangement of the residual plutonium cementation containers produced at the Plutonium Finishing Plant (PFP). The plutonium stabilization program at PFP takes Sand, Slag, and Crucible (SS&C) scrap and cements it within bagged cans. The cans are then loaded, unconstrained in position, within 55 gallon drums up to a limit for the total amount of plutonium in a given drum. The purpose of this CSER is to increase the total limit of plutonium stored in each 55 gallon drum from 100 g to 200 g.

The normal and off-normal conditions for the storage array of drums were analyzed by performing explicit calculations of the geometry and materials involved. Normal conditions were conservatively modeled by assuming the most reactive normal material composition (maximum normal moderation and material density), position of the cans within the drums, and an essentially infinite two-dimensional array of drums stacked 4 drums high. Several off-normal contingencies were analyzed. These included: plutonium over batch in a can; interspersed moderation between the drums; interspersed moderation within the drums, including an extra can within a fraction of the drums; crushing the drums because of a storage building catastrophe; and stacking the drums in 5 or 6 layers.

This evaluation demonstrates that 200 g of plutonium in cement may be safely stored in each 55-gallon drum if a number of administrative controls are maintained. Stacking the drums as many as six high is acceptable with no other contingency, while stacking the drums four high is shown to be acceptable with other contingencies. Concentrating the plutonium tends to increase the reactivity, but it has been shown that each can may contain up to 113 g of plutonium. Increasing the hydrogen content of the cement increases the reactivity, but at feasible water concentrations the storage remains safe. The steel in the drum absorbs significant fractions of thermal neutrons, thereby reducing the system reactivity. The plastic liner used in the drums acts as a neutron shield, lowering interaction between drums. Either the steel drum must be present with a mass of at least 16 kg or the polyethylene liner (0.229 cm thick) must be present.

2.0 DESCRIPTION OF SYSTEM AND FACILITY

A criticality safety evaluation has been performed for the process of stabilizing SS&C scrap for long term storage by a cementation process (Hess 1996). The SS&C scrap is mixed with cement and water within 5-1/2-in. (14 cm) inner diameter and 7-in. (17.8 cm) inner height cylindrical slip cover cans. The exact composition of the cement and the exact amount of water in each mixture is not well known. Typical cement composition for the process is documented (PFD-Z-180-00004, Slag and Crucible Dissolver Flowsheet) and the approximate amount of added cement and water are determined and recorded for each can. Table 2-1 gives the cement composition used for normal conditions. This composition actually contains a higher than average free water content according to process operations engineers. More typical compositions have contained about 8 wt% free water and hydrogen concentrations of about 2.3 wt%. The total water added to the cement should be between 25 and 32 percent of the total weight in order for the cement to cure. The cement composition is combined with the desired amount of plutonium in a can to obtain the final composition of the cemented material used in the computer model. A cemented residue bulk density of 2.059 g/cm^3 was used for all calculations. The isotope Pu-239 is used to model all plutonium in all calculations.

Table 2-1. Normal condition expected cement composition.

Compound	Weight Fraction	Element	Weight Fraction
CaF	0.102	H	0.04132
MgO	0.112	O	0.49146
$Ca(OH)_2$	0.551	F	0.03267
H_2O (unbound)	0.235	Mg	0.06779
		Ca	0.36675

The cans are made of electrolytic chrome-coated steel with a wall thickness of 0.0012 in. (0.003 cm). The composition of the can was modeled as solid steel (composition supplied by the manufacturer), ignoring the ultra-thin chrome plating. Because chrome has a larger thermal neutron absorption cross section than iron, this simplification should be conservative. The can manufacturer lists 16 elements in the can composition. Only those elements that make up at least 0.1 wt% or more of the can were considered for the model composition. Also, all trace elements in the can composition that have a thermal neutron absorption cross section larger than natural iron were replaced with iron in the model. The modeled can composition is listed in table 2-3. Each can is bagged in polyvinyl chloride (PVC) plastic of thickness 0.012 in. (0.03 cm) before being placed in the drum. Under normal operating conditions, the cans are sometimes double or triple bagged to contain contamination that is present. All cases, unless otherwise specified, were modeled with a single PVC bag containing each can.

Table 2-3. Composition of the steel can containing the cemented plutonium residue.

Element	Weight Percent
C	0.5
Al	0.1
Si	0.6
P	0.2
S	0.2
Fe	98.3
Sn	0.1

The cans are placed into 55 gallon UN1A2 drums that each have a rigid internal polyethylene liner that is 0.09 in. (0.23 cm) thick. The drum was modeled with an inner radius of 11.25 in. (28.575 cm), a wall thickness of 0.06 in. (0.15189 cm) (16 gage), and an internal height of 33.25 in. (84.455 cm). The drum material was assumed to be standard carbon steel (1% carbon) with a bulk density of 7.86 g/cm^3. This steel composition should provide a somewhat conservative estimate for the calculated reactivities because most other steels contain nickel and chromium replacing small amounts of iron and often have bulk densities closer to 8 g/cm^3. The mass of each cementation can may contain up to 2 wt% plutonium (about 113 g). This 2 wt% limit per can was established by Safeguards as the maximum concentration of plutonium for unguarded storage. The attractiveness level of low concentrations of plutonium in a cement matrix is very low. Cans are added to the drum up to the drum limit for total plutonium mass. The drums will be stacked together in an array three or four drums high for storage. It is planned to stack the drums on wooden palettes which would provide a vertical spacing of about 10 cm between the drums. For modeling purposes, the palettes and the spacing they provide has been neglected, which should produce a conservative result. The storage location is expected to be within metal-wall or concrete-wall buildings at the Hanford Site. Because the drum arrays are modeled as infinite in two dimensions, the walls are ignored in the modeling. The floor of the storage facility is assumed to be a concrete floor with a high moisture content for modeling purposes. The ceiling of the storage facility is modeled as an eight-in.-thick concrete slab placed directly above the top layer of drums.

3.0 REQUIREMENTS DOCUMENTATION

There are no unique requirements applicable to this evaluation.

4.0 METHODOLOGY

The MONK6B code was used for this analysis. MONK6B is a commercially licensed code from the British ANSWERS organization (UKEAE 1988). The MONK6B code uses pointwise cross sections from the United Kingdom Nuclear Data Library (UKNDL). It is currently verified per MONK6B quality assurance plan WHC-SD-SQA-CSWD-20017 (Miller, 1994) and validated on the SUN2 and SUN4 workstations in the science and engineering computing center (SECC). A copy of the executable code for the preferred computer platform was received from the vendor. The verification of this code was received along with the code. A description of the code validation for use on plutonium systems, such as those found in PFP is included below.

4.1 MONK VALIDATION

Validation Procedure

The validation of the method used in the analysis consists of testing the ability of the MONK6A code (UKEAE, 1988) and neutron cross-sections in calculation of known critical configurations from various benchmark experiments with plutonium as the fissile material. Such analyses determine a calculational bias (the deviation of calculated k_{eff} from unity) and the uncertainties culminating from the experimental and calculational errors.

The safety criteria for future calculations on undetermined systems requires that the bias-adjusted k_{eff} does not exceed 0.95 at the 95% confidence interval. This is expressed by the following equation:

$$k_{eff} = k_{calc} - bias + (U_b^2 + U_c^2)^{\frac{1}{2}} \leq 0.95 \tag{1}$$

where: k_{calc} = k value given by the calculation of the system
bias = mean difference (k_{calc}-1.0) for benchmark criticals
U_b = 95% confidence level uncertainty in bias determination
U_c = 95% confidence level uncertainty in new calculation.

Thus, the bias-adjusted k_{eff} includes the statistical uncertainties.

Generic Validation of Plutonium Systems

A report by Maklin and Miller (1992) presents the results of calculations to determine a generic bias for plutonium configurations, as encountered in the PFP. Seventy benchmark experiments were calculated, ranging from simple metal spheres to highly diluted (9g plutonium per liter) plutonium nitrate solution spheres, and compacts of PuO_2 blended with polystyrene. A mean k_{eff} value of 1.0047 was determined over the full experimental range, with an average standard deviation of 0.0097.

The direct calculational bias is thus +0.0047 (average k_{eff} greater than unity). Accounting for the uncertainties using tolerance limit analysis, the report then concludes that:

At least 95% of all critical experiments of this type computed by the MONK6A code will produce calculated k_{eff} values greater than 0.9857 with 95% confidence.

For a standard deviation (σ) of 0.01 or less for the convergence of a future calculation (U_c), the 0.9857 value is lowered to 0.9855. Rounded conservatively, a value of +0.015 can be used for [-bias$(U^2_b - U^2_c)^{1/2}$]. On this basis, it is determined that the true k_{eff} of an analyzed configuration with plutonium will not exceed 0.95 with a 95% confidence level if the calculated value (k_{calc}, $\sigma \leq 0.01$) is limited to a maximum of 0.935.

The 95% confidence level on 99.9% of the data is 0.9699. So a subcritical margin of 5% is 3.5% larger than the uncertainties between the 95.0% and the 99.9% coverage of the benchmark data.

Validation of MONK6B

The validation of MONK6B code on the SUN microcomputer was documented in Miller (1994). The essence of the validation was cross-correlation of calculational results obtained with this code version and computer with results for identical model input done on a CRAY machine with MONK6A. Also, the equivalence of MONK6A and MONK6B was well documented by the vendor in the verification package shipped with the software.

5.0 DISCUSSION OF CONTINGENCIES

Over batch -The volume of the can is 2.74 L and the bulk density of the cemented material is 2.059 g/cm^3 so that a completed filled can will contain about 5652 g of cemented material. The maximum plutonium concentration is normally limited to 2 wt% so that the total plutonium in a single can is 113 g. If a can were to be double batched, it could contain as much as 226 g of plutonium. The contingent conditions have 2% or 4% of the drums in the array containing three cans: one with 226g and two with 66.67 g of plutonium. The total amount of plutonium in the drum is 359.3 g, or about 1.8 times the 200 g limit.

Internal moderation - The cemented material in the cans contains both water and calcium hydroxide which act to moderate the system. Normally the material will contain significant amounts of calcium fluoride and magnesium oxide and trace quantities of other compounds like calcium iodide and silicon oxide that do not provide significant moderation. For the contingency condition the cement will be modeled with different free water contents up to 65 wt% (7.8 wt% hydrogen) for all cans in the model.

Interspersed moderation - Interspersed moderation between the drums and or within the drums (between the cans) from 0% to 100% H_2O will be considered to account for sprinklers or fire fighting sprays. The presence of more than very low density water, such as humid air, in the room is considered as a contingent condition, and will therefore be evaluated.

Cement composition - The cement composition, most importantly its water or hydrogen concentration, may vary. The cement is modeled with different unbound water concentrations ranging from 8 to 65 wt%. The larger unbound water concentrations would likely produce cement that would not cure and would therefore be rejected.

Additional cans of material - Because the drums are packaged, one can at a time, by hand, human error could lead to the placing of an additional can in the drum after the 200 g limit has already been attained. Two contingent conditions will be considered where 8 percent or 16 percent of the drums in the array contain four cans: three with 66.67 g of plutonium and one can that has 113 g of plutonium.

Over stacking of drums - It is planned to stack these drums in a large array that is up to four drum levels high. Infinite two-dimensional arrays that contain five levels and six levels will be evaluated as a contingent conditions.

Packaging material - The drum, its liner, and the cementation can materials reduce the reactivity of the configuration. For the most reactive can geometry each of these materials will be replaced with void or with reduced thickness material to assess the effects upon reactivity.

Loss of spacing - Normal conditions place the drums, with sides touching, in a square array. The drums act as the agent to maintain required spacing of the packaged plutonium bearing materials. Drums used for this purpose are typically certified to meet strength requirements necessary for legal shipping purposes in the United States. No mechanism could cause the loss of spacing for the array of drums other than a catastrophic event that crushed the array of drums. Partial crushing of the entire array of drums is considered as a contingent condition. Drum integrity must be maintained. The drums must be protected from significant corrosion because the loss of the drum iron both eliminates neutron absorbing material and weakens the drum containment.

6.0 EVALUATION AND RESULTS

Significant work related to this evaluation was performed in a prior study of plutonium storage in 55 gallon drums: *Packaging, Storage and Disposal of Solid Waste (55-Gallon Drums, Unrestricted H/Pu Only)* (Carter 1980). This report investigated a large number of parameters concerning the storage of plutonium waste in 55 gallon drums including, hydrogen to plutonium ratio, fissile shape (height to diameter ratios), and bulk density. Information learned from this report helped direct the chosen parameter studies performed in this report. In general, situations where the hydrogen content of the material is high and where the fissile material is concentrated into smaller volumes are expected to be the most reactive.

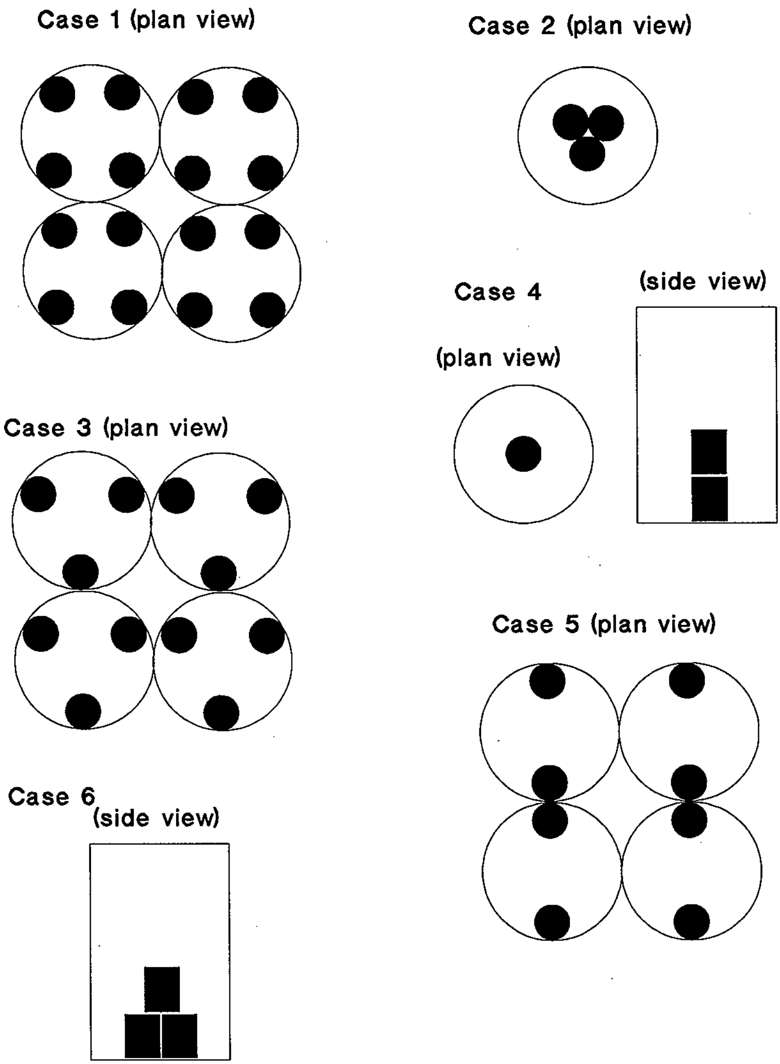
All uncertainties reported in these results are indicative of the one sigma stochastic precision of the calculation. Input filenames, usually beginning with "cemd", are given for each case where results are reported. These input files may be found in Appendix B.

6.1 NORMAL CONDITIONS

Several configurations were investigated to determine the credible configuration within the drum with near maximum reactivity. Based upon the previous study (Carter 1980), it was expected that a configuration where the plutonium was stored with the highest density would provide for nearly optimal reactivity. Therefore, all physical can placements within the drum considered in this evaluation used two or three cans of cemented residue with the total amount of plutonium in each drum equal to 200 g. All normal calculations were performed for a rectangular array of drums with dimensions: $\infty \times \infty \times 4$, unless specified otherwise.

Six different physical can arrangements were considered to be representative of the more reactive credible arrangements that could be attained. Figure 6-1 shows a sketch of the five different arrangements considered. One arrangement used 4 cans in the drum, three arrangements used three cans in the drum and the other two used two can in the drum. For the 4 can arrangement (Case 1), each can was modeled containing equal amounts of plutonium (50 g). Case 2 has three cans arranged in the bottom center of each drum with each can touching its two

Figure 6-1. Sketch of the 5 normal condition can arrangements.



neighbors. Case 3 has three cans arranged in the bottom of each drum at the drum sides with the cans spaced at 120 degree angles about the drum center. Case 6 has 3 cans: two arranged side by side at the drum center with a third can resting on top the other two at the drum center. For each of the three can arrangements, the cases were modeled with equal amounts of plutonium each can (67 g) and with 113 g in one can and 43.5 g in the other two cans (Case 3). Case 4 has two cans, one on top of the other, at the drum center. Case 5 also contains two cans, but places them both at the drum bottom at opposite sides of the drum. For both of the two can arrangements, the cases were modeled with equal amounts of plutonium in the cans (100 g) and with 113 grams in one can and 87 g in the other can. Table 6-1 summarizes the results of the calculations for these five arrangements. Case 2, with 66.67 g of plutonium per can, was also analyzed for a finite array (5 x 5 x 4) surrounded by concrete walls. The results from this finite array are indicative of the difference in reactivity expected between a very large array and a smaller array surrounded with reflective materials. For the finite array considered, $k_{eff} = 0.600 \pm 0.003$, indicating that an infinite array most likely produces conservative results.

Table 6-1. Results of normal condition can arrangement study.

Case	Model File Name	Plutonium in Each Can (g)				k_{eff}	Uncertainty
		1	2	3	4		
1	cemd1_a	50	50	50	50	0.698	0.002
2	cemd2_a	66.7	66.7	66.7	N/A	0.729	0.002
2	cemd2_2a	113	43.5	43.5	N/A	0.707	0.002
3	cemd3_a	66.7	66.7	66.7	N/A	0.695	0.002
3	cemd3_2a	113	43.5	43.5	N/A	0.679	0.002
4	cemd4_a	100	100	N/A	N/A	0.686	0.002
4	cemd4_2a	113	87	N/A	N/A	0.684	0.002
5	cemd5_a	100	100	N/A	N/A	0.686	0.002
5	cemd5_2a	113	87	N/A	N/A	0.686	0.002
6	cemd2_3a	66.7	66.7	66.7	N/A	0.714	0.002

The most reactive situation was found to be for Case 2 (cemd2_a) with the plutonium equally distributed among the cans. This case is the physical arrangement that most approximates a sphere in shape. Because a spherical arrangement would likely be more reactive, a case was modeled where 200 g of plutonium would be uniformly distributed in a sphere of cement with volume equal to that of two cans. The sphere was placed in each drum of the array at its bottom center and was not covered with either the steel can or PVC bag that usually contains the cement. For this situation, the predicted k_{eff} was 0.734 ± 0.002 (sphere1), or just slightly above that of the most reactive realistic case.

6.2 OFF-NORMAL CONDITIONS

For off-normal conditions the following contingencies were considered: over batch, over stacking, extra can in a drum, cement composition/moderation, interspersed moderation, packaging material, unconventional can placement, and loss of spacing due to drum crushing. Each of these contingencies will be covered individually in the sections following. Except for the over stacking contingency, all of these contingency calculations were performed for a rectangular array of drums with dimensions: $\infty \times \infty \times 4$. The positioning of the cans within the drums is exactly like that for the normal condition case that showed the greatest reactivity except for the contingency with the added can.

6.2.1 Over Batch Contingency

For the over batch analysis, the contingent condition has 2% or 4% of the drums in the array containing three cans: one with 226 g and two with 66.67 g of plutonium. The over batched drums were assumed to be located directly above one another in the array and regularly spaced every 5 drums in each lateral direction. When 2% of the drums have the over batch, the calculated $k_{eff} = 0.734 \pm 0.003$ (cemd2_a_ob3). When 4% of the drums have the over batch, the calculated $k_{eff} = 0.735 \pm 0.003$ (cemd2_a_ob2).

6.2.2 Internal Drum Moderation

The cement composition presented in Table 2-2 was used to model the maximum realistic H/Pu ratio for the cemented plutonium residue. Using this cement composition, a parameter study of water vapor density interspersed within each drum was completed to determine the maximum reactivity. Table 6-2 shows the results of this study. For very low water vapor concentrations the reactivity is increased slightly above the dry case. As the concentration of water vapor increases, the reactivity declines as the cans in each drum become isolated from those in neighboring drums. When the void space in each drum filled with water, the complete reflection enhances the reactivity in each drum.

Table 6-2. Results of the internal moderation parameter study.

Water Density Surrounding Cans in Drum (g/cm^3)	k_{eff}	Uncertainty	Model Filename
0.0	0.729	0.002	cemd2_a
0.0001	0.734	0.002	cemd2_l
0.0005	0.734	0.002	vemd2_k
0.001	0.729	0.002	cemd2_j
0.005	0.718	0.002	cemd2_f
0.01	0.707	0.002	cemd2_g
0.1	0.594	0.002	cemd2_h
1.0	0.658	0.002	cemd2_i

6.2.3 External Drum Moderation Contingency

For the interspersed moderation contingency analysis, a parameter study of H_2O densities in the region surrounding the drums was performed. Water densities between 0% and 100% of full density were calculated to find the most reactive density. The results of the parameter study can be found in Table 6-3.

Table 6-3. Results of interspersed moderation parameter study.

Water Density Surrounding Cans in Drum (g/cm^3)	k_{eff}	Uncertainty	Model Filename
0.0005	0.734	0.002	cemd2_m
0.005	0.728	0.002	cemd2_b
0.01	0.727	0.002	cemd2_c
0.1	0.658	0.002	cemd2_d
1.0	0.520	0.002	cemd2_e

6.2.4 Cement Composition Contingency

Because the cement composition and moisture (or hydrogen) concentration may vary, a study of this effect was performed. In the cement's final form, hydrogen is present both bound to the calcium and in unbound water. The cement composition was varied by increasing the weight fraction of unbound water in the cement while maintaining the relative proportions of the other constituents. The plutonium content of each can was maintained at 66.67 g and the most reactive normal arrangement of cans was utilized. The cement composition of all cans in the array was modified by this contingency. The unbound water content was modeled ranging from 8 wt% (2.7 wt% hydrogen) to 65 wt% (7.8 wt% hydrogen). Figure 6-2 shows the predicted value of k_{eff} as a function of the total hydrogen concentration in each can (cemd2_ac1, 3, 5, 7, 9, 11, 13, 15, 17). A cement composition with unbound water content as high as 65 wt% is very unlikely, and still only produces keff = 0.865 ± 0.002 (cemd2_ac17). At this high of a bound water concentration the cement would likely not cure as a solid. The results in figure 6-2 assume that the bulk density of the cement remains constant at 2.059 g/cm^3. This is an unrealistic assumption for large hydrogen (water) concentrations. For example, at a hydrogen concentration of 5.8 wt%, the density of the cement would likely be below 1.3 g/cm^3 because of the large water content. The results shown in figure 6-2 for the higher hydrogen concentrations are conservative (i.e. the reported reactivities are higher than would actually be expected).

6.2.5 Additional Can of Material Contingency

The contingent condition has 2% or 4% of the drums in the array containing four cans: one with 113g and three with 66.67 g of plutonium. The physical arrangement of the cans is similar to normal condition case 2, except that one of the three cans from that model is replaced with one containing 113g, with the replaced (66.67 g) can now being placed at on top of the three cans at the barrel center. The additional can drums were assumed to be located directly above one another in the array and regularly spaced every 5 drums in each lateral direction. When 2% of the drums have the additional can the calculated k_{eff} = 0.737 ± 0.003 (cemd2_a_xc1). When 4% of the drums have the over batch the calculated k_{eff} = 0.737 ± 0.003 (cemd2_a_xc2).

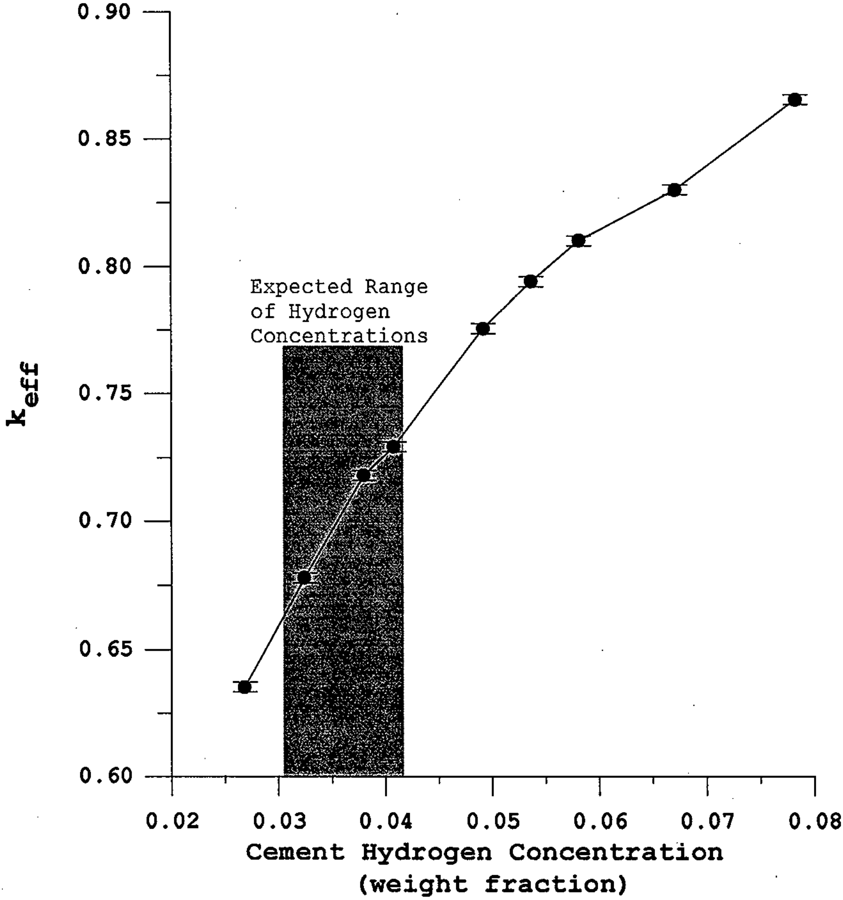
6.2.6 Over Stacking Drum Contingency

For this contingency, the two-dimensional infinite array of drums was stacked 5 and 6 drums high. Table 6-4 provides the results of this study.

Table 6-4. Reactivity as a function of array stacking height.

Array Stack Height (Number of Drums)	k_{eff}	Uncertainty	Model Filename
4	0.729	0.002	cemd2_a
5	0.753	0.002	cemd2_ahi5
6	0.767	0.002	cemd2_ahi6

Figure 6-2. Reactivity (k_{eff}) shown as a function of the cement hydrogen concentration.



6.2.7 Miscellaneous Material Contingencies

Several materials are present in the geometry that act as neutron absorbers or neutron shields. These materials are primarily found in the drum, the drum liner, and the can. Several small cases were investigated that give an indication of the importance of these materials in reducing the reactivity.

To investigate the effects of the drum and its liner several cases were investigated. A case was run where the wall thickness of the steel drum was reduced to one-half its original thickness. A case was run where only the steel drum was replaced with void. A case was run replacing only the polyethylene liner with void. A case was run that replaced material in both the drum and its liner with void. The normal can spacings and arrangements were maintained for all of these cases. Table 6-5 summarizes the results of this study. It is obviously incredible for both the drum and liner to not exist. The importance of having either the drum or its liner present is clearly indicated. An administrative control will be placed upon the drum thickness and total mass. Use of a polyethylene liner, from a criticality standpoint, is optional.

Table 6-5. Results of drum and drum liner material contingency studies.

Case Description	k_{eff}	Uncertainty	Model Filename
Steel drum wall thickness reduced by 50%	0.768	0.002	cemd2_ahd
Steel drum wall material replaced with void	0.913	0.002	cemd2_and
Polyethylene drum liner material replaced with void	0.861	0.002	cemd2_anp
Both steel drum and polyethylene liner materials replaced with void	1.013	0.002	cemd2_andp

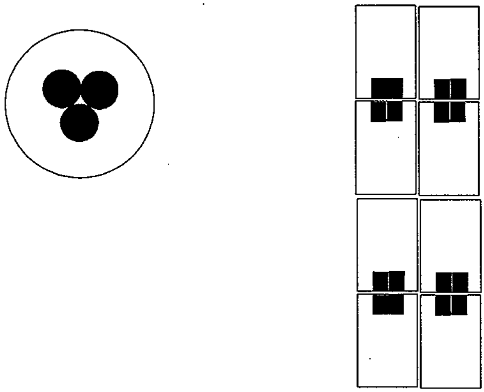
The most reactive normal condition can arrangement was modeled with the can material replaced by void. The reactivity was found to increase by less than 1 percent, giving a value of 0.744 ± 0.002 for k_{eff} (cemd2_anc).

6.2.8 Can Arrangement Contingencies

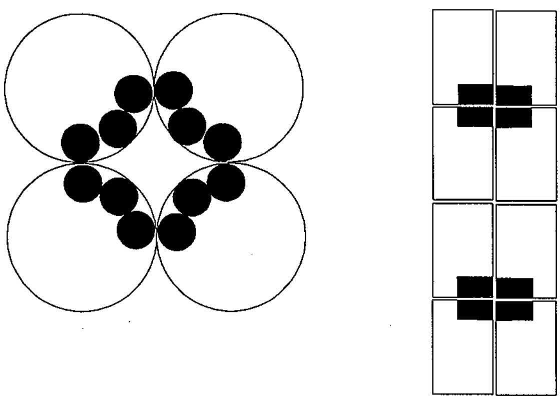
If the can arrangement within the drum is truly unconfined, then placing the cans in locations within the drum where they would not likely be found should be considered. The worst arrangements of this sort would place cans in the bottom layer of drums at the top of the drum and cans in the next higher layer of drums at the bottom of the drums. Since other materials have not been excluded from placement in the drums, this could be achieved, for instance by filling the drum with lightweight packaging material (like shredded paper or contaminated clothing) before loading the cans. Figure 6-3 shows a sketch of the two can arrangements considered. The calculated values of k_{eff} for the two cases are: 0.771 ±0.002 (case 1c, filename: cemd2_aerict), and 0.791 ±0.002 (case 2c, filename: cemd2_aeric).

Figure 6-3. Sketch of the two contingency can arrangements.

Case 1 (plan view) (side view)



Case 2 (plan view) (side view)



Because these can arrangement contingencies increase the reactivity over the normal can arrangements considered and do not represent incredible arrangements, they are not true contingencies. In order to verify that these can arrangements would be acceptable given other contingencies, case 2c was run with the steel drum wall thickness reduced by 50% and was run with a cement hydrogen concentration of 5.8 wt% (in normal drum). The calculated values for these conditions were: $k_{eff} = 0.821 \pm 0.003$ (cemd2_aerichd) with a reduced steel drum wall thickness, and $k_{eff} = 0.865 \pm 0.003$ (cemd2_aricc13) with a cement hydrogen concentration of 5.8 wt%.

6.2.9 Loss of Spacing Contingency: Drum Crushing

The storage building for these drums may fail under certain natural disaster conditions, such as an earthquake. The roof and roof supporting beams could come down upon these drums during such an event. Using the can arrangement described for case 2c in the can arrangement contingency (Section 6.2.8), each drum in the 4-high array was crushed to the height of one layer of upright internal cementation cans (about 20 cm). The total mass of both polyethylene and of steel in the drums was maintained in the model by increasing their input bulk densities by the inverse of the fraction of volume lost when the drum height was reduced. The calculated reactivity under this severely crushed condition was $k_{eff} = 0.765 \pm 0.003$ (cemd2_ariccr). The reactivity was also calculated without maintaining the mass of polyethylene and steel, but by simply reducing the height of the drum and liner to a height of about 20 cm. For this situation the reactivity is $k_{eff} = 0.880 \pm 0.004$ (cemd2_ariccr1).

There might be concern if cans were released from the drums during such an accident. However, these drums under beam loading are expected to deform and crush rather than rupture or shear because of the ductile and strength properties of the steel drums. Therefore, under credible accidents, few cans would be expected to be released from the drums. Those cans that are released from the drums are unlikely to coalesce because the matrix of drums will keep them separated. The interspersed steel drums will act as a neutron absorber for these few uncontained cans, maintaining safe reactivities.

7.0 DESIGN FEATURES AND ADMINISTRATIVELY CONTROLLED LIMITS AND REQUIREMENTS

The administratively controlled limits applicable to this evaluation are:

1) Stacking heights shall not exceed 4 drums high,

2) Each cementation can may not contain more than 113 g of plutonium,

3) Each drum may not contain more that 200 g of total plutonium, and

4) The steel drum mass (empty) must exceed 16 kg.

8.0 SUMMARY AND CONCLUSIONS

This analysis has shown that the operation described above in Section 2, under the controls listed in Section 7 is safe from a criticality standpoint. No single identified credible contingency was able to exceed the criticality safety limit of k_{eff}=0.95.

This evaluation demonstrates that 200 g of plutonium in cement may be safely stored in each 55-gallon drum if a number of administrative controls are maintained. Normal arrangements of the drums typically result in k_{eff} values below 0.8 Stacking the drums as many as six high is acceptable with no other continency, while stacking the drums four high is shown to be acceptable with other contingencies. Concentrating the plutonium tends to increase the reactivity, but it has been shown that each can may contain up to 113 g of plutonium, with a maximum of 200 g per drum. The steel in the drum absorbs significant fractions of thermal neutrons, thereby reducing the system reactivity. The plastic liner used in the drums acts as a neutron shield, lowering interaction between drums. Either the steel drum must be present with a mass of at least 16 kg or the polyethylene liner (0.229 cm thick) must be present.

9.0 REFERENCES

Carter, R. D., 1980, *Criticality Safety Analysis Report CSAR 80-021: Packaging, Storage and Disposal of Solid Waste (55-Gallon Drums, Unrestricted H/Pu Only)*, Rockwell Hanford Company, Richland, Washington.

Hess, A. L., 1996, *CSER 96-013: Cementation Process, Glovebox HA-20MB at PFP*, WHC-SD-SQA-CSA-513, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Macklin, L.L. and E.M. Miller, 1992, CCVR 91-001; *MONK6A Pu Validation*, WHC-SD-SQA-CSWD-20015, REV. 0, Westinghouse Hanford Company, Richland, Washington.

Miller, E.M., 1994, CCVR 94-001; *MONK6B Pu Validation*, WHC-SD-SQA-CSWD-20019, REV. 0, Westinghouse Hanford Company, Richland, Washington.

UKEAE, 1988, MONK6A Monte Carlo Code for Criticality Calculations, Users Manual, AEEW R2195, Answers Business Center, Winfirth Technology Centre, Dorchester, Dorset, DT2 8DH, United Kingdom.

APPENDIX A

INDEPENDENT REVIEW COMMENTS AND CHECKLIST

An independent technical review of *CSER 96-027: Storage of Cemented Plutonium Residue Containers in 55 Gallon Drums* was done by D. G. Erickson, Senior Scientist, in the Criticality and Shielding group. His comments are as follows:

The objective of this CSER is to increase the approved plutonium mass limit allowed in the 55-gallon drums loaded with cementation cans from. The current limit of 100 g was analyzed and approved in 1980 in CSAR 80-021 by Roger D. Carter. This CSER increases the approved limit to 200 g. per 55-gallon drum.

The analysis addressed normal drum and cementation can mass loadings and spacings. It was noticed as a part of this review that the most reactive credible geometry may not have been used for all normal and off normal analyses. Additional cases were requested and were run as a result. The results of those cases are reported in the off-normal section, along with several off-normal perturbations to very the criticality safety of the geometry.

All identified off-normal contingencies were also addressed. These include overbatching in cans and drums, internal and external moderation, cement composition, additional cans, drum overstacking, loss of absorbing or isolating materials, and loss of spacing. All normal and contingency conditions are subcritical with an adequate margin of safety.

The computer code input files were checked for correctness of geometry, materials and atom densities. Output files were checked for adequate convergence.

The CSER was reviewed and several editorial and spelling comments were made. Additional cases were requested to verify the worst credible condition were analyzed. Additional information on case identifiers was requested, and has been added to the final CSER.

Conservatism was introduced into the authors models by assuming the maximum plutonium mass loading for each drum, the worst moisture content for each cementation can, and minimizing the number of cans that may be in a drum. All reported results were for an infnite array in both lateral directions, with drums stacked 4 to 6 high. A comparison of a finite concrete reflected array to the infinite array was also made and was shown to be less reactive.

The analysis shows that internal moderation of the material in the cans has only a small effect on the k_{eff}. Interspersed moderation up to and including full density water encompassing all drums has a k_{eff} well below the safety limit, and therefore bounds any conceivable water flooding.

The most reactive credible normal case had a $k_{eff} < 0.8$, significantly less than the criticality safety limit of 0.95, and all credible off-normal cases were also below the criticality safety limit.

Based on the examination of the input data, assumptions and computer output this reviewer concurs with the conclusions of the CSER. It is acceptable to increase the mass loading of the 55-gallon drums loaded with cementation cans from 100 g of plutonium to 200 g of plutonium.

CHECKLIST FOR INDEPENDENT REVIEW

Document Reviewed: CSER 96-027 Storage of Cemented Plutonium Residue Containers in 55 Gallon Drums.
Author: W. T. Watson

Yes	No	N/A	
[X]	[ ]	[ ]	Problem completely defined.
[X]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[X]	[ ]	[ ]	Computer codes and data files documented.
[X]	[ ]	[ ]	Data checked for consistency with original source information as applicable.
[X]	[ ]	[ ]	Mathematical derivations checked including dimensional consistency of results.
[X]	[ ]	[ ]	Models appropriate and used within range of validity or use outside range of established validity justified.
[ ]	[ ]	[X]	Hand calculations checked for errors.
[X]	[ ]	[ ]	Code run streams correct and consistent with analysis documentation.
[X]	[ ]	[ ]	Code output consistent with input and with results reported in analysis documentation.
[X]	[ ]	[ ]	Acceptability limits on analytical results applicable and supported. Limits checked against sources.
[X]	[ ]	[ ]	Safety margins consistent with good engineering practices.
[X]	[ ]	[ ]	Conclusions consistent with analytical results and applicable limits.
[X]	[ ]	[ ]	Results and conclusions address all points required in the problem statement.
[X]	[ ]	[ ]	Have all reasonable accidents been considered?
[X]	[ ]	[ ]	Has low density water (steam) been evaluated as a moderator?
[X]	[ ]	[ ]	Is the fuel and other hardware composition correct?
[X]	[ ]	[ ]	Are the cases considered conservative? Too conservative?
[X]	[ ]	[ ]	Do the computer models adequately reflect the actual geometry? Have cross sectional cuts of the geometry been made and do they show the desired geometry?
[X]	[ ]	[ ]	Has the analysis been reviewed by Safety? This may not be required in a preliminary design.
[X]	[ ]	[ ]	Has the reviewer completed the Criticality Safety Course for Managers and Engineers?

Date completed March 1996

Reviewed by: D. S. Erik Date 01/21/97

NOTE: Any hand calculations, notes, or summaries generated as part of this review should be signed, dated, and attached to this checklist. Materials should be labeled and recorded so that it is intelligible to a technically-qualified third party.

APPENDIX B

MONK INPUT FILES

```
* CEMD1_a  Array of Drums, 4 cans 50 g Pu ea arrange drum side
FISSION
* #MATERIALs #NUCLIDEs
  7        14    NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 50 g Pu per can)
* density  weightfractions
WGT 2.059   HINH2O 0.040956  O 0.487085  F19 0.032381
      MG 0.067182  CA 0.363486  PU239 0.008910
*
* Mat #2 Carbon Steel 1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  4 Cans near drum side (Case 1), including space in drum
CLUSTER 5
ZROD ORIGIN  15.081  15.081 0.0000  P1 7.018 17.846
ZROD ORIGIN  15.081 -15.081 0.0000  P1 7.018 17.846
ZROD ORIGIN -15.081 -15.081 0.0000  P1 7.018 17.846
ZROD ORIGIN -15.081  15.081 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*        ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-6       30       1000       300  STDV 0.002   -1
MULTIPOINT 4
29. 29. 10.  1
29. 29. 95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
*  yz
0.1 43.78 85.  57.4 43.78 85.  0.1 43.78 -5.
*  yz
13.6 57.4 20.  13.6 .1 20.  13.6 57.4 -2.
*  xy
.1 57.4 8.  57.4 57.4 8. .1 .1 8.
END
```

```
* CEMD2_a  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
  7        14    NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density  weightfractions
WGT 2.059   HINH2O 0.040833  O 0.485625  F19 0.032284
      MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel 1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
```

```
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575  84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*        ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10       30      1000      300  STDV 0.002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
*  xy
0.1 28.7 85.  57.4 28.7 85.  0.1 28.7 -5.
*  yz
14 38. 10.  38. 38. 10.  14 19 10.
*  xy
.1 57.4 8.  57.4 57.4 8. .1 .1 8.
END


* CEMD2_2a  Array of Drums, 3 cans (2@ 43.5g, 1@ 113g) Pu ea
arrange drum center
FISSION
* #MATERIALs #NUCLIDEs
   8        14    NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 43.5 g Pu per can)
* density  weightfractions
WGT 2.059    HINH2O 0.041003  O 0.487654  F19 0.032419
       MG 0.067261  CA 0.363911  PU239 0.007752
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
* Mat #8  Cement/Pu (normal (high) water content, 113 g Pu per can)
* density  weightfractions
WGT 2.059    HINH2O 0.040492  O 0.481567  F19 0.032014
        MG 0.066421  CA 0.359369  PU239 0.020138
*
CM
* PART #1  Cementation can (cemented residue 43.5g Pu, steel can,
PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P6 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575  84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*        ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* PART #6  Cementation can (cemented residue 113g Pu, steel can,
PVC bag)
NEST 3
ZCYL  8   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* strtstage, endstage, #histperstage, time(min), -1
-5        30      1000        300  STDV  0.002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
*  xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
*  yz
19 38. 10.  38. 38. 10.  19 19 10.
*  xy
19. 19 20.  38. 19. 20. 19 19 -1
END


* CEMD2_3a  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
   7        14    NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density  weightfractions
WGT 2.059    HINH2O 0.040833  O 0.485625  F19 0.032284
       MG 0.066981  CA 0.362397  PU239 0.011881
*
```

```
* Mat #2 Carbon Steel 1% C 7.86 g/cm3
CONC C 0.003941 FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT 7.9 C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983 SN 0.001
*
* Mat #4 PVC [(CH2CH(Cl)]n
WGT 0.9 HINH2O 0.048386 C 0.384338 CL 0.567275
*
* Mat #5 Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C 0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC AL27 0.003358 CA 0.002614 FE 0.001344
   HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1 Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL 1 6.985 17.813 0.033
ZCYL 3 6.988 17.816 0.030
ZCYL 4 7.018 17.846 0.000
* PART #2 3 Cans near drum center, one stacked (Case 2_3),
including space in drum
CLUSTER 4
ZROD ORIGIN 0.0000 7.0181 0.0000 P1 7.018 17.846
ZROD ORIGIN 0.0000 -7.0181 0.0000 P1 7.018 17.846
ZROD ORIGIN 0.0000 0.0000 17.8461 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464 84.3783 0.3805
ZCYL 6 28.575 84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4 Array of drums: X by Y by Z
ARRAY 1 1 4
* Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0 0.
*        ceiling(339.04cm+8in) floor (0-12in)
CUBOID 7 57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10     30     1000     300  STDV 0.002 -1
MULTIPOINT 4
29. 29. 10. 1
29. 29. 95. 1
29. 29. 180. 1
29. 29. 265. 1
END
CODE 7
PSsVWpC
* yz
0.1 28.7 85. 57.4 28.7 85. 0.1 28.7 -5.
* yz
28.7 57.4 40. 28.7 .1 40. 28.76 57.4 -2.
* xy
.1 57.4 8. 57.4 57.4 8. .1 .1 8.
END
```

```
* CEMD3_a Array of Drums, 3 cans 66.67 g Pu ea arrange drum
side
FISSION
* #MATERIALs #NUCLIDEs
  7       14    NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density weightfractions
WGT 2.059  HINH2O 0.040833 O 0.485625 F19 0.032284
      MG 0.066981 CA 0.362397 PU239 0.011881
*
* Mat #2 Carbon Steel 1% C 7.86 g/cm3
CONC C 0.003941 FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT 7.9 C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983 SN 0.001
*
* Mat #4 PVC [(CH2CH(Cl)]n
WGT 0.9 HINH2O 0.048386 C 0.384338 CL 0.567275
*
* Mat #5 Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C 0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC AL27 0.003358 CA 0.002614 FE 0.001344
   HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1 Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL 1 6.985 17.813 0.033
ZCYL 3 6.988 17.816 0.030
ZCYL 4 7.018 17.846 0.000
* PART #2 3 Cans near drum side (Case 3), including space in drum
CLUSTER 4
ZROD ORIGIN 0.0000 -21.328 0.0000 P1 7.018 17.846
ZROD ORIGIN 18.47  10.66 0.0000 P1 7.018 17.846
ZROD ORIGIN -18.47  10.66 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464 84.3783 0.3805
ZCYL 6 28.575 84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4 Array of drums: X by Y by Z
ARRAY 1 1 4
* Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0 0.
*        ceiling(339.04cm+8in) floor (0-12in)
CUBOID 7 57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
PERIODIC Y
* strtstage, endstage, #histperstage, time(min), -1
-10     30     1000     300  STDV .002 -1
MULTIPOINT 4
29. 29. 10. 1
29. 29. 95. 1
29. 29. 180. 1
29. 29. 265. 1
```

```
END
CODE 7
PSsVWpC
* yz
0.1 39.4 85. 57.4 39.4 85. 0.1 39.4 -5.
* yz
28.7 57.4 20. 28.7 .1 20. 28.7 57.4 -2.
* xy
.1 57.4 8. 57.4 57.4 8. .1 .1 8.
END


* CEMD3_2a Array of Drums, 3 cans (2@ 43.5g, 1@ 113g) Pu ea
arrange drum side
FISSION
* #MATERIALs #NUCLIDEs
  8        14   NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 43.5 g Pu per can)
* density  weightfractions
WGT 2.059   HINH2O 0.041003  O 0.487654  F19 0.032419
       MG 0.067261  CA 0.363911  PU239 0.007752
*
* Mat #2 Carbon Steel 1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5 Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
* Mat #8 Cement/Pu (normal (high) water content, 113 g Pu per can)
* density  weightfractions
WGT 2.059   HINH2O 0.040492  O 0.481567  F19 0.032014
       MG 0.066421  CA 0.359369  PU239 0.020138
*
CM
* PART #1  Cementation can (cemented residue 43.5g Pu, steel can,
PVC bag)
NEST 3
ZCYL  1  6.985 17.813 0.033
ZCYL  3  6.988 17.816 0.030
ZCYL  4  7.018 17.846 0.000
* PART #2  3 Cans near drum side (Case 3), including space in drum
CLUSTER 4
ZROD ORIGIN  0.0000 -21.328 0.0000  P6 7.018 17.846
ZROD ORIGIN  18.47   10.66  0.0000  P1 7.018 17.846
ZROD ORIGIN -18.47   10.66  0.0000  P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
* Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*       ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* PART #6  Cementation can (cemented residue 113g Pu, steel can,
PVC bag)
NEST 3
ZCYL  8   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* strtstage, endstage, #histperstage, time(min), -1
-5        30       1000        180  STDV 0.002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
* xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
* yz
19 38. 10.  38. 38. 10.  19 19 10.
* xy
19. 19 20.  38. 19. 20. 19 19 -1
END


* CEMD4_a  Array of Drums, 2 cans (2@ 100g) Pu arrange drum
center, stacked
FISSION
* #MATERIALs #NUCLIDEs
  7        14   NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 100 g Pu per can)
* density  weightfractions
WGT 2.059    HINH2O 0.040587  O 0.482706  F19 0.032090
       MG 0.066578  CA 0.360218  PU239 0.017821
*
* Mat #2 Carbon Steel 1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5 Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
*
CM
* PART #1  Cementation can (cemented residue 43.5g Pu, steel can,
PVC bag)
NEST 3
ZCYL  1  6.985 17.813 0.033
```

```
ZCYL 3  6.988 17.816 0.030
ZCYL 4  7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 4), including space in
drum
CLUSTER 3
ZROD ORIGIN  0.0000  0.0000 0.0000  P1 7.018 17.846
ZROD ORIGIN  0.0000  0.0000 17.8461  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*          ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-5        30       1000        300   STDV  0.0020  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
*  yz
0.1 28.7 85.  57.4 28.7 85.  0.1 28.7 -5.
*  yz
28.7 57.4 40.  28.7 .1 40.  28.7 57.4 -2.
*  xy
.1 57.4 8.  57.4 57.4 8. .1 .1 8.
END


* CEMD4_2a  Array of Drums, 2 cans (1@ 113g, 1@ 87g) Pu
arrange drum center, stacked
FISSION
*  #MATERIALs  #NUCLIDEs
   8          14    NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 87 g Pu per can)
*  density   weightfractions
WGT 2.059    HINH2O 0.040683  O 0.483844  F19 0.032165
        MG 0.066735  CA 0.361068  PU239 0.015504
*
* Mat #2 Carbon Steel  1% C   7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
     HINH2O 0.007023 O 0.045396 SI 0.012905
*
* Mat #8  Cement/Pu (normal (high) water content, 113 g Pu per can)
*  density   weightfractions
WGT 2.059    HINH2O 0.040492  O 0.481567  F19 0.032014
        MG 0.066421  CA 0.359369  PU239 0.020138
*
CM
* PART #1  Cementation can (cemented residue 87g Pu, steel can,
PVC bag)
NEST 3
ZCYL  1  6.985 17.813 0.033
ZCYL  3  6.988 17.816 0.030
ZCYL  4  7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 4), including space in
drum
CLUSTER 3
ZROD ORIGIN  0.0000  0.0000 0.0000  P6 7.018 17.846
ZROD ORIGIN  0.0000  0.0000 17.8461  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*          ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* PART #6  Cementation can (cemented residue 113g Pu, steel can,
PVC bag)
NEST 3
ZCYL  8  6.985 17.813 0.033
ZCYL  3  6.988 17.816 0.030
ZCYL  4  7.018 17.846 0.000
* strtstage, endstage, #histperstage, time(min), -1
-5        30       1000        300  STDV  0.002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
*  xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
*  yz
19 38. 10.  38. 38. 10.  19 19 10.
*  xy
19. 19 20.  38. 19. 20. 19 19 -1
END


* CEMD5_a  Array of Drums, 2 cans (2@ 100g) Pu arrange drum
side
FISSION
```

```
* #MATERIALs #NUCLIDEs
  7       14   NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 100 g Pu per can)
* density weightfractions
WGT 2.059   HINH2O 0.040587  O 0.482706  F19 0.032090
        MG 0.066578  CA 0.360218  PU239 0.017821
*
* Mat #2 Carbon Steel 1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT 7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5 Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
*
CM
* PART #1  Cementation can (cemented residue 100g Pu, steel can,
PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum wall (Case 5), including space in drum
CLUSTER 3
ZROD ORIGIN  0.0000  21.328 0.0000  P1 7.018 17.846
ZROD ORIGIN  0.0000 -21.328 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*          ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-5      30      1000        300 STDV  0.002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29.  180.  1
29. 29.  265.  1
END
CODE 7
PSsVWpC
*  yz
0.1 50 85.  57.4 50 85.  0.1 50 -5.
*  yz
28.7 57.4 20.  28.76 .1 20.  28.7 57.4 -2.
*  xy
.1 57.4 8.  57.4 57.4 8. .1 .1 8.
END


* CEMD5_2a  Array of Drums, 2 cans (1@ 113g, 1@ 87g) Pu
arrange drum wall
FISSION
* #MATERIALs #NUCLIDEs
  8       14   NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 87 g Pu per can)
* density  weightfractions
WGT 2.059   HINH2O 0.040683  O 0.483844  F19 0.032165
        MG 0.066735  CA 0.361068  PU239 0.015504
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT 7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
* Mat #8  Cement/Pu (normal (high) water content, 113 g Pu per can)
* density  weightfractions
WGT 2.059   HINH2O 0.040492  O 0.481567  F19 0.032014
        MG 0.066421  CA 0.359369  PU239 0.020138
*
CM
* PART #1  Cementation can (cemented residue 87g Pu, steel can,
PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum wall (Case 5), including space in drum
CLUSTER 3
ZROD ORIGIN  0.0000  21.328 0.0000  P6 7.018 17.846
ZROD ORIGIN  0.0000 -21.328 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
```

```
*       ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* PART #6  Cementation can (cemented residue 113g Pu, steel can,
PVC bag)
NEST 3
ZCYL  8   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* strtstage, endstage, #histperstage, time(min), -1
-5        30       1000        300 STDV  0.002   -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
*  xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
*  yz
19 38. 10.  38. 38. 10.  19 19 10.
*  xy
19. 19 20.  38. 19. 20. 19 19 -1
END


* CEMD2_ac1  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
   7        14    NUCNAMES
*
* Mat #1  Cement/Pu (66.67 g Pu per can)
* Water weight fraction: 0.24  , equivilent to H conc assuming all H
from H2O
* density   weightfractions
WGT 2.059   HINH2O 0.026857  O 0.407088  F19 0.038753
       MG 0.080403  CA 0.435018  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C   7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC    [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*        ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10        30       1000        300  STDV .002   -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
*  xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
*  yz
19 38. 10.  38. 38. 10.  19 19 10.
*  xy
19. 19 20.  38. 19. 20. 19 19 -1
END


* CEMD2_ac3  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
   7        14    NUCNAMES
*
* Mat #1  Cement/Pu (66.67 g Pu per can)
* Water weight fraction: 0.29  , equivilent to H conc assuming all H
from H2O
* density   weightfractions
WGT 2.059    HINH2O 0.032452  O 0.43853  F19 0.036163
       MG 0.07503  CA 0.405944  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C   7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC    [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
```

```
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC  AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*         ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10         30        1000         300  STDV .002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
*  xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
*  yz
19 38. 10.  38. 38. 10.  19 19 10.
*  xy
19. 19 20.  38. 19. 20. 19 19 -1
END


* CEMD2_ac5  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
   7          14    NUCNAMES
*
* Mat #1  Cement/Pu (66.67 g Pu per can)
* Water weight fraction: 0.32  , equivilent to H conc assuming all H
from H2O
* density   weightfractions
WGT 2.059    HINH2O 0.038047  O 0.469973  F19 0.033573
        MG 0.069656  CA 0.37687  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
```

```
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC    [(CH2CH(Cl))]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC  AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*         ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10         30        1000         300  STDV .002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
*  xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
*  yz
19 38. 10.  38. 38. 10.  19 19 10.
*  xy
19. 19 20.  38. 19. 20. 19 19 -1
END


* CEMD2_ac7  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
```

```
* #MATERIALs #NUCLIDEs
   7        14    NUCNAMES
*
* Mat #1  Cement/Pu (66.67 g Pu per can)
* Water weight fraction: 0.40  , equivilent to H conc assuming all H
from H2O
* density  weightfractions
WGT 2.059    HINH2O 0.044762  O 0.507704  F19 0.030465
        MG 0.063207  CA 0.341981  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC    [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
```

```
PSsVWpC
* xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
* yz
19 38. 10.  38. 38. 10.  19 19 10.
* xy
19. 19 20.  38. 19. 20. 19 19 -1
END
```

```
* CEMD2_ac9  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
   7        14    NUCNAMES
*
* Mat #1  Cement/Pu (66.67 g Pu per can)
* Water weight fraction: 0.44  , equivilent to H conc assuming all H
from H2O
* density  weightfractions
WGT 2.059    HINH2O 0.049238  O 0.532858  F19 0.028393
        MG 0.058908  CA 0.318722  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC    [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
```

```
*        ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10       30       1000       300  STDV 0.002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
* xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
* yz
19 38. 10.  38. 38. 10.  19 19 10.
* xy
19. 19 20.  38. 19. 20. 19 19 -1
END


* CEMD2_ac11  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
   7        14    NUCNAMES
*
* Mat #1  Cement/Pu (66.67 g Pu per can)
* Water weight fraction: 0.48  , equivilent to H conc assuming all H
from H2O
* density  weightfractions
WGT 2.059    HINH2O 0.053714  O 0.558012  F19 0.026321
        MG 0.054609  CA 0.295463  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
       FE 0.983  SN 0.001
*
* Mat #4 PVC    [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
     HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0 0.
*        ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10       30       1000       300  STDV 0.002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
* xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
* yz
19 38. 10.  38. 38. 10.  19 19 10.
* xy
19. 19 20.  38. 19. 20. 19 19 -1
END


* CEMD2_ac13  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
   7        14    NUCNAMES
*
* Mat #1  Cement/Pu (66.67 g Pu per can)
* Water weight fraction: 0.52  , equivilent to H conc assuming all H
from H2O
* density  weightfractions
WGT 2.059    HINH2O 0.05819  O 0.583166  F19 0.024249
        MG 0.050311  CA 0.272203  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
       FE 0.983  SN 0.001
*
* Mat #4 PVC    [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
     HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
```

```
NEST 3
ZCYL 1 6.985 17.813 0.033
ZCYL 3 6.988 17.816 0.030
ZCYL 4 7.018 17.846 0.000
* PART #2 3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN 0.0000 8.1037 0.0000 P1 7.018 17.846
ZROD ORIGIN 7.0181 -4.0519 0.0000 P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464 84.3783 0.3805
ZCYL 6 28.575 84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4 Array of drums: X by Y by Z
ARRAY 1 1 4
* Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0 0.
*       ceiling(339.04cm+8in) floor (0-12in)
CUBOID 7 57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10      30      1000      300  STDV 0.002 -1
MULTIPOINT 4
29. 29. 10. 1
29. 29. 95. 1
29. 29. 180. 1
29. 29. 265. 1
END
CODE 7
PSsVWpC
* xy
0.1 29. 85. 57.4 29. 85. 0.1 29. -10.
* yz
19 38. 10. 38. 38. 10. 19 19 10.
* xy
19. 19 20. 38. 19. 20. 19 19 -1
END

* CEMD2_ac15 Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
   7      14   NUCNAMES
*
* Mat #1 Cement/Pu (66.67 g Pu per can)
* Water weight fraction: 0.60 , equivilent to H conc assuming all H
from H2O
* density weightfractions
WGT 2.059   HINH2O 0.067143 O 0.633475 F19 0.020105
      MG 0.041713 CA 0.225684 PU239 0.011881
*
* Mat #2 Carbon Steel 1% C 7.86 g/cm3
CONC C 0.003941 FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT 7.9 C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983 SN 0.001
*
* Mat #4 PVC [(CH2CH(Cl)]n
WGT 0.9 HINH2O 0.048386 C 0.384338 CL 0.567275
*
* Mat #5 Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C 0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC AL27 0.003358 CA 0.002614 FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1 Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL 1 6.985 17.813 0.033
ZCYL 3 6.988 17.816 0.030
ZCYL 4 7.018 17.846 0.000
* PART #2 3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN 0.0000 8.1037 0.0000 P1 7.018 17.846
ZROD ORIGIN 7.0181 -4.0519 0.0000 P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464 84.3783 0.3805
ZCYL 6 28.575 84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4 Array of drums: X by Y by Z
ARRAY 1 1 4
* Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0 0.
*       ceiling(339.04cm+8in) floor (0-12in)
CUBOID 7 57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10      30      1000      300  STDV 0.002 -1
MULTIPOINT 4
29. 29. 10. 1
29. 29. 95. 1
29. 29. 180. 1
29. 29. 265. 1
END
CODE 7
PSsVWpC
* xy
0.1 29. 85. 57.4 29. 85. 0.1 29. -10.
* yz
19 38. 10. 38. 38. 10. 19 19 10.
* xy
19. 19 20. 38. 19. 20. 19 19 -1
END


* CEMD2_b Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
   7      14   NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density weightfractions
WGT 2.059   HINH2O 0.040833 O 0.485625 F19 0.032284
```

```
      MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  5  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*    Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*         ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10        30       800        300 STDV .002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
*  xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
*  yz
19 38. 10.  38. 38. 10.  19 19 10.
*  xy
19. 19 20.  38. 19. 20. 19 19 -1
END
```

```
* CEMD2_c  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
*  #MATERIALs  #NUCLIDEs
   7        14    NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density   weightfractions
WGT 2.059    HINH2O 0.040833  O 0.485625  F19 0.032284
      MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.01 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  5  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*    Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*         ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10        30       800        300 STDV .002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
```

```
29. 29. 265. 1
END
CODE 7
PSsVWpC
* xy
0.1 29. 85. 57.4 29. 85. 0.1 29. -10.
* yz
19 38. 10. 38. 38. 10. 19 19 10.
* xy
19. 19 20. 38. 19. 20. 19 19 -1
END


* CEMD2_d Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
  7        14    NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density weightfractions
WGT 2.059  HINH2O 0.040833  O 0.485625  F19 0.032284
       MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel 1% C 7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5 Water Vapor (mixed with void)
WGT 0.1 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1 Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL 1  6.985 17.813 0.033
ZCYL 3  6.988 17.816 0.030
ZCYL 4  7.018 17.846 0.000
* PART #2 3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  5  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4 Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*         ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10        30       800         300 STDV .002  -1
MULTIPOINT 4
29. 29. 10. 1
29. 29. 95. 1
29. 29. 180. 1
29. 29. 265. 1
END
CODE 7
PSsVWpC
* xy
0.1 29. 85. 57.4 29. 85. 0.1 29. -10.
* yz
19 38. 10. 38. 38. 10. 19 19 10.
* xy
19. 19 20. 38. 19. 20. 19 19 -1
END


* CEMD2_e Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
  7        14    NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density weightfractions
WGT 2.059  HINH2O 0.040833  O 0.485625  F19 0.032284
       MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel 1% C 7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5 Water Vapor (mixed with void)
WGT 1.0 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1 Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL 1  6.985 17.813 0.033
ZCYL 3  6.988 17.816 0.030
ZCYL 4  7.018 17.846 0.000
* PART #2 3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
```

```
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464 84.3783 0.3805
ZCYL 6 28.575 84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 5 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4 Array of drums: X by Y by Z
ARRAY 1 1 4
* Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0 0.
*       ceiling(339.04cm+8in) floor (0-12in)
CUBOID 7 57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10      30      800      300 STDV .002 -1
MULTIPOINT 4
29. 29. 10. 1
29. 29. 95. 1
29. 29. 180. 1
29. 29. 265. 1
END
CODE 7
PSsVWpC
* xy
0.1 29. 85. 57.4 29. 85. 0.1 29. -10.
* yz
19 38. 10. 38. 38. 10. 19 19 10.
* xy
19. 19 20. 38. 19. 20. 19 19 -1
END


* CEMD2_f Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
   7      14   NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density weightfractions
WGT 2.059  HINH2O 0.040833 O 0.485625 F19 0.032284
      MG 0.066981 CA 0.362397 PU239 0.011881
*
* Mat #2 Carbon Steel 1% C 7.86 g/cm3
CONC C 0.003941 FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT 7.9 C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983 SN 0.001
*
* Mat #4 PVC  [(CH2CH(Cl)]n
WGT 0.9 HINH2O 0.048386 C 0.384338 CL 0.567275
*
* Mat #5 Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C 0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC  AL27 0.003358 CA 0.002614 FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1 Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL 1  6.985 17.813 0.033
ZCYL 3  6.988 17.816 0.030
ZCYL 4  7.018 17.846 0.000
* PART #2 3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000 8.1037 0.0000 P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000 P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 5 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464 84.3783 0.3805
ZCYL 6 28.575 84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4 Array of drums: X by Y by Z
ARRAY 1 1 4
* Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0 0.
*       ceiling(339.04cm+8in) floor (0-12in)
CUBOID 7 57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10      30      800      300 STDV .002 -1
MULTIPOINT 4
29. 29. 10. 1
29. 29. 95. 1
29. 29. 180. 1
29. 29. 265. 1
END
CODE 7
PSsVWpC
* xy
0.1 29. 85. 57.4 29. 85. 0.1 29. -10.
* yz
19 38. 10. 38. 38. 10. 19 19 10.
* xy
19. 19 20. 38. 19. 20. 19 19 -1
END


* CEMD2_g Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
   7      14   NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density weightfractions
WGT 2.059  HINH2O 0.040833 O 0.485625 F19 0.032284
      MG 0.066981 CA 0.362397 PU239 0.011881
*
* Mat #2 Carbon Steel 1% C 7.86 g/cm3
CONC C 0.003941 FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT 7.9 C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983 SN 0.001
*
* Mat #4 PVC  [(CH2CH(Cl)]n
WGT 0.9 HINH2O 0.048386 C 0.384338 CL 0.567275
*
```

```
* Mat #5  Water Vapor (mixed with void)
WGT 0.01 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 5 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*          ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10        30      800         300 STDV .002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
*  xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
*  yz
19 38. 10.  38. 38. 10.  19 19 10.
*  xy
19. 19 20.  38. 19. 20. 19 19 -1
END


* CEMD2_h  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs  #NUCLIDEs
    7          14    NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density   weightfractions
WGT 2.059    HINH2O 0.040833  O 0.485625  F19 0.032284
        MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C   7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005  AL27 0.001  SI 0.006  P31 0.002  S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC    [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.1 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 5 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*          ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10        30      800         300 STDV .002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
*  xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
*  yz
19 38. 10.  38. 38. 10.  19 19 10.
*  xy
19. 19 20.  38. 19. 20. 19 19 -1
END
```

```
* CBMD2_i Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
  7       14    NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density  weightfractions
WGT 2.059  HINH2O 0.040833 O 0.485625 F19 0.032284
     MG 0.066981 CA 0.362397 PU239 0.011881
*
* Mat #2 Carbon Steel 1% C 7.86 g/cm3
CONC C 0.003941 FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT 7.9 C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
    FE 0.983 SN 0.001
*
* Mat #4 PVC  [(CH2CH(Cl)]n
WGT 0.9 HINH2O 0.048386 C 0.384338 CL 0.567275
*
* Mat #5 Water Vapor (mixed with void)
WGT 1.0 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C 0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC  AL27 0.003358 CA 0.002614 FE 0.001344
   HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1 Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL 1  6.985 17.813 0.033
ZCYL 3  6.988 17.816 0.030
ZCYL 4  7.018 17.846 0.000
* PART #2 3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN 0.0000 8.1037 0.0000 P1 7.018 17.846
ZROD ORIGIN 7.0181 -4.0519 0.0000 P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 5 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464 84.3783 0.3805
ZCYL 6 28.575  84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4 Array of drums: X by Y by Z
ARRAY 1 1 4
*  Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0 0.
*       ceiling(339.04cm+8in) floor (0-12in)
CUBOID 7 57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10      30      800        300 STDV .002  -1
MULTIPOINT 4
29. 29. 10. 1
29. 29. 95. 1
29. 29. 180. 1
29. 29. 265. 1
END
CODE 7
PSsVWpC
* xy
0.1 29. 85. 57.4 29. 85. 0.1 29. -10.
* yz
19 38. 10. 38. 38. 10. 19 19 10.
* xy
19. 19 20. 38. 19. 20. 19 19 -1
END
```

```
* CBMD2_j Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
  7       14    NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density  weightfractions
WGT 2.059  HINH2O 0.040833 O 0.485625 F19 0.032284
     MG 0.066981 CA 0.362397 PU239 0.011881
*
* Mat #2 Carbon Steel 1% C 7.86 g/cm3
CONC C 0.003941 FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT 7.9 C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
    FE 0.983 SN 0.001
*
* Mat #4 PVC  [(CH2CH(Cl)]n
WGT 0.9 HINH2O 0.048386 C 0.384338 CL 0.567275
*
* Mat #5 Water Vapor (mixed with void)
WGT 0.001 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C 0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC  AL27 0.003358 CA 0.002614 FE 0.001344
   HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1 Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL 1  6.985 17.813 0.033
ZCYL 3  6.988 17.816 0.030
ZCYL 4  7.018 17.846 0.000
* PART #2 3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN 0.0000 8.1037 0.0000 P1 7.018 17.846
ZROD ORIGIN 7.0181 -4.0519 0.0000 P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 5 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464 84.3783 0.3805
ZCYL 6 28.575  84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4 Array of drums: X by Y by Z
ARRAY 1 1 4
*  Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
```

```
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*         ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10       30       800        300 STDV .002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
* xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
* yz
19 38. 10.  38. 38. 10.  19 19 10.
* xy
19. 19 20.  38. 19. 20. 19 19 -1
END


* CEMD2_k  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
   7        14    NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density   weightfractions
WGT 2.059    HINH2O 0.040833  O 0.485625  F19 0.032284
       MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C   7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005  AL27 0.001  SI 0.006 P31 0.002  S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC    [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.0005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 5 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*         ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10       30       800        300 STDV .002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
* xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
* yz
19 38. 10.  38. 38. 10.  19 19 10.
* xy
19. 19 20.  38. 19. 20. 19 19 -1
END


* CEMD2_and  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center no drum mat
FISSION
* #MATERIALs #NUCLIDEs
   7        14    NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density   weightfractions
WGT 2.059    HINH2O 0.040833  O 0.485625  F19 0.032284
       MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C   7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005  AL27 0.001  SI 0.006 P31 0.002  S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC    [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
```

```
NEST 3
ZCYL 1  6.985 17.813 0.033
ZCYL 3  6.988 17.816 0.030
ZCYL 4  7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 0  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*         ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10        30       1000        300   STDV 0.002  -1
MULTIPOINT 4
29. 29. 10.  1
29. 29. 95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
*  xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
*  yz
19 38. 10.  38. 38. 10.  19 19 10.
*  xy
19. 19 20.  38. 19. 20. 19 19 -1
END


* CEMD2_ac17  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
   7         14    NUCNAMES
*
* Mat #1  Cement/Pu (66.67 g Pu per can)
* Water weight fraction: 0.70  , equivilent to H conc assuming all H
from H2O
* density  weightfractions
WGT 2.059    HINH2O 0.078333  O 0.69636  F19 0.014925
        MG 0.030965  CA 0.167536  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC    [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
     HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL 1  6.985 17.813 0.033
ZCYL 3  6.988 17.816 0.030
ZCYL 4  7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*         ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10        30       1000        300   STDV 0.002  -1
MULTIPOINT 4
29. 29. 10.  1
29. 29. 95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
*  xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
*  yz
19 38. 10.  38. 38. 10.  19 19 10.
*  xy
19. 19 20.  38. 19. 20. 19 19 -1
END


* sphere1  Array of Drums, sphere 200 g Pu  arrange drum center
bottom
FISSION
* #MATERIALs #NUCLIDEs
   7         14    NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 200 g Pu in total
sphere)
* density  weightfractions
```

```
WGT 2.059   HINH2O 0.040587  O 0.482706  F19 0.03209
       MG 0.066578  CA 0.360218  PU239 0.017821
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983  SN 0.001
*
* Mat #4 PVC    [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.0005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation Sphere (cemented residue)
NEST 2
SPHERE ORIGIN 0 0 11.0  1 5
SPHERE ORIGIN 0 0 11.0  1 10.917
* PART #2  3 Cans near drum center (Case 2), including space in
drum
NEST 2
SPHERE ORIGIN  0 0 11.0  P1 10.917
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*         ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-5        30       800        300   STDV 0.002  -1
MULTIPOINT 4
29. 29. 10.  1
29. 29. 95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
*  xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
*  yz
19 38. 10.  38. 38. 10.  19 19 10.
*  xy
19. 19 20.  38. 19. 20. 19 19 -1
END
```

```
*  CEMD2_andp  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center no drum mat
FISSION
*  #MATERIALs  #NUCLIDEs
   7        14    NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
*  density   weightfractions
WGT 2.059    HINH2O 0.040833  O 0.485625  F19 0.032284
       MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983  SN 0.001
*
* Mat #4 PVC    [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 0  28.575   84.6069  0.15189
ZCYL 0  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*         ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10       30       1000       300   STDV 0.002  -1
MULTIPOINT 4
29. 29. 10.  1
29. 29. 95.  1
29. 29. 180.  1
29. 29. 265.  1
```

```
END
CODE 7
PSsVWpC
* xy
0.1 29. 85. 57.4 29. 85. 0.1 29. -10.
* yz
19 38. 10. 38. 38. 10. 19 19 10.
* xy
19. 19 20. 38. 19. 20. 19 19 -1
END


* CEMD2_ahi5 Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
  7      14    NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density  weightfractions
WGT 2.059   HINH2O 0.040833  O 0.485625  F19 0.032284
       MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel 1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 5
*   Part (#3) placed in array 5 times (high)
(3)*5
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 423.8 0.0 0.0  0.
*        ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 444.12 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10        30       1000       300  STDV 0.002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
* xy
0.1 29. 85. 57.4 29. 85. 0.1 29. -10.
* yz
19 38. 10. 38. 38. 10. 19 19 10.
* xy
19. 19 20. 38. 19. 20. 19 19 -1
END


* CEMD2_ahi6  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
  7        14    NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density  weightfractions
WGT 2.059    HINH2O 0.040833  O 0.485625  F19 0.032284
       MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983  SN 0.001
*
* Mat #4 PVC    [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
```

```
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 6
*   Part (#3) placed in array 6 times (high)
(3)*6
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 508.56 0.0 0.0  0.
*         ceiling(508.56cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 528.88 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10       30       1000       300  STDV 0.002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
*  xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
*  yz
19 38. 10.  38. 38. 10.  19 19 10.
*  xy
19. 19 20.  38. 19. 20. 19 19 -1
END


* CEMD2_a_ob2  Array of Drums, 2 cans @66.67 g, 1 @226g Pu ea
arrang drum center
FISSION
* #MATERIALs #NUCLIDEs
   8         14    NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density   weightfractions
WGT 2.059    HINH2O 0.040833  O 0.485625  F19 0.032284
        MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC    [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
     HINH2O 0.007023 O 0.045396 SI 0.012905
*
* Mat #8  Cement/Pu (normal (high) water content, 226 g Pu per can)
* density   weightfractions
WGT 2.059    HINH2O 0.039659   O 0.47167  F19 0.031356
        MG 0.065056  CA 0.351983  PU239 0.040275
*
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN   0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN   7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN  -7.0181 -4.0519 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 5 5 4
*   Part #3 placed in array 12 times then part #7 placed once
*   followed by part #3 12 times in each of the 4 layers
*   overbatch occurs 4 out of 25 drums = 16% of the time
(3)*12 8 (3)*12 (3)*12 8 (3)*12 (3)*12 8 (3)*12 (3)*12 8 (3)*12
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 287.27 287.27 339.04 0.0 0.0  0.
*         ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  287.27 287.27 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* PART #6  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  8   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #7  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN   0.0000  8.1037 0.0000  P6 7.018 17.846
ZROD ORIGIN   7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN  -7.0181 -4.0519 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #8 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P7 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* strtstage, endstage, #histperstage, time(min), -1
-10       30       1000       300  STDV 0.003  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
*  xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
*  yz
19 38. 10.  38. 38. 10.  19 19 10.
```

```
* xy
19. 19 20. 38. 19. 20. 19 19 -1
END


* CEMD2_a_ob3 Array of Drums, 2 cans @66.67 g, 1 @226g Pu ea
arrang drum center
FISSION
* #MATERIALs #NUCLIDEs
  8      14   NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density weightfractions
WGT 2.059   HINH2O 0.040833 O 0.485625 F19 0.032284
      MG 0.066981 CA 0.362397 PU239 0.011881
*
* Mat #2 Carbon Steel 1% C 7.86 g/cm3
CONC C 0.003941 FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT 7.9 C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983 SN 0.001
*
* Mat #4 PVC  [(CH2CH(Cl)]n
WGT 0.9 HINH2O 0.048386 C 0.384338 CL 0.567275
*
* Mat #5 Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C 0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC  AL27 0.003358 CA 0.002614 FE 0.001344
   HINH2O 0.007023 O 0.045396 SI 0.012905
*
* Mat #8 Cement/Pu (normal (high) water content, 226 g Pu per can)
* density weightfractions
WGT 2.059   HINH2O 0.039659 O 0.47167 F19 0.031356
      MG 0.065056 CA 0.351983 PU239 0.040275
*
*
CM
* PART #1 Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL 1  6.985 17.813 0.033
ZCYL 3  6.988 17.816 0.030
ZCYL 4  7.018 17.846 0.000
* PART #2 3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000 8.1037 0.0000 P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000 P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464 84.3783 0.3805
ZCYL 6 28.575  84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4 Array of drums: X by Y by Z
ARRAY 5 5 4
*  Part #3 placed in array 12 times then part #7 placed once
*  followed by part #3 12 times in each of the bottom 2 layers
*  overbatch occurs 2 out of 25 drums = 8% of the time
(3)*12 8 (3)*12 (3)*12 8 (3)*12 (3)*50
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 287.27 287.27 339.04 0.0 0.0 0.
*        ceiling(339.04cm+8in) floor (0-12in)
CUBOID 7 287.27 287.27 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* PART #6 Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL 8  6.985 17.813 0.033
ZCYL 3  6.988 17.816 0.030
ZCYL 4  7.018 17.846 0.000
* PART #7 3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000 8.1037 0.0000 P6 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000 P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #7 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P7 28.3464 84.3783 0.3805
ZCYL 6 28.575  84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* strtstage, endstage, #histperstage, time(min), -1
-10     30     1000     300  STDV 0.003 -1
MULTIPOINT 4
29. 29. 10. 1
29. 29. 95. 1
29. 29. 180. 1
29. 29. 265. 1
END
CODE 7
PSsVWpC
* xy
0.1 29. 85. 57.4 29. 85. 0.1 29. -10.
* yz
19 38. 10. 38. 38. 10. 19 19 10.
* xy
19. 19 20. 38. 19. 20. 19 19 -1
END


* CEMD2_a_xc1 Array of Drums, 3 cans @66.67 g, 1 @113g Pu ea
arrang drum center
FISSION
* #MATERIALs #NUCLIDEs
  8      14   NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density weightfractions
WGT 2.059   HINH2O 0.040833 O 0.485625 F19 0.032284
      MG 0.066981 CA 0.362397 PU239 0.011881
*
* Mat #2 Carbon Steel 1% C 7.86 g/cm3
CONC C 0.003941 FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT 7.9 C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983 SN 0.001
*
* Mat #4 PVC  [(CH2CH(Cl)]n
WGT 0.9 HINH2O 0.048386 C 0.384338 CL 0.567275
*
* Mat #5 Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
```

```
WGT 0.96 HINH2O 0.14397 C 0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC  AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
* Mat #8  Cement/Pu (normal (high) water content, 113 g Pu per can)
* density   weightfractions
WGT 2.059    HINH2O 0.040492  O 0.481567  F19 0.032014
        MG 0.066421  CA 0.359369  PU239 0.020138
*
*
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 5 5 4
*   Part #3 placed in array 12 times then part #7 placed once
*   followed by part #3 12 times in each of the bottom 2 layers
*   overbatch occurs 2 out of 25 drums = 8% of the time
(3)*12 8 (3)*12 (3)*12 8 (3)*12 (3)*50
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 287.27 287.27 339.04 0.0 0.0  0.
*          ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  287.27 287.27 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* PART #6  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  8   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #7  3 Cans + 1 Xtra near drum center (Case 2), including
space in drum
CLUSTER 5
ZROD ORIGIN  0.0000  8.1037 0.0000  P6 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN  0.0000  0.0000 17.8461 P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #7 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P7 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* strtstage, endstage, #histperstage, time(min), -1
-10        30       1000       300  STDV 0.003  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
*  xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
*  yz
19 38. 10.  38. 38. 10.  19 19 10.
*  xy
19. 19 20.  38. 19. 20.  19 19 -1
END


* CEMD2_a_xc2  Array of Drums, 3 cans @66.67 g, 1 @113g Pu ea
arrang drum center
FISSION
* #MATERIALs #NUCLIDEs
    8          14    NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density   weightfractions
WGT 2.059    HINH2O 0.040833  O 0.485625  F19 0.032284
        MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC    [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
* Mat #8  Cement/Pu (normal (high) water content, 113 g Pu per can)
* density   weightfractions
WGT 2.059    HINH2O 0.040492  O 0.481567  F19 0.032014
        MG 0.066421  CA 0.359369  PU239 0.020138
*
*
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
```

```
NEST 4
ZCYL P2 28.3464 84.3783 0.3805
ZCYL 6 28.575 84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4 Array of drums: X by Y by Z
ARRAY 5 5 4
* Part #3 placed in array 12 times then part #7 placed once
* followed by part #3 12 times in each of the 4 layers
* overbatch occurs 4 out of 25 drums = 16% of the time
(3)*12 8 (3)*12 (3)*12 8 (3)*12 (3)*12 8 (3)*12 (3)*12 8 (3)*12
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 287.27 287.27 339.04 0.0 0.0 0.
*       ceiling(339.04cm+8in) floor (0-12in)
CUBOID 7 287.27 287.27 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* PART #6 Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL 8 6.985 17.813 0.033
ZCYL 3 6.988 17.816 0.030
ZCYL 4 7.018 17.846 0.000
* PART #7 3 Cans + 1 Xtra near drum center (Case 2), including
space in drum
CLUSTER 5
ZROD ORIGIN 0.0000 8.1037 0.0000 P6 7.018 17.846
ZROD ORIGIN 7.0181 -4.0519 0.0000 P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000 P1 7.018 17.846
ZROD ORIGIN 0.0000 0.0000 17.8461 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #7 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P7 28.3464 84.3783 0.3805
ZCYL 6 28.575 84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* strtstage, endstage, #histperstage, time(min), -1
-10     30     1000     300  STDV 0.003 -1
MULTIPOINT 4
29. 29. 10. 1
29. 29. 95. 1
29. 29. 180. 1
29. 29. 265. 1
END
CODE 7
PSsVWpC
* xy
0.1 29. 85. 57.4 29. 85. 0.1 29. -10.
* yz
19 38. 10. 38. 38. 10. 19 19 10.
* xy
19. 19 20. 38. 19. 20. 19 19 -1
END


* CEMD2_1 Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center .
FISSION
* #MATERIALs #NUCLIDEs
  7       14   NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density  weightfractions
WGT 2.059   HINH2O 0.040833 O 0.485625 F19 0.032284
      MG 0.066981 CA 0.362397 PU239 0.011881
*
* Mat #2 Carbon Steel 1% C 7.86 g/cm3
CONC C 0.003941 FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT 7.9 C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
    FE 0.983 SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9 HINH2O 0.048386 C 0.384338 CL 0.567275
*
* Mat #5 Water Vapor (mixed with void)
WGT 0.0001 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C 0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC  AL27 0.003358 CA 0.002614 FE 0.001344
   HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1 Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL 1 6.985 17.813 0.033
ZCYL 3 6.988 17.816 0.030
ZCYL 4 7.018 17.846 0.000
* PART #2 3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN 0.0000 8.1037 0.0000 P1 7.018 17.846
ZROD ORIGIN 7.0181 -4.0519 0.0000 P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 5 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464 84.3783 0.3805
ZCYL 6 28.575 84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4 Array of drums: X by Y by Z
ARRAY 1 1 4
* Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0 0.
*       ceiling(339.04cm+8in) floor (0-12in)
CUBOID 7 57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10     30     800     300 STDV .002 -1
MULTIPOINT 4
29. 29. 10. 1
29. 29. 95. 1
29. 29. 180. 1
29. 29. 265. 1
END
CODE 7
PSsVWpC
* xy
0.1 29. 85. 57.4 29. 85. 0.1 29. -10.
* yz
19 38. 10. 38. 38. 10. 19 19 10.
* xy
19. 19 20. 38. 19. 20. 19 19 -1
END


* CEMD2_m Array of Drums, 3 cans 66.67 g Pu ea arrang drum
```

```
center
FISSION
* #MATERIALs #NUCLIDEs
  7        14    NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density  weightfractions
WGT 2.059   HINH2O 0.040833  O 0.485625  F19 0.032284
        MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.0005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  5  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
*         ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10        30       800        300 STDV .002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
```

```
CODE 7
PSsVWpC
*  xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
*  yz
19 38. 10.  38. 38. 10.  19 19 10.
*  xy
19. 19 20.  38. 19. 20. 19 19 -1
END
```

```
* CEMD2_anp  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center no drum mat
FISSION
* #MATERIALs #NUCLIDEs
  7        14    NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density  weightfractions
WGT 2.059   HINH2O 0.040833  O 0.485625  F19 0.032284
        MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 0  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*   Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.454 57.454 339.04 0.0 0.0  0.
```

```
*       ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.454 57.454 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10      30      1000      300  STDV 0.002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
* xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
* yz
19 38. 10.  38. 38. 10.  19 19 10.
* xy
19. 19 20.  38. 19. 20. 19 19 -1
END


* CEMD2_ahd  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
   7        14    NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density   weightfractions
WGT 2.059    HINH2O 0.040833  O 0.485625  F19 0.032284
       MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.6509 84.75879 0.0
CUBOID  0  28.66 28.66 84.759 -28.66 -28.66 -0.001
* PART #4  Array of drums: X by Y by Z
ARRAY 1 1 4
*  Part (#3) placed in array 4 times
(3)*4
* PART #5 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P4 57.32 57.32 339.04 0.0 0.0  0.
*       ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  57.32 57.32 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10      30      1000      300  STDV 0.002  -1
MULTIPOINT 4
29. 29.  10.  1
29. 29.  95.  1
29. 29. 180.  1
29. 29. 265.  1
END
CODE 7
PSsVWpC
* xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
* yz
19 38. 10.  38. 38. 10.  19 19 10.
* xy
19. 19 20.  38. 19. 20. 19 19 -1
END


* CEMD2_aeric  Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
   7        14    NUCNAMES
*
* Mat #1  Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density   weightfractions
WGT 2.059    HINH2O 0.040833  O 0.485625  F19 0.032284
       MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
```

```
ZCYL 3  6.988 17.816 0.030
ZCYL 4  7.018 17.846 0.000
* PART #2 Drum1 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN 2.41 -21.18 0.0000 P1 7.018 17.846
ZROD ORIGIN 15.081 -15.081 0.0000 P1 7.018 17.846
ZROD ORIGIN 21.18 -2.41 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3 Drum2 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN -2.41 -21.18 0.0000 P1 7.018 17.846
ZROD ORIGIN -15.081 -15.081 0.0000 P1 7.018 17.846
ZROD ORIGIN -21.18 -2.41 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #4 Drum3 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN 2.41 21.18 0.0000 P1 7.018 17.846
ZROD ORIGIN 15.081 15.081 0.0000 P1 7.018 17.846
ZROD ORIGIN 21.18 2.41 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #5 Drum4 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN -2.41 21.18 0.0000 P1 7.018 17.846
ZROD ORIGIN -15.081 15.081 0.0000 P1 7.018 17.846
ZROD ORIGIN -21.18 2.41 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #6 Drum5 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN 2.41 -21.18 66.1 P1 7.018 17.846
ZROD ORIGIN 15.081 -15.081 66.1 P1 7.018 17.846
ZROD ORIGIN 21.18 -2.41 66.1 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #7 Drum6 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN -2.41 -21.18 66.1 P1 7.018 17.846
ZROD ORIGIN -15.081 -15.081 66.1 P1 7.018 17.846
ZROD ORIGIN -21.18 -2.41 66.1 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #8 Drum7 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN 2.41 21.18 66.1 P1 7.018 17.846
ZROD ORIGIN 15.081 15.081 66.1 P1 7.018 17.846
ZROD ORIGIN 21.18 2.41 66.1 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #9 Drum8 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN -2.41 21.18 66.1 P1 7.018 17.846
ZROD ORIGIN -15.081 15.081 66.1 P1 7.018 17.846
ZROD ORIGIN -21.18 2.41 66.1 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #10 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464 84.3783 0.3805
ZCYL 6 28.575 84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #11 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P3 28.3464 84.3783 0.3805
ZCYL 6 28.575 84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #12 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P4 28.3464 84.3783 0.3805
ZCYL 6 28.575 84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #13 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P5 28.3464 84.3783 0.3805
ZCYL 6 28.575 84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #14 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P6 28.3464 84.3783 0.3805
ZCYL 6 28.575 84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #15 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P7 28.3464 84.3783 0.3805
ZCYL 6 28.575 84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #16 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P8 28.3464 84.3783 0.3805
ZCYL 6 28.575 84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #17 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P9 28.3464 84.3783 0.3805
ZCYL 6 28.575 84.6069 0.15189
ZCYL 2 28.72689 84.75879 0.0
CUBOID 0 28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #18 Array of drums: X by Y by Z
ARRAY 2 2 4
*  Part (#) placed in array 2 times
(16 17 14 15 12 13 10 11)*2
* PART #19 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P18 114.908 114.908 339.04 0.0 0.0  0.
*       ceiling(339.04cm+8in) floor (0-12in)
CUBOID 7 114.908 114.908 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10     30     1000     300  STDV 0.002 -1
MULTIPOINT 4
80. 80. 10. 1
80. 80. 95. 1
80. 80. 180. 1
75. 75. 265. 1
END
CODE 7
PSsVWpC
* yz
0.1 55 85. 57.4 55 85. 0.1 55 -5.
* yz
54 57.4 170. 54 .1 170. 54 57.4 -2.
* xy
.1 114 70. 114 114 70. .1 .1 70.
* xy
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.1 114 100. 114 114 100. .1 .1 100.
END


* CEMD2_aerict Array of Drums, 3 cans 66.67 g Pu ea arrang drum
center
FISSION
* #MATERIALs #NUCLIDEs
   7        14    NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density weightfractions
WGT 2.059   HINH2O 0.040833  O 0.485625  F19 0.032284
        MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel 1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5 Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  3 Cans near drum center (Case 2), including space in
drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 0.0000  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 0.0000  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3  3 Cans near drum center at top of drum (Case 2),
including space in drum
CLUSTER 4
ZROD ORIGIN  0.0000  8.1037 66.1  P1 7.018 17.846
ZROD ORIGIN  7.0181 -4.0519 66.1  P1 7.018 17.846
ZROD ORIGIN -7.0181 -4.0519 66.1  P1 7.018 17.846
*  55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #4 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #5 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P3 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #6  Array of drums: X by Y by Z
ARRAY 2 2 4
*   Part (#) placed in array 2 times
(5 5 5 5 4 4 4 4)*2
* PART #7 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P6 114.908 114.908 339.04 0.0 0.0  0.
*        ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  114.908 114.908 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10        30      1000       300  STDV 0.002  -1
MULTIPOINT 4
40. 40.  10.  1
40. 40.  95.  1
40. 40. 180.  1
35. 35. 265.  1
END
CODE 7
PSsVWpC
*  xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
*  yz
19 38. 10.  38. 38. 10.  19 19 10.
*  xy
19. 19 20.  38. 19. 20. 19 19 -1
END


* CEMD2_aericc13  Array of Drums, 3 cans 66.67 g Pu ea arrang
drum center
FISSION
* #MATERIALs #NUCLIDEs
   7        14    NUCNAMES
*
* Mat #1  Cement/Pu (66.67 g Pu per can)
* Water weight fraction: 0.52  , equivilent to H conc assuming all H
from H2O
* density  weightfractions
WGT 2.059   HINH2O 0.05819  O 0.583166  F19 0.024249
        MG 0.050311  CA 0.272203  PU239 0.011881
*
* Mat #2 Carbon Steel  1% C  7.86 g/cm3
CONC  C 0.003941  FE 0.0839103
*
* Mat #3  Steel (slip cover can)
WGT  7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
      FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC   AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  Drum1 (Case 2, Erickson), including space in drum
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CLUSTER 4
ZROD ORIGIN  2.41  -21.18 0.0000  P1 7.018 17.846
ZROD ORIGIN  15.081 -15.081 0.0000  P1 7.018 17.846
ZROD ORIGIN 21.18 -2.41 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #3  Drum2 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN  -2.41  -21.18 0.0000  P1 7.018 17.846
ZROD ORIGIN  -15.081 -15.081 0.0000  P1 7.018 17.846
ZROD ORIGIN -21.18 -2.41 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #4  Drum3 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN  2.41  21.18 0.0000  P1 7.018 17.846
ZROD ORIGIN  15.081 15.081 0.0000  P1 7.018 17.846
ZROD ORIGIN 21.18 2.41 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #5  Drum4 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN  -2.41  21.18 0.0000  P1 7.018 17.846
ZROD ORIGIN  -15.081 15.081 0.0000  P1 7.018 17.846
ZROD ORIGIN -21.18 2.41 0.0000  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #6  Drum5 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN  2.41  -21.18 66.1  P1 7.018 17.846
ZROD ORIGIN  15.081 -15.081 66.1  P1 7.018 17.846
ZROD ORIGIN  21.18 -2.41 66.1  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #7  Drum6 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN  -2.41  -21.18 66.1  P1 7.018 17.846
ZROD ORIGIN  -15.081 -15.081 66.1  P1 7.018 17.846
ZROD ORIGIN -21.18 -2.41 66.1  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #8  Drum7 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN  2.41  21.18 66.1  P1 7.018 17.846
ZROD ORIGIN  15.081 15.081 66.1  P1 7.018 17.846
ZROD ORIGIN 21.18 2.41 66.1  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #9  Drum8 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN  -2.41  21.18 66.1  P1 7.018 17.846
ZROD ORIGIN  -15.081 15.081 66.1  P1 7.018 17.846
ZROD ORIGIN -21.18 2.41 66.1  P1 7.018 17.846
*  55 Gal 17C drum inner:  22.5 in ID, 33.25 in inside height
*  drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 83.9978
* PART #10 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #11 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P3 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #12 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P4 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #13 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P5 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #14 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P6 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #15 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P7 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #16 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P8 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #17 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P9 28.3464  84.3783  0.3805
ZCYL 6  28.575   84.6069  0.15189
ZCYL 2  28.72689 84.75879 0.0
CUBOID  0  28.727 28.727 84.759 -28.727 -28.727 -0.001
* PART #18  Array of drums: X by Y by Z
ARRAY 2 2 4
*   Part (#) placed in array 2 times
(16 17 14 15 12 13 10 11)*2
* PART #19 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P18 114.908 114.908 339.04 0.0 0.0  0.
*        ceiling(339.04cm+8in)  floor (0-12in)
CUBOID 7  114.908 114.908 359.36 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10      30      1000      300  STDV 0.003  -1
MULTIPOINT 4
80. 80.  10.  1
80. 80.  95.  1
80. 80. 180.  1
75. 75. 265.  1
END
CODE 7
PSsVWpC
*  xy
0.1 29. 85.  57.4 29. 85.  0.1 29. -10.
*  yz
19 38. 10.  38. 38. 10.  19 19 10.
*  xy
19. 19 20.  38. 19. 20. 19 19 -1
END
```

* CEMD2_aericcr Array of Drums (Drums Crushed), 3 cans 66.67 g

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Pu ea arrang drum center
FISSION
* #MATERIALs #NUCLIDEs
  7      14   NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density  weightfractions
WGT 2.059   HINH2O 0.040833 O 0.485625 F19 0.032284
        MG 0.066981 CA 0.362397 PU239 0.011881
*
* Mat #2 Carbon Steel 1% C 7.86 g/cm3 (density altered for
crushing -maintain mass)
CONC C 0.01338 FE 0.284945
*
* Mat #3 Steel (slip cover can)
WGT 7.9 C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983 SN 0.001
*
* Mat #4 PVC  [(CH2CH(Cl)]n
WGT 0.9 HINH2O 0.048386 C 0.384338 CL 0.567275
*
* Mat #5 Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n (density altered for crushing -maintain
mass)
WGT 3.26 HINH2O 0.14397 C 0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC  AL27 0.003358 CA 0.002614 FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1 Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL 1  6.985 17.813 0.033
ZCYL 3  6.988 17.816 0.030
ZCYL 4  7.018 17.846 0.000
* PART #2 Drum1 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN 2.41 -21.18 0.0000 P1 7.018 17.846
ZROD ORIGIN 15.081 -15.081 0.0000 P1 7.018 17.846
ZROD ORIGIN 21.18 -2.41 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #3 Drum2 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN -2.41 -21.18 0.0000 P1 7.018 17.846
ZROD ORIGIN -15.081 -15.081 0.0000 P1 7.018 17.846
ZROD ORIGIN -21.18 -2.41 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #4 Drum3 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN 2.41 21.18 0.0000 P1 7.018 17.846
ZROD ORIGIN 15.081 15.081 0.0000 P1 7.018 17.846
ZROD ORIGIN 21.18 2.41 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #5 Drum4 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN -2.41 21.18 0.0000 P1 7.018 17.846
ZROD ORIGIN -15.081 15.081 0.0000 P1 7.018 17.846
ZROD ORIGIN -21.18 2.41 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #6 Drum5 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN 2.41 -21.18 0.00 P1 7.018 17.846
ZROD ORIGIN 15.081 -15.081 0.00 P1 7.018 17.846
ZROD ORIGIN 21.18 -2.41 0.00 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #7 Drum6 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN -2.41 -21.18 0.00 P1 7.018 17.846
ZROD ORIGIN -15.081 -15.081 0.00 P1 7.018 17.846
ZROD ORIGIN -21.18 -2.41 0.00 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #8 Drum7 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN 2.41 21.18 0.00 P1 7.018 17.846
ZROD ORIGIN 15.081 15.081 0.00 P1 7.018 17.846
ZROD ORIGIN 21.18 2.41 0.00 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #9 Drum8 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN -2.41 21.18 0.00 P1 7.018 17.846
ZROD ORIGIN -15.081 15.081 0.00 P1 7.018 17.846
ZROD ORIGIN -21.18 2.41 0.00 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #10 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464 20.3805 0.3805
ZCYL 6 28.575 20.6091 0.15189
ZCYL 2 28.72689 20.76099 0.0
CUBOID 0 28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #11 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P3 28.3464 20.3805 0.3805
ZCYL 6 28.575 20.6091 0.15189
ZCYL 2 28.72689 20.76099 0.0
CUBOID 0 28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #12 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P4 28.3464 20.3805 0.3805
ZCYL 6 28.575 20.6091 0.15189
ZCYL 2 28.72689 20.76099 0.0
CUBOID 0 28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #13 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P5 28.3464 20.3805 0.3805
ZCYL 6 28.575 20.6091 0.15189
ZCYL 2 28.72689 20.76099 0.0
CUBOID 0 28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #14 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P6 28.3464 20.3805 0.3805
ZCYL 6 28.575 20.6091 0.15189
ZCYL 2 28.72689 20.76099 0.0
CUBOID 0 28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #15 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P7 28.3464 20.3805 0.3805
ZCYL 6 28.575 20.6091 0.15189
ZCYL 2 28.72689 20.76099 0.0
CUBOID 0 28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #16 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P8 28.3464 20.3805 0.3805
```

```
Pu ea arrang drum center
FISSION
* #MATERIALs #NUCLIDEs
   7       14   NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density  weightfractions
WGT 2.059   HINH2O 0.040833  O 0.485625  F19 0.032284
      MG 0.066981  CA 0.362397  PU239 0.011881
*
* Mat #2 Carbon Steel 1% C  7.86 g/cm3 (density altered for
crushing -maintain mass)
CONC  C 0.01338  FE 0.284945
*
* Mat #3 Steel (slip cover can)
WGT 7.9  C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
     FE 0.983  SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9  HINH2O 0.048386  C 0.384338  CL 0.567275
*
* Mat #5  Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n (density altered for crushing -maintain
mass)
WGT 3.26 HINH2O 0.14397 C  0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC  AL27 0.003358  CA 0.002614  FE 0.001344
    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1  Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL  1   6.985 17.813 0.033
ZCYL  3   6.988 17.816 0.030
ZCYL  4   7.018 17.846 0.000
* PART #2  Drum1 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN  2.41  -21.18 0.0000  P1 7.018 17.846
ZROD ORIGIN  15.081 -15.081 0.0000  P1 7.018 17.846
ZROD ORIGIN 21.18 -2.41 0.0000  P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #3  Drum2 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN  -2.41  -21.18 0.0000  P1 7.018 17.846
ZROD ORIGIN  -15.081 -15.081 0.0000  P1 7.018 17.846
ZROD ORIGIN -21.18 -2.41 0.0000  P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #4  Drum3 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN  2.41  21.18 0.0000  P1 7.018 17.846
ZROD ORIGIN  15.081 15.081 0.0000  P1 7.018 17.846
ZROD ORIGIN 21.18 2.41 0.0000  P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #5  Drum4 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN  -2.41  21.18 0.0000  P1 7.018 17.846
ZROD ORIGIN  -15.081 15.081 0.0000  P1 7.018 17.846
ZROD ORIGIN -21.18 2.41 0.0000  P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #6  Drum5 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN  2.41  -21.18 0.00  P1 7.018 17.846
ZROD ORIGIN  15.081 -15.081 0.00  P1 7.018 17.846
ZROD ORIGIN  21.18 -2.41 0.00  P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #7  Drum6 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN  -2.41  -21.18 0.00  P1 7.018 17.846
ZROD ORIGIN  -15.081 -15.081 0.00  P1 7.018 17.846
ZROD ORIGIN -21.18 -2.41 0.00  P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #8  Drum7 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN  2.41  21.18 0.00  P1 7.018 17.846
ZROD ORIGIN  15.081 15.081 0.00  P1 7.018 17.846
ZROD ORIGIN 21.18 2.41 0.00  P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #9  Drum8 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN  -2.41  21.18 0.00  P1 7.018 17.846
ZROD ORIGIN  -15.081 15.081 0.00  P1 7.018 17.846
ZROD ORIGIN -21.18 2.41 0.00  P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #10 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  20.3805  0.3805
ZCYL 6  28.575  20.6091  0.15189
ZCYL 2  28.72689 20.76099 0.0
CUBOID  0  28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #11 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P3 28.3464  20.3805  0.3805
ZCYL 6  28.575  20.6091  0.15189
ZCYL 2  28.72689 20.76099 0.0
CUBOID  0  28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #12 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P4 28.3464  20.3805  0.3805
ZCYL 6  28.575  20.6091  0.15189
ZCYL 2  28.72689 20.76099 0.0
CUBOID  0  28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #13 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P5 28.3464  20.3805  0.3805
ZCYL 6  28.575  20.6091  0.15189
ZCYL 2  28.72689 20.76099 0.0
CUBOID  0  28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #14 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P6 28.3464  20.3805  0.3805
ZCYL 6  28.575  20.6091  0.15189
ZCYL 2  28.72689 20.76099 0.0
CUBOID  0  28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #15 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P7 28.3464  20.3805  0.3805
ZCYL 6  28.575  20.6091  0.15189
ZCYL 2  28.72689 20.76099 0.0
CUBOID  0  28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #16 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P8 28.3464  20.3805  0.3805
```

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ZCYL 6 28.575 20.6091 0.15189
ZCYL 2 28.72689 20.76099 0.0
CUBOID 0 28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #17 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P9 28.3464 20.3805 0.3805
ZCYL 6 28.575 20.6091 0.15189
ZCYL 2 28.72689 20.76099 0.0
CUBOID 0 28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #18 Array of drums: X by Y by Z
ARRAY 2 2 4
* Part (#) placed in array 2 times
(16 17 14 15 12 13 10 11)*2
* PART #19 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P18 114.908 114.908 83.0488 0.0 0.0 0.
*       ceiling (thin) floor (0-12in)
CUBOID 7 114.908 114.908 88.0 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10     30     1000     300  STDV 0.003 -1
MULTIPOINT 4
80. 80. 10. 1
80. 80. 35. 1
80. 80. 50. 1
75. 75. 75. 1
END
CODE 7
PSsVWpC
* yz
0.1 55 85. 57.4 55 85. 0.1 55 -5.
* yz
54 57.4 170. 54 .1 170. 54 57.4 -2.
* xy
.1 114 70. 114 114 70. .1 .1 70.
* xy
.1 114 100. 114 114 100. .1 .1 100.
END


* CEMD2_aericcrl Array of Drums (Drums Crushed), 3 cans 66.67
g Pu ea arrang drum center
FISSION
* #MATERIALs #NUCLIDEs
  7      14   NUCNAMES
*
* Mat #1 Cement/Pu (normal (high) water content, 66.67 g Pu per
can)
* density  weightfractions
WGT 2.059  HINH2O 0.040833 O 0.485625 F19 0.032284
      MG 0.066981 CA 0.362397 PU239 0.011881
*
* Mat #2 Carbon Steel 1% C  7.86 g/cm3
CONC  C 0.003941 FE 0.0839103
*
* Mat #3 Steel (slip cover can)
WGT 7.9 C 0.005 AL27 0.001 SI 0.006 P31 0.002 S32 0.002
    FE 0.983 SN 0.001
*
* Mat #4 PVC   [(CH2CH(Cl)]n
WGT 0.9 HINH2O 0.048386 C 0.384338 CL 0.567275
*
* Mat #5 Water Vapor (mixed with void)
WGT 0.005 HINH2O 0.111885 O 0.888115
*
* Mat #6 Polyethylene (CH2)n
WGT 0.96 HINH2O 0.14397 C 0.856303
*
* Mat #7 Concrete, conservative Hanford (dens=2.35 g/cm3)
CONC  AL27 0.003358 CA 0.002614 FE 0.001344
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    HINH2O 0.007023 O 0.045396 SI 0.012905
*
CM
* PART #1 Cementation can (cemented residue, steel can, PVC bag)
NEST 3
ZCYL 1  6.985 17.813 0.033
ZCYL 3  6.988 17.816 0.030
ZCYL 4  7.018 17.846 0.000
* PART #2 Drum1 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN 2.41 -21.18 0.0000 P1 7.018 17.846
ZROD ORIGIN 15.081 -15.081 0.0000 P1 7.018 17.846
ZROD ORIGIN 21.18 -2.41 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #3 Drum2 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN -2.41 -21.18 0.0000 P1 7.018 17.846
ZROD ORIGIN -15.081 -15.081 0.0000 P1 7.018 17.846
ZROD ORIGIN -21.18 -2.41 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #4 Drum3 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN 2.41 21.18 0.0000 P1 7.018 17.846
ZROD ORIGIN 15.081 15.081 0.0000 P1 7.018 17.846
ZROD ORIGIN 21.18 2.41 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #5 Drum4 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN -2.41 21.18 0.0000 P1 7.018 17.846
ZROD ORIGIN -15.081 15.081 0.0000 P1 7.018 17.846
ZROD ORIGIN -21.18 2.41 0.0000 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #6 Drum5 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN 2.41 -21.18 0.00 P1 7.018 17.846
ZROD ORIGIN 15.081 -15.081 0.00 P1 7.018 17.846
ZROD ORIGIN 21.18 -2.41 0.00 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #7 Drum6 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN -2.41 -21.18 0.00 P1 7.018 17.846
ZROD ORIGIN -15.081 -15.081 0.00 P1 7.018 17.846
ZROD ORIGIN -21.18 -2.41 0.00 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #8 Drum7 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN 2.41 21.18 0.00 P1 7.018 17.846
ZROD ORIGIN 15.081 15.081 0.00 P1 7.018 17.846
ZROD ORIGIN 21.18 2.41 0.00 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
ZROD 0 28.3464 20.00
* PART #9 Drum8 (Case 2, Erickson), including space in drum
CLUSTER 4
ZROD ORIGIN -2.41 21.18 0.00 P1 7.018 17.846
ZROD ORIGIN -15.081 15.081 0.00 P1 7.018 17.846
ZROD ORIGIN -21.18 2.41 0.00 P1 7.018 17.846
* 55 Gal 17C drum inner: 22.5 in ID, 33.25 in inside height
* drum lined with 0.09 in thick poly -> (22.32 ID, 33.07 IH)
```

```
ZROD 0 28.3464 20.00
* PART #10 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P2 28.3464  20.3805  0.3805
ZCYL 6  28.575   20.6091  0.15189
ZCYL 2  28.72689 20.76099 0.0
CUBOID  0  28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #11 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P3 28.3464  20.3805  0.3805
ZCYL 6  28.575   20.6091  0.15189
ZCYL 2  28.72689 20.76099 0.0
CUBOID  0  28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #12 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P4 28.3464  20.3805  0.3805
ZCYL 6  28.575   20.6091  0.15189
ZCYL 2  28.72689 20.76099 0.0
CUBOID  0  28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #13 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P5 28.3464  20.3805  0.3805
ZCYL 6  28.575   20.6091  0.15189
ZCYL 2  28.72689 20.76099 0.0
CUBOID  0  28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #14 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P6 28.3464  20.3805  0.3805
ZCYL 6  28.575   20.6091  0.15189
ZCYL 2  28.72689 20.76099 0.0
CUBOID  0  28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #15 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P7 28.3464  20.3805  0.3805
ZCYL 6  28.575   20.6091  0.15189
ZCYL 2  28.72689 20.76099 0.0
CUBOID  0  28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #16 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P8 28.3464  20.3805  0.3805
ZCYL 6  28.575   20.6091  0.15189
ZCYL 2  28.72689 20.76099 0.0
CUBOID  0  28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #17 Drum with Poly liner (inside cube box of space)
NEST 4
ZCYL P9 28.3464  20.3805  0.3805
ZCYL 6  28.575   20.6091  0.15189
ZCYL 2  28.72689 20.76099 0.0
CUBOID  0  28.727 28.727 20.7612 -28.727 -28.727 -0.001
* PART #18  Array of drums: X by Y by Z
ARRAY 2 2 4
*  Part (#) placed in array 2 times
(16 17 14 15 12 13 10 11)*2
* PART #19 Array container / Concrete Floor (12in) & Ceiling (8in)
NEST 2
CUBOID P18 114.908 114.908 83.0488 0.0 0.0  0.
*        ceiling (thin)  floor (0-12in)
CUBOID 7  114.908 114.908 88.0 0.0 0.0 -30.48
* reflective surfaces on X and Y surfaces of outer cube
ALBEDO 1.0 1.0 0.0 1.0 1.0 0.0
* strtstage, endstage, #histperstage, time(min), -1
-10        30      1000        300  STDV 0.005  -1
MULTIPOINT 4
80. 80.  10.  1
80. 80.  35.  1
80. 80.  50.  1
75. 75. 75.  1
END
CODE 7
PSsVWpC
*  yz
0.1 55 85.  57.4 55 85.  0.1 55 -5.
*  yz
54 57.4 170.  54 .1 170.  54 57.4 -2.
*  xy
.1 114 70.  114 114 70.  .1 .1 70.
*  xy
.1 114 100.  114 114 100.  .1 .1 100.
END
```

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Environmental and Nuclear Initiatives	Date 01/13/97
Project Title/Work Order		EDT No. 620278
CSER 96-027: Storage of Cemented Plutonium Residue Containers in 55 Gallon Drums		ECN No.

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
G. G. Bergquest	T5-55	X			
D. G. Erickson	H0-35	X			
S. R. Gedeon	H0-35	X			
H. J. Goldberg	H0-35	X			
J. Greenborg	H0-35	X			
R. Gregory	T5-56	X			
K. E. Hillesland	H0-35	X			
D. A. Himes	H0-35	X			
R. M. Irwin	T4-03	X			
J. A. Locklair	T3-05	X			
E. M. Miller	H0-35	X			
L. T. Nirider	T5-35	X			
S. E. Nunn	T5-11	X			
R. J. Puigh	H0-3[illegible]	X			
A. L. Ramble	T5-54	X			
R. F. Richard	H0-35	X			
S. P. Roblyer	H0-35	X			
V. E. Roetman	H0-35	X			
R. H. Ruben	H0-35	X			
K. N. Schwinkendorf	H0-35	X			
W. T. Watson	H0-3[illegible]	X			
W. D. Wittekind	H0-35	X			
Central Files	A3-88	X			