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ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 605739

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [] Direct Revision [x] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	D. G. Erickson, 403, B4-44, 6-4146	[] Yes [X] No	10/16/98
	6. Project Title/No./Work Order No. PFP CSER 98-003 for Glovebox HC-21A	7. Bldg./Sys./Fac. No. PFP	8. Approval Designator S
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) HNF-2705 Rev 0	10. Related ECN No(s). N/A	11. Related PO No. N/A

12a. Modification Work	12b. Work Package No.	12c. Modification Work Complete	12d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 12b) [X] No (NA Blks. 12b, 12c, 12d)	~~EDT 623015~~ KDD 10/23/98	N/A Design Authority/Cog. Engineer Signature & Date	N/A Design Authority/Cog. Engineer Signature & Date

13a. Description of Change

13b. Design Baseline Document? [] Yes [X] No

CSER 98-003: "Criticality Safety Evaluation Report for PFP Glovebox HC-21A with Button Can Opening" is changed from limiting the number of open containers to limiting the volume of the unit mass.

14a. Justification (mark one)

Criteria Change	[X]	Design Improvement	[]	Environmental	[]	Facility Deactivation	[]
As-Found	[]	Facilitate Const	[]	Const. Error/Omission	[]	Design Error/Omission	[]

14b. Justification Details

For the off-normal fire event, the volume of open containers in a group containing fissile material needs to be limited for criticality safety. The original document required the number of open containers to be limited, which presents procedural problems for the plant. The revision, instead, limits the volume of containers in a grouping.

15. Distribution (include name, MSIN, and no. of copies)

See attached distribution sheet.

RELEASE STAMP

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A-7900-013-1 (06/92)

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1) 605739

16. Design Verification Required	17. Cost Impact				18. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	[] $	Additional	[] $	Improvement	[]
[X] No	Savings	[] $	Savings	[] $	Delay	[]

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[X]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[X]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[X]
Environmental Report	[]	Inspection Plan	[]	FSAR ANNUAL UPDATE	[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
CPS-Z-165-80639 Rev A-1	Z0-160-032 Rev J-1 Z0-160-034 Rev G-0 Z0-160-035 Rev B-0	WHC-SD-CP-SAR-021 Rev 0-J

21. Approvals

Signature	Date	Signature	Date
Design Authority RA Szempruch [signature]	10/19/98	Design Agent AL Ramble [signature] for ALR	10/19/98
Cog. Eng. DG Erickson [signature]	10-16-98	PE	
Cog. Mgr. JP Estrellado [signature]	10/16/98	QA	
QA		Safety ~~SE Nunn~~ D.A. CONNERS IV [signature]	10/20/98
Safety See Right Column KDD 10/22/98		Design	
Environ.		Environ.	
Tech. Review RF Richard [signature]	10-17-98	Trans. Ops. MG Thien [signature]	10/19/98
CSE KD Dobbin [signature]	10/16/98	Indep. Tech. Review J Greenborg [signature]	10/16/98
Contributor EM Miller [signature]	10/16/98		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

CSER 98-003: CRITICALITY SAFETY EVALUATION REPORT FOR PFP GLOVEBOX HC-21A WITH BUTTON CAN OPENING

David G. Erickson
Fluor Daniel Northwest, Inc., Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: ~~623015~~/605739 KDD 10/23/98	UC: 510
Org Code: 403	Charge Code: 101417/AJ60
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Key Words: PFP, PLUTONIUM, BUTTONS, HC-21A, THERMAL STABILIZATION

Abstract: This Criticality Safety Evaluation was prepared by Fluor Daniel Northwest under contract to BWHC. This document establishes the critically safety parameters for plutonium operations in glovebox HC-21A

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Approved for Public Release

RECORD OF REVISION	(1) Document Number HNF-2705	Page 1

(2) Title

CSER 98-003: Criticality Safety Evaluation Report for PFP Glovebox HC-21A with Button Can Opening

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) Initial release EDT # 623015 on 10/9/98	D.G. Erickson [signature]	J. P. Estrellado [signature] 10/16/98
RS 1	Replace entire document HNF-2705 per ECN 605739	D. G. Erickson [signature] 10-16-98	J. P. Estrellado [signature] 10/16/98

CSER 98-003: Criticality Safety Evaluation Report for PFP Glovebox HC-21A with Button Can Opening

October 1998

Prepared by
Fluor Daniel Northwest, Inc.
Richland, Washington

For
B&W Hanford, Inc.
In Support of
Task Order No. PF-804 Rev. 16

Prepared by: ______________________ Date: 10-16-98
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Executive Summary

Glovebox HC-21A is an enclosure where cans containing plutonium metal buttons or other plutonium bearing materials are prepared for thermal stabilization in the muffle furnaces. The Inert Atmosphere Confinement (IAC), a new feature added to Glovebox HC-21A, allows the opening of containers suspected of containing hydrided plutonium metal. The argon atmosphere in the IAC prevents an adverse reaction between oxygen and the hydride. The hydride is then stabilized in a controlled manner to prevent glovebox over pressurization. After removal from the containers, the plutonium metal buttons or plutonium bearing materials will be placed into muffle furnace boats and then be sent to one of the muffle furnace gloveboxes for stabilization.

The materials allowed to be brought into Glovebox HC-21A are limited to those with a hydrogen to fissile atom ratio (H/X)$\leq$ 20. Glovebox HC-21A is classified as a DRY glovebox, meaning it has no internal liquid lines, and no free liquids or solutions are allowed to be introduced.

The double contingency principle states that designs shall incorporate sufficient factors of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident is possible.

This criticality safety evaluation report (CSER) shows that the operations to be performed in this glovebox are safe from a criticality standpoint. No single identified event that causes criticality controls to be lost exceeded the criticality safety limit of $k_{eff} = 0.95$ (including uncertainties). Therefore, this CSER meets the requirements for a criticality analysis contained in the Hanford Site Nuclear Criticality Safety Manual, HNF-PRO-334, and meets the double contingency principle.

Table of Contents

1.0 Introduction

Glovebox HC-21A is an enclosure where cans containing plutonium metal buttons or plutonium bearing materials are prepared for thermal stabilization in the muffle furnaces. Cans containing plutonium metal that may be hydrided will be opened in the Inert Atmosphere Confinement (IAC) in an atmosphere containing argon and about 1.0% oxygen. The argon atmosphere in the IAC prevents an adverse rapid reaction between oxygen and the hydride. The hydride is then stabilized in a controlled manner to prevent glovebox over pressurization. After removal from the containers, the plutonium metal buttons and the plutonium bearing materials will be placed into muffle furnace boats. These boats will then be weighed to assure that fissionable material limits are met and then be sent to one of the muffle furnace gloveboxes via conveyor HC-2.

The non-metal forms of plutonium (hereafter referred to as plutonium oxide or PuO_2) will also be prepared for thermal stabilization in the muffle furnaces. The plutonium oxide containers will most likely be opened in the normal glovebox atmosphere and placed into muffle furnace boats. These boats will then be weighed to assure that fissionable material limits are met and will then be sent to one of the muffle furnace gloveboxes via conveyor HC-2.

The materials being brought into Glovebox HC-21A will have a hydrogen to fissile atom ratio $(H/X) \leq 20$. Glovebox HC-21A is classified as a DRY glovebox, meaning it has no internal liquid lines, and no free liquids or solutions are allowed to be introduced.

2.0 Summary

This criticality safety evaluation report (CSER) shows that the operations described in the process flow description and that are controlled to the limits listed in Section 3.1 are safe from a criticality standpoint. No single unlikely event that causes criticality controls to be lost exceeded the criticality safety limit of $k_{eff} = 0.95$. Therefore, this CSER meets the requirements for a criticality analysis contained in the Criticality Safety General Requirements document, HNF-PRO-334, and meets the double contingency principle. A contingency is defined to be any single unlikely event that causes criticality controls to be lost.

3.0 Limits, Controls, and Engineered Features

Table 3-1 lists each of the parameters of concern for criticality safety, and discusses whether controls on these parameters are necessary, and if not, why not.

Table 3-1. Controls on Parameters Related to Criticality in Glovebox HC-21A

Parameter	Controlled	Discussion (Limit or Process Control if Yes, Reason if No)
Mass	Yes	3.5 kg plutonium total glovebox mass, consisting of: 1) Maximum 2.5 kg plutonium unit masses, and 2) glovebox holdup.
Volume or Geometry	Yes	There is no volume limit associated with the glovebox; however, a limit of 4.6 ℓ for each unit mass is imposed that includes all open containers within 25.4 cm (10.0 in.). Individual container limits as follows are also required. Furnace boat maximum 2.3 ℓ, fissionable material container maximum 1.9 ℓ, powder accumulation can inside height ≤ 2.54 cm (1 in.), powder boat inside height ≤ 2.54 cm (1 in.).
Spacing	Yes	25.4 cm (10 in.) edge-to-edge minimum spacing between a unit mass and other unit masses or containers of fissionable material, including containers on conveyor HC-2.
Moderator	Yes	Maximum allowed H/X = 20.
Reflector	Yes	No free liquids or solutions are allowed in the glovebox. No neutron reflectors or moderators (or fissionable materials > 15 g) are allowed to be moved or stored under the glovebox, unless explicitly covered by analysis.
Poisons	No	Poisons were not used in this analysis.
Concentration	No	Worst credible concentrations were analyzed.
Enrichment	No	Plutonium was assumed to be 100 wt% ^{239}Pu. This conservatively encompasses all allowed fissionable materials including depleted or natural uranium as well as small quantities of high enriched uranium.
Density	No	Maximum credible densities were used for all materials.
Other	N/A	No other parameters affecting criticality were identified.

3.1 Limits for Criticality Safety

The operations in Glovebox HC-21A are defined in Section 4.1. Operations are performed in either the Inert Atmosphere Confinement (IAC) area or in the main glovebox area. The fissionable material mass limits specified for these operations are under the constraints of the overall fissionable material mass limits of the glovebox. The glovebox limits for criticality are:

- The overall combined mass limit of plutonium in Glovebox HC-21A is 3.5 kg Pu including holdup.
- Unit mass, 2.5 kg Pu maximum as metallic plutonium, plutonium oxides or compounds, and mixed oxides/compounds of plutonium and uranium (≤ 1 wt% as enriched uranium).
- Unit mass volume limit = 4.6 ℓ, this includes all containers within a 25.4 cm (10 in.) edge-to-edge spacing.

- 25.4 cm (10 in.) edge-to-edge minimum spacing between a unit mass and other unit masses or containers of fissionable material, including containers on conveyor HC-2.
- Furnace boat maximum volume 2.3 ℓ.
- Fissionable material container maximum volume 1.9 ℓ.
- Maximum allowed H/X =20.
- Stacking of containers and/or boats is prohibited.

3.2 Process Controls for Criticality Safety

To assure continued criticality safety during operations, several process controls are required. They are:

- One 0.5 ℓ nominal volume container for floor sweepings is allowed.
- One empty 0.5 ℓ nominal volume slip lid can stored upside down in the IAC for emergency use in covering opened button can is allowed.
- One (1) damp rag (limited to 6 sq. ft. total) is allowed for cleaning.
- Powder accumulation can inside height ≤ 2.54 cm (1 in.).
- Powder boat inside height ≤ 2.54 cm (1 in.)
- Cans of MgO_2 for fire fighting are allowed.
- Noticeable accumulations of fissionable materials, such as from spills, are not allowed to remain in Glovebox HC-21A, and are to be cleaned up as soon as practical.
- No neutron reflectors or moderators are allowed to be moved or stored under the glovebox, unless explicitly covered by analysis.
- The glovebox depression is to be filled (max volume = 2.3 ℓ), sealed or made into a non-container in order to prevent accumulation of fissionable materials.
- During HEPA filter change out, all loaded containers shall be removed from the glovebox.
- No fissionable materials > 15 g are permitted underneath the glovebox at any time.

3.3 Supporting Information

Operations within Glovebox HC-21A require:

Fire Fighting Category: C.

This allows mists or fogs during fire fighting, but no directed solid streams of water are allowed (that may move or upset containers of fissionable materials).

3.4 Controlled Dimensions and Assumptions

No additional equipment dimension controls are required.

4.0 Facility and Operation Description

Glovebox HC-21A will be used to receive metallic plutonium, plutonium oxide or other plutonium or uranium compounds in preparation for thermal stabilization in the muffle furnaces. The normal operational sequence relating to criticality safety is given in Section 4.1 below.

The following sections describe the facilities, fissionable materials, and technical practices and process features of the handling processes.

4.1 Operational Sequence

The following is an approximate sequence of the operations as they occur in the glovebox. Not all steps are necessarily listed; however, every effort has been made to adequately describe all steps that may have an impact on criticality safety.

Step 1. Bring one container of fissile material into glovebox:
Mass ≤ 2.5 kg plutonium
Volume ≤ 1.9 ℓ
H/X ratio ≤ 20.

Follow this set of steps if concerns exist about possible hydride reaction.

Note: A 1 lb slip lid can (nominal volume 0.5ℓ) may be in the IAC, stored upside down for use in case the inert atmosphere is lost, to cover the opened can. Cans of MgO_2 sand for fire fighting are also allowed in the IAC and main glovebox.

Step 2.01 Move fissile material into IAC (through airlock)
2.02 Move powder boat(s) into IAC (through airlock)
2.03 Move muffle furnace boat/boathouse into airlock (until ready to place button into it)
2.04 Place screened powder funnel into powder accumulation can
2.05 Open outer can
2.06 Remove inner can
2.07 Transfer any fissionable material from outer can onto screened funnel over powder accumulation can
2.08 Make outer can into non-container (remove other end and crush)
2.09 Repeat steps 2.04 - 2.08 until innermost can is opened
2.10 Remove fissile material (button) from innermost can and transfer onto screen funnel over powder accumulation can
2.11 Brush 'hydride' off of button
2.12 Move furnace boat into IAC (from airlock)
2.13 Transfer 'cleaned' button into boat
2.14 Move furnace boat back into IAC airlock
2.15 Make innermost can into non-container (remove other end and crush)
2.16 Clean up any powder on IAC floor and transfer to powder accumulation can
2.17 Remove powder funnel from powder accumulation can
2.18 Fill powder measuring scoop with powder from powder accumulation can

2.18 Fill powder measuring scoop with powder from powder accumulation can
2.19 Spread powder from scoop into bottom of powder boat
2.20 Close lids on powder accumulation can and powder boat
2.21 Move furnace boat out of IAC to main glovebox
2.22 Move powder boat out of IAC and place on hot plate, cook appropriately
2.23 Transfer material from powder boat into furnace boat
2.24 Repeat steps 2.18 - 2.23 until complete
2.25 Weigh furnace boat
2.26 Transfer furnace boat out of glovebox
2.27 Return to Step 1.

Follow these steps if there is not a concern about any adverse reaction with air (use of the IAC while performing these step is not excluded).

Step 3.01 Open outer can
3.02 Remove inner can
3.03 Transfer any material from outer can into furnace boat
3.04 Make outer can into non-container (remove other end and crush)
3.05 Repeat steps 3.01 - 3.04 until innermost can is opened
3.06 Transfer fissile material from innermost can into furnace boat
3.07 Make innermost can into non-container (remove other end and crush)
3.08 Clean up any powder on floor and transfer to furnace boat
3.09 Weigh furnace boat
3.10 Transfer furnace boat out of glovebox
3.11 Return to Step 1.

4.2 Facility and Equipment Description

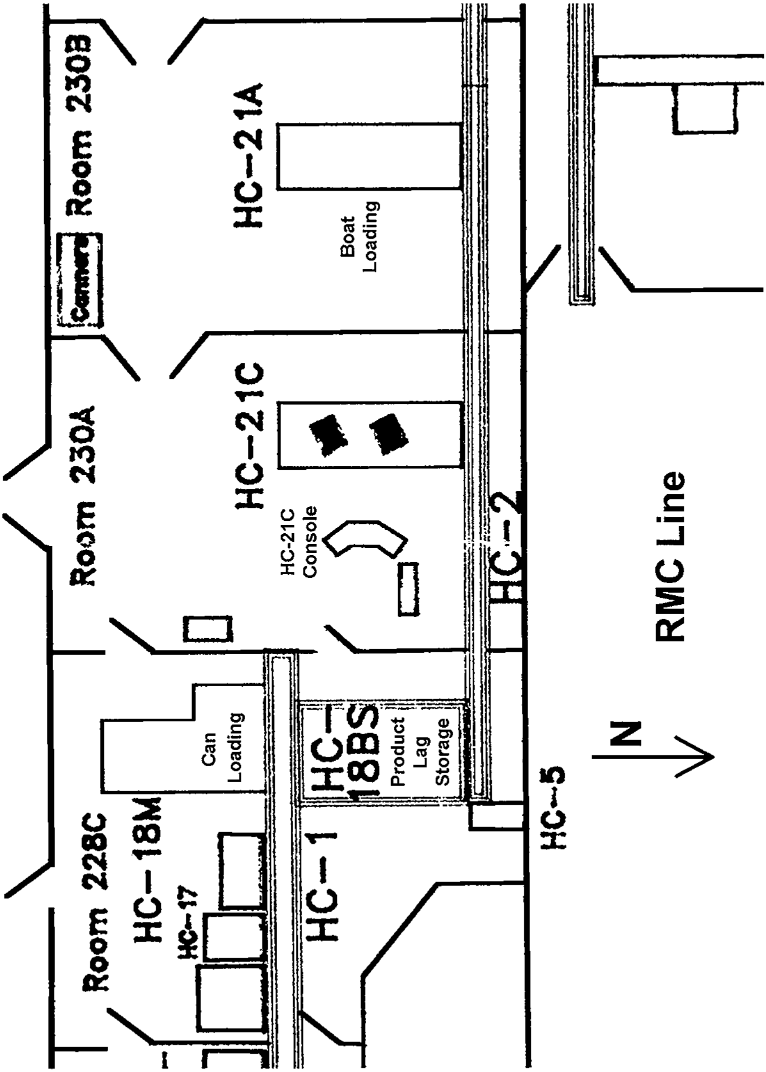
The glovebox and the equipment within it are described in this section.

4.2.1 Glovebox HC-21A Description

Glovebox HC-21A is located in room 230B in the main PFP Building 234-5Z. Figure 4-1 shows a sketch of the approximate layout of the glovebox in relation to the other gloveboxes and conveyors used for thermal stabilization activities. HC-21A is 106.7 cm (42 in.) deep, 91.4 cm (36 in.) high, 322.6 cm (127 in.) long, and supported 137.2 cm (54 in.) above the room floor by a table frame. A sketch of the glovebox is shown in Figure 4-2. Note that this glovebox has gloveports on both sides. The sketches show the approximate layout of operations in the glovebox.

The southwest corner of the glovebox contains the Inert Atmosphere Confinement (IAC). The IAC will have an essentially argon atmosphere present for button can opening and boat loading. Though the IAC is essentially sealed off from the main glovebox, it is not considered a container for purposes of fissionable material handling. The north end of HC-21A connects to conveyor HC-2. The HC-2 conveyor connection acts as a criticality drain for the glovebox, excluding the IAC section, and eliminates the concern for the main section of the glovebox

Figure 4-1. Approximate Layout for Gloveboxes and Conveyors Utilized for Thermal Stabilization Activities



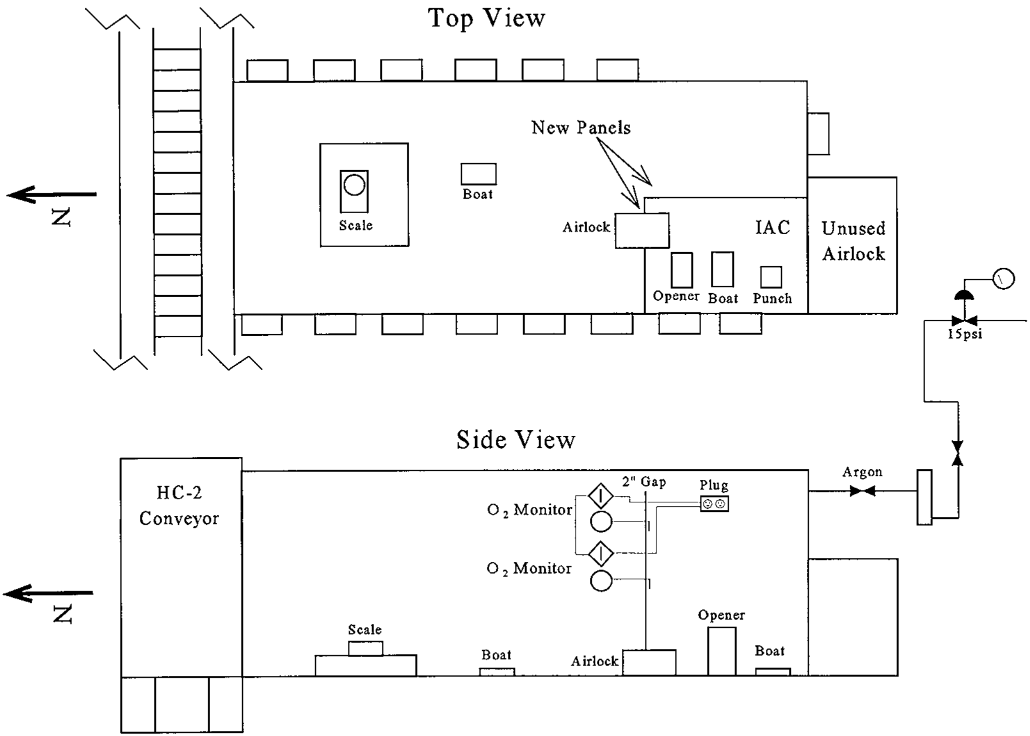


Figure 4-2. Sketch of Glovebox HC-21A

holding water and flooding. The table frame supporting the Glovebox HC-21A has horizontal members that do not allow a transport wagon to roll underneath the glovebox from any side. The 12.7 cm (5 in.) by 13.14 cm (5.175 in.) by 58.42 cm (23 in.) depression, in the southeast corner of the glovebox, is to be filled (maximum residual volume < 2.3 ℓ), sealed or made into a non-container to prevent accumulations of fissionable materials or liquids inside it.

The glovebox will also contain an electronic scale for weighing items, boats, boat lids, etc. This device does not have any volumes that would be a container. A summary of the process equipment and containers expected in Glovebox HC-21A for operations is given below.

The equipment available in Glovebox HC-21A are:

- Electronic scale,
- Can puncturing unit,
- Electric can openers (2),
- Hot plate

The containers available in Glovebox HC-21A are:

- Furnace boats (2.3 ℓ max.),
- Furnace boat boathouses,
- Containers resulting from uncanning operations (1.9 ℓ max.),
- Powder accumulation can (≤ 2.54 cm [1 in.] inside height, volume not of concern),
- Powder boat (≤ 2.54 cm [1 in.] inside height, volume not of concern),
- 1 lb slip lid can (0.5 ℓ nominal volume) to be stored upside down in the IAC for emergency use,
- 1 lb slip lid can (0.5 ℓ nominal volume) for floor sweeps (if needed),
- Containers of MgO_2 sand in the IAC and main glovebox in case of fire (2.3 ℓ max.).

Other materials available in Glovebox HC-21A are:

- Damp rag (limited to 6 sq. ft. total) for cleaning.

Glovebox HC-21A does not have any internal water lines or water fire protection. It does have a halon fire suppression system. The glovebox is listed as a "seismically unqualified" glovebox. Such gloveboxes could incur structural damage as a result of stresses from a Design Basis Earthquake (DBE).

4.2.2 Metallic Plutonium Button Cans

Metallic plutonium buttons are generally introduced into the glovebox in multiple nested cans. The wall thickness of each can is typically 0.0229 cm (0.009 in.). The largest outer container allowed in the glovebox is the 1.9 ℓ Hanford oversize can. Its dimensions and maximum volume are defined in Table 4-1.

The plutonium button will generally be contained in a smaller inner can with a nominal volume ranging from 0.25 to 0.5 ℓ, but may be directly inside the outer can.

4.2.3 Plutonium Oxide Cans

Plutonium oxide is introduced into the glovebox in cans or polyjars. The typical dimensions of some of the cans used in Glovebox HC-21A are listed in Table 4-1. The wall thickness of each can is typically 0.0229 cm (0.009 in.). The 7 inch cans are normally used for overpacking the inner container. The oversize can is the largest can allowed in the glovebox. The oversize can would be introduced infrequently into Glovebox HC-21A.

Table 4-1. Nominal Dimensions and Volumes of Typical Cans Containing Plutonium Metal or Plutonium Oxide in Glovebox HC-21A

Description	Outer Diameter		Outer Height		Volume
	(cm)	(in.)	(cm)	(in.)	(liter)
1 lb Slip Lid Can	8.89	3.50	8.89	3.50	0.50
Purex Slip Lid Can	8.73	3.44	13.65	5.38	0.80
2 lb Slip Lid Can	10.80	4.25	14.13	5.56	1.20
7 Inch Can	10.80	4.25	17.78	7.00	1.50
Oversize Can	12.07	4.75	17.15	6.75	1.90

4.2.4 Muffle Furnace Boat

The furnace boat is made from 0.3175 cm (1/8 in.) thick Hastelloy-X[1] sheet stock shaped into a "cake pan", with an outside width of 13.34 cm (5.25 in.) and an outside length of 28.58 cm (11.25 in.). Inside, the bottom of the pan has an area of 354.84 cm^2. A measured brim-full volume of 2.2 ℓ equates to an inside height of 6.20 cm (2.44 in.). Two 0.794 cm (5/16 in.) diameter holes were located at an outside height of 4.45 cm (1.75 in.) in each end plate. The holes were centered at a distance of 5.08 cm (2.0 in.) center-to-center. The boat may be covered to minimize dispersion of PuO_2 powder.

4.3 Fissionable Materials Description

The fissionable material handled in Glovebox HC-21A is plutonium in the forms of metal, oxide and other compounds as well as mixed oxides of plutonium and uranium. The fissionable isotope content and physical forms are discussed below.

[1] Hastelloy is a trademark of Stellite Rod Division, Stoody Deloro Stellite, Inc., Industry, Ca.

4.3.1 Fissionable Isotopes

The plutonium used in the models in this CSER is all ^{239}Pu. This simplification is conservative for the plutonium with more ^{240}Pu than ^{241}Pu, which is the case for the reactor produced plutonium at PFP. This also includes any depleted or natural uranium or mixed oxides of plutonium and uranium that may be present. Plutonium metal, oxide, oxalate (and oxycarbonate), and nitrate may all be present. The plutonium oxide may contain a nominal 5 wt% or less of other dry plutonium compounds, 1 wt% or less of the fissionable mass may be enriched uranium (counted as an equivalent mass of plutonium per CPS-Z-165-80010), and 10 wt% or less of carbon.

4.3.2 Metallic Plutonium

Metallic plutonium is generally in the form of 2.5 kg or smaller buttons that are introduced into Glovebox HC-21A in a multiple nested can arrangement, or as scrap pieces from clean out operations. The density of metallic plutonium may be close to the maximum value of 19.6 g/cm^3 as given in ARH-600 Section II.C.1 (Carter, 1968).

4.3.3 Plutonium Oxide

The non-metal forms of plutonium may be PuO_2, PuHx, PuN or other forms (e.g., MOX), hereafter referred to as plutonium oxide (PuO_2). The plutonium oxide will be contained in sealed polyjars or cans. The allowable H/X ratio for operations in this glove box will be less than or equal to 20.

4.4 Fissionable Material Handling

Fissionable materials will be handled as a safe batch so that the limits and controls for criticality safety will be easier to implement. These controls include multiple levels of protection of a safe batch such as limits on fissionable mass, maximum container volume, elimination of moderation, and separation distance from other fissionable materials. The multiple levels of protection will assure that criticality safety will not be jeopardized by the inadvertent failure of a single control.

In addition, processing will be stopped as necessary to clean up visible accumulations of fissionable materials from spills or processing.

The following is a description of the handling of fissionable materials in this glovebox.

4.4.1 Port-In of Fissionable Material

Material will be received in Glovebox HC-21A in containers of ≤ 2.5 kg Pu with an H/X ≤ 20. Up to five plutonium bearing containers may arrive in a transport wagon and be parked adjacent to (but not underneath) the glovebox. The containers will be inserted one at a time into the glovebox through the sphincter port, will be bagged in, or brought in from the conveyor. The maximum mass (a unit mass) will be ≤ 2.5 kg plutonium or its equivalent in other fissionable materials. The unit mass may consist of a grouping of containers, each containing less than a unit mass, with a combined total mass not exceeding the unit mass limit and a volume not to exceed 4.6 ℓ. Empty open containers within 25.4 cm (10.0 in.) of a container of fissionable material is to be counted as part of the unit mass volume.

4.4.2 Plutonium Button Can Opening and Boat Loading in IAC

If there is a concern of a possible adverse reaction between the material in the can to be opened and a normal oxygen atmosphere, the Inert Atmosphere Confinement (IAC) area, described in Section 4.2.1, provides a partially inert atmosphere for opening the container. This will generally be true of any can containing metallic plutonium (i.e., plutonium buttons). The cans may first be punctured, or may just be opened utilizing the electric can opener, in this partially inert atmosphere. The partially inert atmosphere is a precaution to prevent a glovebox overpressurization due to a rapid chemical reaction because of potential hydriding of the plutonium metal. The partially inert atmosphere will allow a controlled reaction between the hydrided plutonium and oxygen.

The plutonium buttons are generally packaged in multiple nested cans. As each can is opened, any loose fissionable material is transferred into a funnel that is placed in the powder accumulation can. Each container is then made into a non-container. Once the innermost can is opened, the plutonium button or other plutonium metal is transferred to the funnel, where any loose material is brushed off. The cleaned button will then be placed into a furnace boat inside the IAC. The furnace boat is then removed from the IAC. Small batches (up to about 25 g each) of the loose powder that was collected in the powder accumulation can are placed in the powder boat, removed from the IAC one batch at a time, and allowed to react on a hot plate in the main portion of the glovebox. These batches of reacted powder are then placed in the furnace boat. This process is repeated until all of the powder has been reacted and placed into the furnace boat. The furnace boat will then hold the contents of only one plutonium button and/or oxide, or up to an equivalent mass (2.5 kg) of plutonium material. The furnace boat is then weighed, and if within limits, is placed on the HC-2 conveyor for transport to a muffle furnace for thermal stabilization.

4.4.3 Plutonium Button or Oxide Can Opening and Boat Loading Outside of IAC

If there is not a concern of a possible adverse reaction between the material in the can to be opened and a normal oxygen atmosphere, the cans may be opened in the normal glovebox atmosphere, outside the IAC. This will generally be true of any can containing plutonium oxide or other plutonium compound.

The plutonium oxide is generally packaged in multiple nested cans. As each can is opened any loose fissionable material is placed into a furnace boat. Each container is then made into a non-container. Once the innermost can is opened and emptied, the furnace boat will contain up to the unit mass limit of 2.5 kg Pu as determined by measurements of the feed materials. The furnace boat is then weighed, and if within limits, is placed on the HC-2 conveyor for transport to a muffle furnace for thermal stabilization.

4.5 Technical Practices and Process Features

The IAC can opening area is a unique safety feature that was added to the glovebox process for opening cans containing metallic plutonium. The IAC area provides a location where the reaction of pyrophoric metal corrosion products with oxygen is controlled to reduce or prevent the spread of fissionable materials.

5.0 Requirements and Exemptions

5.1 Regulations and Standards

There are no unique requirements applicable to this evaluation.

5.2 Criticality Controls

Criticality controls consist of engineering and administrative controls. These controls for Glovebox HC-21A are presented in the following discussion.

5.2.1 Engineering Controls

Engineering controls are the primary means of preventing a criticality in the Glovebox HC-21A. These controls include the following:

- Eliminating of water sources or other moderator sources inside the glovebox such as fire sprinkler systems.
- Minimizing of structural materials such as plastics that moderate neutrons.
- Providing adequate drainage of the glovebox into the adjacent conveyor glovebox to prevent flooding of fissionable materials.
- Blocking the area below the glovebox to prevent entry of the transport wagon containing fissionable materials.
- Plugging or filling the depression in the floor of the glovebox.

5.2.2 Administrative Controls

Criticality Prevention Specifications (CPS), postings and procedures provide limits and controls for handling fissionable materials, moderators, and other conditions that will assure criticality safety. These controls will address the following:

- Fissionable material interaction,
- Masses of fissionable materials,
- Elimination or minimization of moderator materials,
- Volumes of fissionable material containers.

The criticality analysis in this document demonstrates that a single failure of any administrative control will not result in a k_{eff} that will exceed the criticality prevention criterion.

5.3 Subcriticality Limit

For the purposes of this report, the principal criticality prevention criterion or parameter is that the effective neutron multiplication (or criticality) factor (k_{eff}) shall not exceed 0.95 (i.e., $k_{eff} \leq 0.95$) for all permitted configurations of materials, containers, etc. This criterion is based on implementing the applicable DOE Orders and HNF-PRO-334. The subcriticality criterion, used to judge the acceptability of a calculated k_{eff} value for fissionable material configuration, must account for the bias inherent in the code and cross sections used, any uncertainties in the physical problem being analyzed, and the uncertainties in both the bias determination (the experimental basis) and the calculational methods.

A discussion of the experimental validation of the MONK6B[2] code is presented in Appendix B. The discussion concludes that if an adequate number of histories are run in the MONK Monte Carlo calculation so that the standard deviation for the calculation is less than or equal to 0.01, the criticality prevention criterion is satisfied if the calculation results in a $k_{calc} \leq 0.935$.

5.4 Application of Double Contingency Principle

The double contingency principle, as defined in DOE-STD-3009-94 to meet the requirements of DOE Orders 5480.23 and 5480.24, states that designs shall incorporate sufficient factors of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident is possible.

In DOE Order 5480.23, Attachment 1, paragraphs 4.f.3(d)8 b and c require application of the double contingency principle as defined in ANSI/ANS-8.1-1983 (ANSI/ANS, 1983). These requirements are prescriptive without providing any quantitative limits on the value of k_{eff} under the double contingency conditions. ANSI/ANS-8.1-1983 is similarly prescriptive.

DOE Order 6430.1A, Chapter 13, Section 1320, delineates criteria for irradiated fissile material storage facilities. It provides no specific guidance on double contingency but references 10 CFR 72 for further guidance. The double contingency criterion delineated in paragraph 10 CFR 72.124 (a) is similar to the one quoted from DOE-STD-3009-94 without defining a quantitative limit on the value of k_{eff}.

HNF-PRO-537 gives $k_{eff} = 0.95$ as the acceptable k_{limit} for calculations of systems if limited experimental data are available for similar systems and relatively large but reasonable interpolations and/or extrapolations of the data are necessary.

The off-normal scenarios addressed in Section 7.0 of this CSER are postulated to have a very low probability of occurrence because of design controls. In addition, the factors affecting reactivity of each single occurrence have been conservatively defined, within the constraints of

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2 Monk, Monk6, and MONK6B are trademarks of the United Kingdom Atomic Energy Authority.

the design or the realistic extent of a control loss, so that the reported consequences represent or exceed all credible situations that can be involved in the scenario considered.

The evaluation of k_{eff} for all single contingencies has been shown to be within the criticality safety limit of 0.95. The k_{eff} could exceed 0.95 after two unlikely, independent, and concurrent changes in process conditions without violating DOE rules and regulations. In some situations, cases consisting of two or more contingencies are evaluated to demonstrate that the system has more margin of safety than is required and approaches criticality incrementally rather than immediately for deviations from limits.

6.0 Methods of Analysis and Results

6.1 Model Assumptions

The following assumptions were used to model the fissionable materials and geometry of equipment in the glovebox. Conservatism was used to represent the normal and off-normal conditions in the most limiting credible forms with respect to fissionable material arrangements and modeling conventions.

6.1.1 Modeling Assumptions of Plutonium Metal Buttons

Several different buttons will be handled in Glovebox HC-21A, however there are no limitations on the shapes of the metal pieces to be thermally stabilized. Two different shapes of buttons, the Hanford button and the British button, were modeled to approximate the different button geometries. The Hanford plutonium metal button was modeled as a double layer cylinder to approximate the curvature of the button. The bottom cylinder (larger of the two cylinders) was modeled with a radius of 3.550 cm (1.398 in.), and a height of 2.540 cm (1.000 in.). The top cylinder was modeled with a radius of 2.601 cm (1.024 in.), and a height of 1.270 cm (0.500 in.). The British button was modeled as a H/D = 1 cylinder with radius of 2.734 cm (1.076 in.), and a height of 5.468 cm (2.153 in.). The plutonium metal button was modeled as 100 wt% ^{239}Pu with a density of 19.6 g/cm^3 as given in ARH-600 Section II.C.1 (Carter, 1968).

6.1.2 Modeling Assumptions of Plutonium Oxide

The H/X ratio of plutonium oxide was modeled at the limits of 2 and 20. At densities of 11.46 g/cm^3 for PuO_2 particles and 1.0 g/cm^3 for water, the components of material densities in the PuO_2 models are listed in Table 6-1.

The highest density for PuO_2 reported in ARH-600 Table II.C.2-2 (Carter, 1968) is 5.8 g PuO_2/cm^3, corresponding to a minimum porosity of 49.4%. The PuO_2 density in Table 6-1 corresponding to a smaller void fraction than 49.4% is a plutonium oxide with an H/X ratio of 2 or 0. The density of 6.5 g/cm^3 for PuO_2 is considered adequate to bound the density of the PuO_2 made or dried in the PFP thermal stabilization processes.

Table 6-1. Densities Assumed in Modeling of Plutonium Oxide for Normal Condition Analysis

Description	H/X = 0	H/X = 2	H/X = 7.46	H/X = 17.54	H/X = 20
PuO_2 Volume Fraction	0.568	0.568	0.260	0.130	0.116
Water / Void Volume Fraction	0.432 (void)	0.432	0.740	0.870	0.884
PuO_2 Density (g/cm^3)	6.505	6.505	2.984	1.492	1.330
Pu Density (g/cm^3)	5.737	5.737	2.632	1.316	1.173
Water Density (g/cm^3)	0.0	0.432	0.740	0.870	0.884
Total Density (g/cm^3)	6.505	6.938	3.723	2.362	2.214

6.1.3 Plutonium Oxide Cans

A single cylinder was modeled to represent the various plutonium oxide cans used in Glovebox HC-21A. The dimensions of the can were modeled with a height and diameter both equal to 13.43 cm (5.29 in.) giving a volume of 1.9 ℓ. This is larger than any expected inner can, and is equal to the largest allowed outer can. The can wall and lids were not modeled for simplicity and conservatism. For normal conditions, the plutonium oxide plus water was modeled with a density of 2.362 g/cm^3 and an H/X of 17.54. This H/X ratio is the largest possible for a plutonium content of 2.5 kg in plutonium oxide and a 1.9 ℓ volume.

6.1.4 Muffle Furnace Boat

The muffle furnace boat was modeled as a box. The dimensions are 27.94 cm (11.00 in.) length, 12.70 cm (5.0 in.) width, and 6.20 cm (2.44 in.) height. These correspond to the inside dimensions for the furnace boat.

The volume of the boat filled level to the top plate is 2.17 ℓ. The mass of plutonium in a boat fully filled with plutonium oxide is 2.5 kg at an H/X ratio of 20. The material in the boats' walls and floor was not included in the model for conservatism and simplicity and to account for any effects due to corrosion. The material acts mainly as a neutron poison.

6.2 Calculational Model

Appendix B provides a standardized summary for the documentation of the validation (Macklin and Miller, 1992; Miller, 1994) carried out for the MONK6B Monte-Carlo code, and its predecessor versions, as applicable to plutonium materials encountered at PFP. With the cross-section library supplied, the MONK6A/6B validation calculations indicate an allowed maximum k_{eff} value of 0.935 for new system calculations to assure subcriticality with an acceptable margin, including the uncertainties in the analytical methods and benchmark experimental data.

The MONK6B code was used for this analysis. This code is commercially licensed from the British ANSWERS organization. The MONK6B code uses cross sections from a point energy library based on the UKNDL and JEF evaluations. It is currently verified and validated on the Sun3 workstation in the Scientific Engineering Computer Center (SECC).

6.3 Normal Cases Results

Normal case evaluations were modeled for each operation defined in Section 4.4. The operational situations, criticality controls, and calculational results are discussed for each operation in the following section. In addition, the descriptions of factors such as reflection, that are not controlled, and may or not be present in a normal situation, are also identified in the table accompanying the operation discussion. The results for all of the normal evaluations are given in Table 6-2.

Table 6-2. MONK Calculational Results of Normal Cases in Glovebox HC-21A

Case	Description	k_{calc}	1σ
21an001	Two 2.5 kg Hanford plutonium buttons, 25.4 cm separation, nominal reflection on both	0.770	0.003
21an002	21an001, but nominal reflection on one button	0.754	0.003
21an003	21an001, but no nominal reflection	0.681	0.003
21an004	Two 2.5 kg Pu in PuO_2 cans (H/X=17.54), 25.4 cm separation, nominal reflection on both	0.740	0.003
21an005	21an004, but nominal reflection on one can	0.717	0.003
21an006	21an004, but no nominal reflection	0.599	0.003
21an007	One 2.5 kg Pu in PuO_2 can (H/X=17.54), and one 2.5 kg Pu button, 25.4 cm separation, nominal reflection on both	0.755	0.003
21an008	One 2.5 kg Pu in PuO_2 furnace boat (H/X=20) and one 2.5 kg Pu button, 25.4 cm separation, nominal reflection on both	0.754	0.003

Note: All cases include a 1.0 kg Pu layer of PuO_2 with an H/X = 20 to represent the maximum allowable glovebox holdup. Hence, all normal cases represent two 2.5 kg unit masses plus holdup, which is one unit mass (2.5 kg Pu) more than is allowed inside glovebox HC-21A by the limits in Section 3.1, but accounts for interaction with a unit mass outside the glovebox.

6.3.1 Normal Operation Analysis

The operational situations and criticality controls for the normal operation are listed in Table 6-3. In addition, the descriptions of credible loss of controls (off-normals) are also listed in this table. The conformance of the normal case to the criticality safety criterion was evaluated for four situations. In each situation, the glovebox has a single 2.5 kg unit mass in it, and is interacting with materials on the HC-2 conveyor or elsewhere in or near the glovebox. The situations were: one unit mass plutonium button interacting with a second button, one unit mass can of plutonium oxide interacting with another can of oxide, a unit mass plutonium button interacting with one can of plutonium oxide, and one unit mass plutonium button interacting with one furnace boat of plutonium oxide.

Table 6-3. Normal and Off-Normal Conditions of Fissionable Material

Normal Conditions		**Off-Normal Conditions**	
Description	Limit	Description	Section
Metallic plutonium and plutonium oxide in sealed containers are brought into the glovebox and transferred into furnace boats.	Limit of 2.5 kg maximum plutonium in a unit mass in glovebox.	Mass limit exceeded	7.1.1
	Volume limit of 1.9 ℓ maximum for PuO_2 in a can, and 2.3 ℓ for a furnace boat. N/A for metallic plutonium.	Volume limit exceeded	7.1.2
	Spacing between unit masses at least 25.4 cm (10 in.) edge-to-edge.	Separation distance violated	7.1.3
		DBE damages glovebox and accumulates all fissionable materials	7.2
	Moderation $H/X \leq 20$ for plutonium oxide. N/A for metallic plutonium.	Moderator limit exceeded	7.1.4
	Reflection and interstitial moderation by water flooding prohibited.	Glovebox flooded	7.1.5

The model of each situation was conservatively defined as a box with outer dimensions of 60.96 cm (24.0 in.) length, 30.48 cm (12.0 in.) width, and 60.96 cm (24.0 in.) height. The 2.5 kg unit mass plutonium content in each plutonium button, 1.9 ℓ container of plutonium oxide, and 2.3 ℓ furnace boat was modeled as 2.5 kg plutonium with dimensions defined in Sections 6.1.1, 6.1.3, and 6.1.4 respectively. The container of plutonium oxide was modeled as a 1.9 ℓ container that conforms to the largest volume container (excluding the furnace boat) allowed in the glovebox. Each of these situations thus represented the maximum quantity of fissionable materials allowed in the glovebox, or an area within the glovebox.

The respective plutonium buttons and containers of plutonium oxide for each situation were separated by a distance of up to 25.4 cm (10 in.) between surfaces. 1.0 kg of plutonium to conservatively account for fissionable material holdup in the glovebox was modeled as a layer of PuO_2 (H/X ratio of 20) with a thickness of 0.46 cm (0.18 in.) in contact with the base of each plutonium button or container of plutonium oxide. The PuO_2 of the 1.9 ℓ container of plutonium oxide was modeled with an H/X ratio of 17.54. This ratio corresponds to a plutonium mass of 2.5 kg that fills the 1.9 ℓ container. The plutonium of the plutonium buttons, the containers of plutonium oxide, and holdup material was modeled as 100% ^{239}Pu.

The outer region of the model immediately surrounding each of the fissionable materials was modeled as a nominal water reflector region of 2.54 cm (1 in.) on all sides and the top. The floor under the holdup material was modeled as a 5.08 cm (2.0 in.) water reflector region. The model also included a nominal (2.54 cm [1.0 in.]) water reflector region on the top, one side and one end of the box, and 30.48 cm (12 in.) on the other side and end of the box. This model represents the most limiting situation that could credibly occur in the glovebox. The interacting unit and the reflection surrounding the model adequately cover all situations of fissionable material brought into close proximity to the glovebox, such as a transport wagon on the floor, and the reflection from the glovebox walls, windows, gloves and personnel.

The results of the MONK calculations for the situations of two unit masses with proper spacing, mass and volume controls are listed in Table 6-2. Case 21an001 is for two metal buttons, 21an004 is for two oxide cans, 21an007 is for a button and an oxide can, and Case 21an008 is for a button and a filled furnace boat. These k_{eff}s are all significantly less than the criticality safety limit. The criticality safety criterion has been met for the normal situation.

6.4 HC-1 Conveyor Fissile Movement Past HC-21A Glovebox

Glovebox HC-21A is open to the HC-2 conveyor, and credit is taken for water not accumulating in HC-21A because of this opening, but this opening is also a path for fissile material movement to, from, and past HC-21A. The PFP conveyor CPS (CPS-Z-165-80608) requires an edge-to-edge spacing limit of 25.4 cm (10 in.) between a button on a conveyor and a loaded container in a connecting glovebox. This separation isolates fissile material on the conveyor from fissile material in the glovebox for normal operations.

6.5 Filter Glovebox Holdup for HEPA Filter Replacement Operation

PFP gloveboxes have in-place High Efficiency Particulate Air (HEPA) filters in the exhaust lines to remove plutonium dust and other particulate. The nominal 8x8x6 inch filter is normally located in a recess in the glovebox roof. A glovebox would only have one significantly contaminated filter since experience has shown that even if there are two filters in sequence, only the first is contaminated with sufficient fissile material to be of any concern for criticality safety. The second filter will be contaminated but only with milligram quantities of plutonium (unless the first filter has been physically broken through).

CSAR 80-014 shows that over the credible range of plutonium particle densities, criticality in an optimally moderated filter is not credible at either full or nominal water reflection. In Glovebox HC-21A with no water lines and the introduction of water prohibited, nominal reflection is considered normal. Per CSAR 80-014, dozens of filters are needed to approach criticality at low plutonium densities; at higher densities, tens of kg of plutonium are needed; and in between, both the number and mass required for criticality is incredible. Clearly the HEPA filter alone is not a threat to criticality safety.

The HEPA filter is made of material that is considered a moderator, so the HEPA filter is classified as having unrestricted moderation. CSER 80-014 shows that for a critical configuration at an optimal moderation of 30 g Pu/ℓ and full water reflection, the 111 g of plutonium contained in the 3.72 ℓ media volume of the 8x8x6 HEPA filter at 30 g/ℓ is about 21% of the minimum critical mass. As the plutonium particle density is increased, the percent of the critical mass increases to about 50% at an upper limit density of 5 g Pu/cc on the filter at 240 g Pu/ℓ. If the remaining plutonium in a glovebox is restricted to less than a quarter of a minimum critical configuration, then criticality would not be possible during HEPA filter change out. By removing all loaded containers from the glovebox, only the holdup on the floor needs to be considered. Figure III.A.5(100)-3 in ARH-600 (Carter, 1968) shows that a slab less than a

1.27 cm (0.5 in.) thick of ^{239}Pu-water fully water reflected is less than a quarter of the critical slab thickness. By having no containers of fissionable material in the glovebox while removing a HEPA filter and limiting floor accumulations to a maximum thickness of 0.3175 cm (1/8 in.), the reactivity would not be increased significantly above that for the filter by itself, which is well within allowables for credible accumulations in the filter.

7.0 Contingency Analysis

The off-normal situations of fissionable material handling for the operations in Glovebox HC-21A are listed in Table 6-3. The following discussions in this section give a description of the off-normal conditions and the calculational results. Each of the off-normal conditions results from a loss of one or more controls, and is therefore considered to be a contingent condition.

7.1 Off-Normal Analysis

Fissionable material in the forms of either metallic plutonium buttons or plutonium oxide in containers was evaluated in Section 6.3 for the normal situation in the glovebox. The model assumed the most limiting allowed conditions for criticality controls of mass, moderator, volume, and separation distance. A contingency is a situation where a control is inadvertently lost. A contingency may involve multiple losses of controls if a common mode of failure is identified. The following cases are evaluations of the off-normal situations where one or more of these controls are violated.

7.1.1 Mass Limit Exceeded

Three off-normal conditions were evaluated of exceeding the fissionable material mass limit. The first condition involved plutonium in the form of plutonium buttons. The second condition involved plutonium in the form of plutonium oxide in a can. The third consisted of mixing of metal and oxide in a furnace boat.

7.1.1.1 Metallic Plutonium

For the case of plutonium in the form of metallic plutonium buttons, the limiting normal situation is to have a unit mass of 2.5 kg plutonium in the glovebox. An off-normal condition was evaluated in which a can containing two plutonium buttons, instead of one, was brought into the glovebox to inadvertently exceed the mass limit.

A MONK calculation was made of the two plutonium buttons in one can with unit masses each of 2.5 kg Pu in contact with each other on their largest flat surfaces. A third plutonium button representing interaction with other fissionable materials was modeled with a unit mass of 2.5 kg Pu at a distance of 25.4 cm (10 in.). The geometry and conditions of all other parameters of this calculation are the same as those of Case 21an001 described in Section 6.3. This situation represents the most limiting situation of exceeding the mass limit with plutonium metal that could credibly occur.

The result of this calculation is listed as Case 21ac001 in Table 7-1 below. This k_{eff} is less than the criticality safety limit. A second unlikely and unrelated contingency would have to occur in order to exceed this k_{eff}. The double contingency criterion has been met.

Table 7-1. Off-Normal Condition Results for Port-In of Fissionable Material, Mass Limit Exceeded

Case	Description	k_{calc}	1σ
21ac001	One 2.5 kg Pu button in a can, two 2.5 kg Pu buttons in contact in another can, 25.4 cm separation between cans, nominal reflection on both.	0.924	0.003
21ac011	One 2.5 kg Pu in PuO_2 can (H/X = 17.54), one 5.0 kg Pu in PuO_2 can (H/X = 7.46), 25.4 cm separation between cans, nominal reflection on both.	0.764	0.003

7.1.1.2 Plutonium Oxide in a Can

For the case of plutonium in the form of plutonium oxide, the normal limiting situation is to have a 2.5 kg plutonium unit mass in the glovebox. The H/X ratio in the plutonium oxide is less than or equal to the limit of 20. An off-normal situation was evaluated in which the fissionable material mass limit was inadvertently exceeded.

A MONK calculation was made to evaluate this situation. The model had twice the unit mass of plutonium in a 1.9 ℓ volume of plutonium oxide that corresponds to the can volume. The 1.9 ℓ container was conservatively modeled as a cylinder of equal height and diameter as described in Section 6.1.3. The relationship of plutonium density in plutonium oxide is discussed in Section 6.1.2. The density of plutonium decreases as the H/X ratio increases due to displacement of plutonium oxide particles by water. The 5.0 kg mass of plutonium in a 1.9 ℓ volume corresponds to an H/X ratio of 7.46. A can of 2.5 kg Pu in PuO_2 representing interaction with fissionable materials in an adjacent station was modeled at a distance of 25.4 cm (10 in.). The geometry and conditions of all other parameters of this calculation are the same as those of Case 21an004 described in Section 6.3. This situation represents the most limiting condition of exceeding the mass limit in a single container of plutonium oxide that could credibly occur. This situation would also bound the inadvertent introduction of a 1.24 ℓ container equivalent to a Hanford Convenience Can (HCC) containing 4.4 kg of plutonium in oxide.

The result of this calculation is listed as Case 21ac011 in Table 7-1 above. This k_{eff} is less than the criticality safety limit. A second unlikely and unrelated contingency would have to occur in order to exceed this k_{eff}. The double contingency criterion has been met.

7.1.1.3 Exceeding Mass Limits in a Furnace Boat

For the normal case, a single 2.5 kg plutonium unit mass of plutonium oxide is contained in a container or a furnace boat. The H/X ratio in the plutonium oxide is less than or equal to the limit of 20. A minimum separation distance of 25.4 cm (10 in.) is maintained between the plutonium oxide in the container or furnace boat and other fissionable materials. An off-normal situation was evaluated in which the fissionable material mass limit was inadvertently exceeded.

The evaluation of a mass violation for a container of plutonium oxide was discussed in Section 7.1.1.2. That discussion also included the introduction of a container equivalent to a 1.24 ℓ HCC containing 4.4 kg of plutonium in oxide. A more limiting situation for this station is the mass violation occurring in the furnace boat. Several MONK calculations were made to analyze this situation. The three models analyzed consisted of: 1) 5.0 kg of Pu in PuO_2 in a 2.3 ℓ furnace boat, 2) a 2.5 kg Hanford button and 2.5 kg of Pu in PuO_2 in the boat, and 3) a 2.5 kg British button and 2.5 kg of Pu in PuO_2 in the boat. Each of these are discussed below.

The first calculation consists of twice the 2.5 kg unit mass of plutonium as oxide in the 2.3 ℓ furnace boat. The volume of the furnace boat corresponds to the volume limit. The dimensions of the furnace boat model are described in Section 6.1.4. The relationship of plutonium density in plutonium oxide is discussed in Section 6.1.2. The density of plutonium decreases as the H/X ratio increases due to displacement of plutonium oxide particles by water. The 5.0 kg mass of plutonium in a 2.3 ℓ volume corresponds to an H/X ratio of 9.582. A plutonium button representing interaction with other fissionable materials was modeled with a unit mass of 2.5 kg at a separation distance of 25.4 cm (10 in.) for each of these cases. The geometry and conditions of all other parameters of this calculation are the same as those of Case 21an007 described in Section 6.3. The result of this calculation is listed as Case 21ac013 in Table 7-2. This k_{eff} is less than the criticality safety limit. A second unlikely and unrelated contingency would have to occur in order to exceed the k_{eff} of this case. The double contingency criterion has been met.

The second calculation consists of a 2.5 kg Hanford button and 2.5 kg of Pu in PuO_2 in the 2.3 ℓ furnace boat. This model is the same as that described above, except there is a 2.5 kg Pu Hanford geometry button as described in Section 6.1.1 placed into the boat, and then 2.5 kg of Pu in PuO_2 at an H/X of 20 surrounding it. A Hanford geometry plutonium button representing interaction with fissionable materials in an adjacent station was modeled with a unit mass of 2.5 kg Pu at a distance of 25.4 cm (10 in.) for each of these cases. The geometry and conditions of all other parameters of this calculation are the same as those of Case 21ac013 described above. The result of this calculation is listed as Case 21ac021 in Table 7-2. This k_{eff} is less than the criticality safety limit. A second unlikely and unrelated contingency would have to occur in order to exceed the k_{eff} of this case. The double contingency criterion has been met.

The final calculation for this situation consists of a 2.5 kg British button and 2.5 kg of Pu in PuO_2 in the 2.3 ℓ furnace boat. This model is the same as that described above, except there is a 2.5 kg Pu British geometry button as described in Section 6.1.1 placed into the boat, and then 2.5 kg of Pu in PuO_2 at an H/X of 20 surrounding it. A Hanford geometry plutonium button representing interaction with other fissionable materials was modeled with a unit mass of 2.5 kg Pu at a distance of 25.4 cm (10 in.) for each of these cases. The geometry and conditions of all other parameters of this calculation are the same as those of Case 21ac013 described above. The result of this calculation is listed as Case 21ac022 in Table 7-2. This k_{eff} is less than the criticality safety limit. A second unlikely and unrelated contingency would have to occur in order to exceed the k_{eff} of this case. The double contingency criterion has been met.

Table 7-2. Off-Normal Condition Results for Plutonium Oxide in a Boat, Mass Limit Exceeded

Case	Description	k_{calc}	1σ
21ac013	One 2.5 kg Pu button, one 5.0 kg Pu in PuO_2 boat (H/X=9.582), 25.4 cm separation, nominal reflection on both.	0.751	0.003
21ac021	21ac013, but overbatch boat has 2.5 kg Hanford button and 2.5 kg Pu in PuO_2 (H/X=20).	0.850	0.003
21ac022	21ac013, but overbatch boat has 2.5 kg British button and 2.5 kg Pu in PuO_2 (H/X=20).	0.852	0.003

7.1.2 Plutonium Oxide Container Volume Limit Exceeded

For the case of plutonium in the form of plutonium oxide, the normal situation is to have one or more containers of plutonium oxide with a combined mass less than or equal to 2.5 kg plutonium. An off-normal situation was evaluated in which the volume limit for a single container of 1.9 ℓ was exceeded. A MONK calculation was made of plutonium oxide in a cylinder of equal height and diameter. The volume of a 2.5 kg mass of plutonium in plutonium oxide at an H/X ratio of 20 corresponds to a volume of 2.13 ℓ. This volume is less than the volume limit of a furnace boat. The boat volume limit cannot be exceeded without also exceeding the H/Pu limit. Due to its more compact geometry, the evaluation based on the can geometry is more limiting than the boat geometry. The can geometry was thus used to also evaluate the boat geometry. The geometry and conditions of all other parameters of this calculation are the same as those of Case 21an004 described in Section 6.3. This situation represents the most limiting situation of exceeding the container volume limit that could credibly occur.

With the limit on container volume, the cylinder with equal height and diameter is the most reactive credible geometry. If the plutonium oxide were distributed in multiple containers, this would increase the neutron leakage, and correspondingly decrease the system reactivity. Section 7.1.4 discusses the effect of exceeding the H/X ratio limit.

The result of this calculation is listed as Case 21ac401 in Table 7-3. This k_{eff} is less than the criticality safety limit. A second unlikely and unrelated contingency would have to occur in order to exceed this k_{eff}. The double contingency criterion has been met.

Table 7-3. Off-Normal Condition Results for Fissionable Material, Container Volume Limit Exceeded

Case	Description	k_{calc}	1σ
21ac401	One 2.5 kg Pu in PuO_2 1.9 ℓ can (H/X=17.54), one 2.5 kg Pu in PuO_2 2.13 ℓ can (H/X=20), 25.4 cm separation between cans, nominal reflection on both.	0.749	0.003

7.1.3 Separation Distance Violated

Two off-normal conditions were evaluated of violating the fissionable material separation distance limit. The first condition involved plutonium in the form of metallic plutonium buttons. The second condition involved plutonium in the form of plutonium oxide in cans or polyjars. Mixing of metal and oxide is analyzed in Section 7.1.1.3.

7.1.3.1 Metallic Plutonium

For the case of plutonium in the form of metallic plutonium buttons, the normal situation is to have a metallic plutonium button with a mass less than or equal to 2.5 kg and a minimum surface-to-surface separation distance of 25.4 cm (10 in.) to the nearest container of fissionable material. An off-normal situation was evaluated in which the separation distance limit was violated. A MONK calculation was made of two plutonium buttons in contact with each other on their largest flat surfaces. A third plutonium button of 2.5 kg mass was modeled at a distance of 25.4 cm (10 in.) from the two buttons in contact. The third metallic plutonium button represents interaction of fissionable materials elsewhere near the glovebox. The geometry and conditions of all other parameters of this calculation are the same as those of Case 21an001 described in Section 6.3.1. This situation represents the most limiting situation of exceeding the separation distance limit for buttons that could credibly occur.

The result of this calculation is listed as Case 21ac001 in Table 7-1 above. This k_{eff} is less than the criticality safety limit. A second unlikely and unrelated contingency would have to occur in order to exceed this k_{eff}. The double contingency criterion has been met.

7.1.3.2 Plutonium Oxide

For the case of plutonium in the form of plutonium oxide, the normal situation is to have a plutonium oxide container with a mass less than or equal to 2.5 kg and a minimum separation distance between surfaces of 25.4 cm (10 in.) to the nearest container of fissionable material. Two MONK calculations were made, the first had two 2.5 kg plutonium oxide cans in contact with each other, the second had two 2.5 kg plutonium oxide furnace boats stacked. The first model also had a third can of 2.5 kg plutonium in oxide modeled at a distance of 25.4 cm (10 in.) from the two cans in contact, while the second model had a plutonium button modeled at a distance of 25.4 cm (10 in.) from the two furnace boats. The extra can or button represents interaction of fissionable materials elsewhere near the glovebox. The geometry and conditions of all other parameters of this calculation are the same as those of Case 21an004 described in Section 6.3.1. These situations represent the most limiting situation of violating the separation distance limit that could credibly occur, since the glovebox mass limit is violated as well to have more than 3.5 kg Pu in the glovebox.

The result of the first calculation is listed as Case 21ac012 in Table 7-4. This k_{eff} is less than the criticality safety limit. A second unlikely and unrelated contingency would have to occur in order to exceed this k_{eff}. The double contingency criterion has been met.

The result of the second calculation is listed as Case 21ac014 in Table 7-4. This k_{eff} is less than the criticality safety limit. A second unlikely and unrelated contingency would have to occur in order to exceed this k_{eff}. The double contingency criterion has been met.

Table 7-4. Off-Normal Condition Results for Fissionable Material, Separation Distance Violated

Case	Description	k_{calc}	1σ
21ac012	Two 2.5 kg Pu in PuO_2 cans (H/X=17.54), 25.4 cm separation between cans, nominal reflection on both, extra 2.5 kg Pu in PuO_2 can (H/X=17.54) next to one can.	0.793	0.003
21ac014	One 2.5 kg Pu button, two 2.5 kg Pu in PuO_2 boats stacked (H/X=20), 25.4 cm separation between button and boat, nominal reflection on both.	0.858	0.003

7.1.4 Plutonium Oxide Moderator Limit Exceeded

Two off-normal conditions were evaluated of violating the fissionable material moderator limit. The moderation in the metallic form of plutonium is not controlled. Only the forms of PuO_2 have moderation control. The first condition involved PuO_2 contained in a can. The second condition involved PuO_2 contained in a furnace boat.

7.1.4.1 Plutonium Oxide in a Can

For the case of plutonium oxide in a can, the normal condition is to have a unit mass of 2.5 kg plutonium and a water content corresponding to an H/X ratio not greater than 20. The cans of plutonium oxide are separated by a distance of 25.4 cm (10 in.) between surfaces. An off-normal situation was evaluated in which the H/X ratio in the plutonium oxide was inadvertently increased above the limit. The addition of water in the plutonium oxide will displace the fissionable material and thus reduce its density. The optimum moderator ratio will not be reached for 2.5 kg of plutonium in the plutonium oxide before the volume limit of 1.9 ℓ is exceeded. Therefore, the volume limit established a controlling limit of fissionable material mass in this situation. A series of MONK calculations were made of a 1.9 ℓ plutonium oxide can with dimensions described in Section 6.1.3. The H/X ratio was varied in the 2.5 kg plutonium mass of homogenized plutonium oxide and water until the volume limit was reached. For higher H/X levels, the mass of fissionable material was reduced below 2.5 kg Pu as a function of its density to fit the 1.9 ℓ volume restriction. The geometry and conditions of all other parameters of this calculation are the same as those of Case 21an004 described in Section 6.3.1. The results of these calculations are shown as Cases 21ac501 through 21ac507 in Table 7-5. The k_{eff} did not change significantly for any of the calculations performed. These k_{eff}s are all less than the criticality safety limit. A second unlikely and unrelated contingency would have to occur in order to exceed this k_{eff}. The double contingency criterion has been met.

Table 7-5. Off-Normal Condition Results for Plutonium Oxide in a Can, Moderator Limit Exceeded

Case	Description	k_{calc}	1σ
21an004	Two 2.5 kg Pu in 1.9 ℓ PuO_2 containers (H/X=17.54), 25.4 cm separation, nominal reflection on both.	0.740	0.003
21ac501	One 2.5 kg Pu in 1.9 ℓ PuO_2 container (H/X=17.54), one 2.25 kg Pu in second 1.9 ℓ PuO_2 container (H/X=19.78), 25.4 cm separation, nominal reflection on both.	0.707	0.003
21ac502	21ac501, but Pu in second PuO_2 container = 2.00 kg (H/X=22.59)	0.706	0.003
21ac503	21ac501, but Pu in second PuO_2 container = 1.75 kg (H/X=26.19)	0.706	0.003
21ac504	21ac501, but Pu in second PuO_2 container = 1.50 kg (H/X=30.99)	0.701	0.003
21ac505	21ac501, but Pu in second PuO_2 container = 1.25 kg (H/X=37.71)	0.706	0.003
21ac506	21ac501, but Pu in second PuO_2 container = 1.00 kg (H/X=47.80)	0.698	0.003
21ac507	21ac501, but Pu in second PuO_2 container = 0.50 kg (H/X=99.22)	0.695	0.003

7.1.4.2 Plutonium Oxide in a Furnace Boat

For the normal case, a single 2.5 kg plutonium unit mass of plutonium oxide is contained in a furnace boat. The H/X ratio in the plutonium oxide is less than or equal to the limit of 20. A minimum separation distance of 25.4 cm (10 in.) is maintained between the plutonium oxide in the furnace boat, and other fissionable materials. An off-normal situation was evaluated in which the H/X ratio in the plutonium oxide was inadvertently increased above the limit due to water ingress into the glovebox as a consequence of sprinklers or firefighting.

A MONK calculation was made of a 2.3 ℓ plutonium oxide furnace boat described in Section 6.1.4. The volume of the 2.3 ℓ furnace boat corresponds to the volume limit in this station for a single container. The content of water, which causes internal moderation in the plutonium oxide, displaces plutonium oxide particles and thus reduces the fissionable material density. The density reduction of fissionable material will reduce the fissionable mass below the 2.5 kg Pu limit in a 2.3 ℓ volume before the optimum H/X ratio is reached. Therefore, the volume limit established a controlling limit of fissionable material mass in this situation. A series of MONK calculations were made to evaluate the relationship of k_{eff} corresponding to the inverse relationship of H/X ratio and plutonium mass in the plutonium oxide for the 2.3 ℓ furnace boat. The results of these calculations are shown in Cases 21ac601 through 21ac607 in Table 7-6. The k_{eff} did not change significantly for any of the calculations performed. These k_{eff}s are all less than the criticality safety limit. A second unlikely and unrelated contingency would have to occur in order to exceed this k_{eff}. The double contingency criterion has been met.

Table 7-6. Off-Normal Condition Results for Plutonium Oxide in a Boat, Moderator Limit Exceeded

Case	Description	k_{calc}	1σ
21ac601	One 2.5 kg Pu In PuO_2 boat (H/X=20.00), one 2.25 kg Pu in second PuO_2 boat (H/X=24.50), 25.4 cm separation, nominal reflection on both.	0.751	0.003
21ac602	21ac601, but Pu in second PuO_2 boat = 2.00 kg (H/X=27.89)	0.751	0.003
21ac603	21ac601, but Pu in second PuO_2 boat = 1.75 kg (H/X=32.25)	0.750	0.003
21ac604	21ac601, but Pu in second PuO_2 boat = 1.50 kg (H/X=38.07)	0.748	0.003
21ac605	21ac601, but Pu in second PuO_2 boat = 1.25 kg (H/X=46.21)	0.752	0.003
21ac606	21ac601, but Pu in second PuO_2 boat = 1.00 kg (H/X=58.41)	0.751	0.003
21ac607	21ac601, but Pu in second PuO_2 boat = 0.50 kg (H/X=119.45)	0.750	0.003

7.1.5 Reflection and Interstitial Moderation by Glovebox Flooding

Three off-normal conditions were evaluated for reflection and interstitial moderation by glovebox flooding. The first condition involved plutonium in the form of plutonium buttons. The second condition involved plutonium in the form of plutonium oxide in cans, and the third condition involved plutonium in the form of plutonium oxide in furnace boats. The glovebox does not have any internal liquid lines, and no free liquids or solutions are allowed. The liquid could be coming from sprinklers in the room or from fire fighting. It was assumed that the fissile material was not moved by the water, and therefore for fire fighting, no solid streams of water are allowed. Only fire fighting category C, such as mists or fogs are allowed.

7.1.5.1 Metallic Plutonium

For the case of plutonium in the form of metallic plutonium buttons, the normal situation is to have a metallic plutonium button with a mass less than or equal to 2.5 kg. An off-normal situation was evaluated of the glovebox flooding with two metallic plutonium buttons separated by a distance of 25.4 cm (10 in.) between surfaces that are reflected and interstitially moderated by water at various densities. The water density of the atmosphere in the glovebox surrounding the plutonium buttons was varied over the range from partial densities to full density. The geometry and conditions of all other parameters of this calculation are the same as those of Case 21an001 described in Section 6.3. This situation represents the most limiting situation of flooding of the glovebox that could credibly occur. The relationship of k_{eff} versus water density is shown in Table 7-7. The maximum k_{eff} corresponds to a water density of 1.00.

The results of the calculations are listed as Cases 21ac101 - 21ac106 in Table 7-7. The result of the limiting k_{eff} (Case 21ac106) is less than the criticality safety limit. A second unlikely and unrelated contingency would have to occur in order to exceed this k_{eff}. The double contingency criterion has been met.

Table 7-7. Off-Normal Condition Results for Plutonium Button, Reflection and Interstitial Moderation from Glovebox Flooding

Case	Description	k_{calc}	1σ
21an001	Two 2.5 kg plutonium buttons, 25.4 cm separation, nominal reflection on both.	0.770	0.003
21ac101	Case 21an001, but interspersed water density = 0.01	0.715	0.003
21ac102	Case 21an001, but interspersed water density = 0.05	0.723	0.003
21ac103	Case 21an001, but interspersed water density = 0.10	0.729	0.003
21ac104	Case 21an001, but interspersed water density = 0.20	0.745	0.003
21ac105	Case 21an001, but interspersed water density = 0.50	0.781	0.003
21ac106	Case 21an001, but interspersed water density = 1.00 (fully flooded)	0.818	0.003

Note: Nominal reflection is removed from all interspersed water density cases.

7.1.5.2 Plutonium Oxide in Cans

For the case of plutonium in the form of plutonium oxide, the normal situation is to have a covered container of plutonium oxide with a mass less than or equal to 2.5 kg of plutonium. An off-normal situation was evaluated of the glovebox flooding with two plutonium oxide volumes in containers. A MONK calculation was made of two plutonium oxide volumes of 2.5 kg plutonium each at a distance of 25.4 cm (10 in.) between surfaces that are reflected and interstitially moderated by flooding. The water density of the atmosphere in the glovebox surrounding the plutonium oxide cans was varied over a range of partial densities to full density. The geometry and conditions of all other parameters of this calculation are the same as those of Case 21an004 described in Section 6.3. This situation represents the most limiting situation of flooding the glovebox that could credibly occur. The relationship of k_{eff} versus water density is shown in Table 7-8. The maximum k_{eff} corresponds to a water density of 1.00.

The results of the calculations are listed as Cases 21ac201 - 21ac206 in Table 7-8. The result of the limiting k_{eff} (Case 21ac206) is less than the criticality safety limit. A second unlikely and unrelated contingency would have to occur in order to exceed this k_{eff}. The double contingency criterion has been met.

Table 7-8. Off-Normal Condition Results for Plutonium Oxide in Cans, Reflection and Interstitial Moderation from Glovebox Flooding

Case	Description	k_{calc}	1σ
21an004	Two 2.5 kg Pu in PuO_2 cans (H/X=17.54), 25.4 cm separation, nominal reflection on both.	0.740	0.003
21ac201	Case 21an004, but interspersed water density = 0.01	0.604	0.003
21ac202	Case 21an004, but interspersed water density = 0.05	0.605	0.003
21ac203	Case 21an004, but interspersed water density = 0.10	0.628	0.003
21ac204	Case 21an004, but interspersed water density = 0.20	0.671	0.003
21ac205	Case 21an004, but interspersed water density = 0.50	0.750	0.003
21ac206	Case 21an004, but interspersed water density = 1.00 (fully flooded)	0.815	0.003

Note: Nominal reflection is removed from all interspersed water density cases.

7.1.5.3 Plutonium Oxide in Furnace Boats

The normal situation of plutonium oxide in furnace boats is to have a single furnace boat of plutonium oxide with a mass of plutonium less than or equal to 2.5 kg. An off-normal situation was evaluated of the liquid control being lost that results in reflection and interstitial moderation by glovebox flooding of the plutonium oxide in the furnace boat.

A parametric set of MONK calculations was made of a plutonium oxide volume of 2.5 kg plutonium in a furnace boat and a 2.5 kg metallic plutonium button at a distance of 25.4 cm (10 in.) between surfaces. The geometry of the furnace boat is given in Section 6.1.4. The flooding was assumed to increase the moderation of plutonium in the uncovered boat beyond the control limit. The moderation limit in the 2.3 ℓ volume with a fissionable material density that corresponds to a mass of 2.5 kg plutonium has an H/X = 21.79. In the parametric calculations, the water density of the atmosphere in the glovebox surrounding the boat of plutonium oxide was varied over a range of partial densities to full density. The plutonium button represented interaction of other fissionable materials. The geometry and conditions of all other parameters of this calculation are the same as those of Case 21an008 described in Section 6.3, including the surrounding nominal water. The boat is in the corner formed by the two water reflectors at the glovebox side and end. This situation represents the most limiting situation of flooding the glovebox that could credibly occur. The maximum k_{eff} corresponds to a water density of 1.00.

The results of the calculations are listed as Cases 21ac701 - 21ac706 in Table 7-9. The result of the limiting k_{eff} (Case 21ac706) is less than the criticality safety limit. A second unlikely and unrelated contingency would have to occur in order to exceed this k_{eff}. The double contingency criterion has been met.

Table 7-9. Off-Normal Condition Results for Plutonium Oxide in a Boat Spaced 25.4 cm from a Button, Reflection and Interstitial Moderation from Glovebox Flooding

Case	Description	k_{calc}	1σ
21an008	A 2.5 kg Pu in PuO_2 furnace boat (H/X = 20) and a 2.5 kg Pu button, 25.4 cm separation, nominal reflection on both	0.754	0.003
21ac701	Case 21an008, but interspersed water density = 0.01	0.752	0.003
21ac702	Case 21an008, but interspersed water density = 0.05	0.756	0.003
21ac703	Case 21an008, but interspersed water density = 0.10	0.761	0.003
21ac704	Case 21an008, but interspersed water density = 0.20	0.774	0.003
21ac705	Case 21an008, but interspersed water density = 0.50	0.802	0.003
21ac706	Case 21an008, but interspersed water density = 1.00 (fully flooded)	0.807	0.003

7.2 Seismic Analysis

Conformance with the "double contingency" principle requires that with any plausible normal, no-error arrangement of fissile-bearing containers in the glovebox, a criticality could not result from the agitation and damage from an earthquake. This glovebox may also be susceptible to a pressure excursion, which could have an effect similar to the earthquake, due to a can containing hydrided plutonium metal being opened outside the IAC, and reacting rapidly with the available oxygen in the glovebox atmosphere. Allowed plutonium in Glovebox HC-21A is 3.5 kg plutonium with an H/X ≤ 20.

Table 9.2.4-1 of the *Plutonium Finishing Plant Final Safety Analysis Report* (Shapley, 1995) lists Glovebox HC-21A as not seismically qualified because the glovebox table stand support is not anchored to the floor. During a design basis earthquake (DBE), the glovebox is assumed to collapse at one end with the containers freely tumbling to that end and spilling their contents. HC-21A is a dry glovebox. No free liquids or solutions are allowed in the glovebox and there is no piping carrying liquids into or through the glovebox. In addition to the contained fissile material, the glovebox is allowed some accumulation as holdup. Because the glovebox contains a combination of plutonium metal and slightly moderated (H/Pu ≤ 20) plutonium compounds, handbook limits are not adequate to establish the criticality safety of the mixture. A parametric computer analysis of the different combinations is used.

The seismic analysis is carried out with the assumption that the earthquake can rearrange the normal materials in the glovebox, but does not introduce any new materials.

The first analysis was of the 2.5 kg plutonium Hanford geometry button, as described in Section 6.1.1. The model consisted of a button surrounded by a spherical region consisting of 1.0 kg Pu in PuO_2 from holdup, and full outside water reflection. Case 21ae001, as reported in Table 7-10 with the geometry just discussed, does not exceed the criticality safety limit. This case justifies a total glovebox mass limit of 3.5 kg of plutonium. With a conservative value of 1.5 kg of Pu in PuO_2 from holdup and full reflection (Case 21ae002) the criticality safety limit is still not exceeded, showing that a significant margin of safety still exists if the glovebox mass limit were exceeded.

Table 7-10. Seismic Analysis Results for Glovebox HC-21A

Case	Description	k_{calc}	1σ
2.5 kg Hanford Button Analysis			
21ae001	2.5 kg Hanford button, 1.0 kg Pu in PuO_2 (H/X=20) surrounding the buttons, full reflection.	0.882	0.003
21ae002	21ae001, but 1.5 kg Pu in PuO_2 (H/X=20) surrounding the button.	0.921	0.003
2.5 kg British Button Analysis			
21ae011	2.5 kg British button, 1.0 kg Pu in PuO_2 (H/X=20) surrounding the button, full reflection.	0.773	0.003
21ae012	21ae011, but 1.5 kg Pu in PuO_2 (H/X=20) surrounding the button.	0.813	0.003

The second analysis was of the 2.5 kg plutonium British geometry button, as described in Section 6.1.1. This model was the same as that for the Hanford button, but a British button was used in its place.

Therefore, as a single contingency effect, a seismically induced criticality in the dry Glovebox HC-21A is not credible. Multiple contingencies can be postulated to produce criticality, such as extensive glovebox overbatching or the entrance of water from external sources. However, the seismic event would not cause the addition of plutonium to the glovebox and over batching is prohibited by the criticality limits and would be a second contingency.

7.3 Fire Analysis

The normal situation is to bring in a single container of fissionable material, containing less than or equal to one 2.5 kg unit mass. This fissionable material will usually be packaged in an inner can with one or more overpack cans. These overpack cans are usually opened one at a time, any fissionable material is transferred from that can into a furnace boat, then the can is made into a non-container, and the steps repeated until the inner can has been opened, and its material transferred to a furnace boat. In the event of a fire, where water could enter the glovebox and enter the open containers, the volume of the can and boat would control the volume of the system to within allowables.

However, at times, it may be necessary to have multiple cans opened, each containing some fissionable material. In this scenario, there are concerns that during a fire, the fissionable material could have additional moderation or reflection added, and with no volume or spacing controls, it is not clear that criticality safety would be assured. Therefore, limits on total volume and spacing for unit masses are being imposed to assure criticality safety under these circumstances.

In case of a fire, the glovebox windows could melt or be broken allowing water to enter the glovebox. For the main section of the glovebox, the water could only reach a limited depth, since the glovebox is open to the conveyor, which will act as a criticality drain. Therefore, for the main section of the glovebox, full reflection of any fissionable material is not credible, because the glovebox drains to the adjacent conveyor glovebox. For the IAC, however, there is no criticality drain, and in the event of a fire, it could theoretically fill with water. This water could create full reflection. The following discussion will demonstrate that with the limited mass and volume, a criticality is not possible in the HC-21A glovebox under each of these circumstances.

7.3.1 Fire Analysis for Plutonium Metal

Whether plutonium metal is located in the IAC or the main section of the glovebox, the seismic analysis in Table 7-10 conservatively models the fire contingency. Case 21ae002 includes a 2.5 kg plutonium metal button surrounded by 1.5 kg of plutonium oxide for a total of 4.0 kg of plutonium and is fully reflected. This model more than adequately covers the potential 3.5 kg of plutonium permitted glovebox inventory being combined and reflected. The k_{eff} of 0.921 is less than the calculational safety limit of 0.935.

7.3.2 Fire Analysis for Plutonium Oxide

For plutonium oxide, the fire analysis depends upon whether the mass is located in the main section of the glovebox or in the IAC. The main section drains to HC-2, so full reflection by flooding is not credible. For the IAC, however, flooding is credible and consideration of full reflection is required.

Considering the main section of the glovebox, only a maximum combined volume of 4.6 ℓ (equivalent to two 2.3 ℓ boats) is allowed in a single unit mass. The combination of a can (1.9 ℓ) and boat is only 4.2 ℓ. To limit reflection in a grouping of containers in a unit mass to nominal reflection (2.54 cm [1.0 in.] of water), all open containers within 25.4 cm (10.0 in.) of a unit mass are included as part of the unit mass volume, even containers not holding fissionable material. For normal conditions in the glovebox, consideration of nominal reflection is appropriate. From ARH-600 (Carter, 1968), Figure III.A.9(100)-4, it can be seen that with a maximum container mass of 2.5 kg in a spherical geometry and nominal reflection, a volume of more than 10.5 ℓ is necessary to approach criticality. The permitted volume of 4.6 ℓ is less than 45% of the 10.5 ℓ volume required to approach criticality. For a 4.6 ℓ volume, the same figure shows that with nominal reflection more than 15 kg of plutonium are needed. The mass of 2.5 kg is less than 45% of the mass required to approach criticality for the 4.6 ℓ volume. Therefore, 4.6 ℓ and 2.5 kg limits on unit masses meet the requirements of HNF-PRO-537. These are also conservative for several other reasons, each of which will be listed below.

- The fissionable material is of a form that is not soluble. A limited quantity may be soluble, or may be fine enough particles to be suspended with added moderation, but, the majority of the fissionable material could be in a saturated layer in each container, and will not occupy the entire container volume at optimum moderation.

- The largest allowed container is the 2.3 ℓ furnace boat, which is of limited height, this reduces the possible interaction between containers.
- Each additional fissionable material container makes the unit mass a less compact mass, therefore, reducing the system reactivity.
- Stacking is not allowed to keep the geometry of the unit mass from approaching a sphere.

If the volume allowed were to be double batched in an off-normal event, i.e. two 4.6 ℓ volumes of containers were to be brought together (this would take multiple containers since the largest allowed container is the 2.3 ℓ furnace boat), the 9.2 ℓ volume does not exceed the more than 10.5 ℓ necessary to approach criticality with nominal reflection. In the same way, if the mass were to be double batched, the resulting 5 kg mass is only 33% of the 15 kg mass of plutonium necessary to approach criticality with nominal reflection. Finally, if the volume were to be exceeded by addition of the largest container (a 2.3 ℓ furnace boat) to 6.9 ℓ, and the mass were to be doubled to 5 kg Pu, the resulting configuration would still be less than 45% of the 12 kg Pu necessary to approach criticality. As a minimum, a second unlikely event such as full reflection would be necessary for criticality to be achieved.

For the non-conformance condition of full reflection, only possible in the IAC, the limit of 4.6 ℓ is less than the 7.1 ℓ necessary to approach criticality with 2.5 kg of plutonium in a unit mass. The glovebox mass limit of 3.5 kg of plutonium is less than 45% of the 8 kg necessary to approach criticality with a 4.6 ℓ sphere fully water reflected. A second unlikely and unrelated contingency such as increasing mass or contiguous volume would have to occur in order to exceed the criticality safety of the system in a fire or other off-normal situation that allows water into the glovebox. The double contingency criterion has been met.

7.3.3 Discussion of Infraction Contingencies

For the 2.5 kg Pu unit mass limit, the ARH-600 (Carter, 1968) Figure III.A.9(100)-4 shows that a sphere of plutonium mixed with water needs at least 10.8ℓ volume with nominal water reflection or 7.1ℓ volume with full water reflection to reach a critical configuration. Since room walls, the floor, the glovebox, rags, material, and workers are considered to give a nominal reflection, water would only have to be added to the fissile material to make the 2.5 kg Pu in a 10.8ℓ spherical volume critical, thus no water needs to be added as a reflector. If there is less mass, volume, or the configuration is not compact (i.e. a sphere, cube, or D=H right cylinder shape), the configuration is subcritical. The number of events, contingencies, needed to take the as-found configuration in the glovebox to a critical configuration defines the contingencies to criticality.

In the case of the 2.5 kg Pu in 7.1ℓ critical configuration specified in the paragraph above, full water reflection is required. The water reflection could be supplied by containers adjacent to the fissile containers. Considering that the 2.54 cm of water is considered the normal reflection of the environment, full water reflection would need at least another 2.54 cm of water reflection. A 2.54 cm spherical shell around the 7.1 ℓ fissile material sphere would have a volume of about 5.5 ℓ. This could be held in adjacent containers. To make a critical configuration, an event would have to add water not only to the containers of fissile material but to adjacent containers for reflective water for the critical configuration of 2.5 kg Pu in 7.1ℓ. Again, if there is less mass of plutonium, plutonium container volume, volume of reflector, or the configuration is not compact, the configuration would be subcritical. The number of events, contingencies, needed to take the as-found configuration in the glovebox to a critical configuration defines the contingencies to criticality.

For the glovebox limit of 3.5 kg Pu, Figure III.A.9.(100)-4 gives a critical volume of 10.5ℓ at nominal reflection and 6.8ℓ at full water reflection. The volume of a 2.54 cm spherical shell around the fissile material volume required as part of full water reflection is 4.9ℓ. Using these values, an evaluation of the number of contingencies remaining to criticality can be made as is done above for an as-found glovebox arrangement of 3.5 kg Pu.

As an example, consider the error situation where the largest normally used container, the 2.3ℓ furnace boat, containing 1 kg of plutonium is brought next to a permitted 4.6ℓ unit mass containing 2.5 kg of plutonium. The event simultaneously brings the entire glovebox inventory of 3.5 kg of plutonium together in a volume of 6.9ℓ that exceeds the unit mass volume limit of 4.6ℓ. This configuration can not go critical without full reflection per the volumes found in the paragraph above. The 6.9ℓ volume of the combined containers exceeds the 6.8ℓ required for criticality when fully reflected and the configuration has the required 3.5 kg of plutonium for criticality. To reach a critical configuration, the containers of plutonium must be compact, must have 4.9ℓ of containers to hold reflective water adjacent to the plutonium, and there must be a source of water. At least two of these contingencies are needed to approach criticality, from the error condition of 3.5 kg Pu in 6.9 ℓ. Two of the contingencies could be the introduction of at least 4.9ℓ of containers that are placed adjacent to the plutonium containers and a water source such as a fire that fills the plutonium and reflecting containers. If the containers are not compact enough but are slab like furnace boats, criticality would not be possible and a third contingency would be needed to reach a critical configuration.

8.0 References

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APPENDIX A

INDEPENDENT REVIEW COMMENTS AND CHECKLIST

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TECHNICAL PEER REVIEW

R. F. Richard of the Criticality and Shielding group in FDNW Specialty Engineering carried out the independent, technical of CSER 98-003, Revision 0. This review addresses Revision 1 of the CSER, for which the following comments are provided.

Comments provided for Revision 0 are still valid.

Revision 1 removes the single unit mass requirement for the glovebox, and adds a combined volume limit of 4.6 ℓ on a grouping of containers that makes up the unit mass. Also added is a 25.4 cm (10 in.) edge-to-edge minimum spacing limit between a unit mass and other unit masses or containers. Section 7.3 was augmented to include a discussion of fissionable material in the IAC, which has no criticality drain. It was shown that with the mass and volume group limits, criticality is not credible. Other editorial changes were made for clarification.

These changes are in the conservative direction and provide further assurance that criticality safety is maintained for Glovebox HC-21A.

CHECKLIST FOR TECHNICAL PEER REVIEW

Document Reviewed: CSER 98-003: Criticality Safety Evaluation Report for PFP Glovebox HC-21A with Button Can Opening

Yes	No*	NA	
[X]	[ ]	[ ]	Problem completely defined.
[X]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[X]	[ ]	[ ]	Computer codes and data files documented.
[X]	[ ]	[ ]	Data used in calculations explicitly stated in document.
[ ]	[ ]	[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. Spreadsheet results should be treated exactly the same as hand calculations.
[X]	[ ]	[ ]	Software input correct and consistent with document reviewed.
[X]	[ ]	[ ]	Software output consistent with input and with results reported in document reviewed.
[X]	[ ]	[ ]	Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
[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]		[ ]	**Review calculations, comments, and/or notes are attached.
[X]	**[ ]**	**[ ]**	**Document approved (i.e., the reviewer affirms the technical accuracy of the document).**
[X]	[ ]	[ ]	Traceability

Robert F. Richard *Robert F. Richard* *10-17-98*

Reviewer: (Printed and Signed) Date

* All "NO" responses must be explained below or on an additional page.

** Any calculations, comments, or notes generated as part of this review should be signed, dated and attached to this checklist.

APPENDIX B

MONK COMPUTER CODE VALIDATION

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B.1 VALIDATION PROCEDURE

The validation of the methods used in the analysis consists of testing the ability of the code and neutron cross-sections in calculations of known critical configurations, which are various benchmark experiments with the fissile material in question. Such analyses determine a calculational bias (the deviations of calculated k_{eff} values from unity for the benchmark cases) 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 level. This safety criteria is often expressed by the following formula:

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

where:

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

The bias-adjusted k_{eff} is to include the statistical uncertainties. This equation, which shows the uncertainties considered, can be used to calculate the bias-adjusted k_{eff}, but in this analysis a regression analysis is used to calculate the lower tolerance limits that are used to set the bias-adjustment.

B.2 GENERIC VALIDATION FOR PLUTONIUM SYSTEMS

A report by L. L. Macklin and E. M. Miller, *MONK6A Pu Validation* (Macklin and Miller 1992), presents the results of calculations to determine a generic bias for plutonium configurations, as encountered in the Plutonium Finishing Plant. Seventy benchmark experiments were calculated, ranging from simple metal spheres to highly dilute (9 g plutonium per liter) plutonium nitrate solution spheres, and also compacts of PuO_2 blended with polystyrene. A mean k_{eff} value of 1.0047 was determined over the full experimental range, with an overall standard deviation of 0.0097.

The direct calculational bias is thus +0.0047 (average k_{eff} greater than unity). Accounting for the uncertainties using a 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 [$-\text{bias} + (U_b^2 + U_c^2)^{1/2}$]. 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 value of **0.935**.

To quantify the safety margin that the 0.05 safety factor represents, a comparison is made using a k_{eff} for different percentages of the population of benchmark data covered the probability table derived for this problem. The k_{eff} value form the validation study for the 95% confidence level on 99.9% of the data is 0.9699. So a subcritical margin of 0.05 is 0.035 (i.e. 0.05 - (0.9855 - 0.9699) larger than the uncertainties between the 95.0% and 99.9% coverage of the benchmark data.

B.3 VALIDATION OF MONK6B

The validation of the MONK6B code on the SUN[3] microcomputers 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 input models done on the CRAY[4] machine with MONK6A, as reported in the previous subsection. Also, the equivalence of MONK6B to MONK6A was well documented by the code vendors, the United Kingdom Atomic Energy Authority, in the verification package supplied with the software.

The abstract from CCVR 94-001 summarizes the validation study as follows;

> The MONK6B validation for bare plutonium and plutonium water systems on the SUN computer and operating system is established in this report. Because the calculational method and nuclear cross-sections have not changed from the MONK6A code to the MONK6B code, the bias determination done for MONK6A is valid for MONK6B.

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3 SUN is a trademark of Sun Microsystems Inc., 901 San Antonio Road, Palo Alto, CA 94303

4 CRAY is a registered trademark of CRAY Research, Inc.

APPENDIX C

ALL MONK INPUT FILES

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MONK NORMAL CONDITION INPUT FILES

Normal Condition Input Files

21AN001

```
* 21AN001      MONK6B model for HC-21A
* Normal Condition Analysis
* button in tuna can, 2.5 kg, R=3.550, H=2.540
*                             R=2.601, H=1.270
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat    No. of nuc
      5              5
*
* Mat #1       Pu Metal (19.6 g/cm3)
* Mat #2       PuO2+H2O (H/X=20)
* Mat #3       Carbon Steel (7.86 g/cm3)
* Mat #4       Water (1.00 g/cc)
* Mat #5       Air (0.0001 H2O)
NUCNAMES

ATOM 19.60   PU239 1.00
ATOM  2.214  PU239 1.00          O 12.00      HINH2O 20.00
CONC            FE 0.083491      C 0.003921
ATOM  1.00  HINH2O 2.00          O 1.00
ATOM 0.0001 HINH2O 2.0           O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 1
 4 3
* Part 2, The rest of the model
NEST 4
1 CUBOID  P1  30.480 60.960 10.000   -0.000  -0.000  0.000
2 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000  0.000
3 CUBOID   2  30.480 60.960 60.960   -0.000  -0.000 -0.480
4 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54      1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54      4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0       1 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0       4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 10.00  -15.240 -15.240 0.0
* Part 4, Other Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54      1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54      4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0       1 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0       4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 10.00  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5        1.0
 -5      25      1000      0       STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5  -2.0  19.0    15.5  91.0  19.0    15.5  -2.0  -2.0
* Top View
 -2.0  60.9   2.0    30.5  60.9   2.0    -2.0  -2.0   2.0
END
```

21AN002

```
* 21AN002      MONK6B model for HC-21A
* Normal Condition Analysis
* button in tuna can, 2.5 kg, R=3.550, H=2.540
*                             R=2.601, H=1.270
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat    No. of nuc
      5              5
*
* Mat #1       Pu Metal (19.6 g/cm3)
* Mat #2       PuO2+H2O (H/X=20)
* Mat #3       Carbon Steel (7.86 g/cm3)
* Mat #4       Water (1.00 g/cc)
* Mat #5       Air (0.0001 H2O)
NUCNAMES

ATOM 19.6    PU239 1.00
ATOM  2.214  PU239 1.00          O 12.00      HINH2O 20.00
CONC            FE 0.083491      C 0.003921
ATOM  1.00  HINH2O 2.00          O 1.00
ATOM 0.0001 HINH2O 2.0           O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 1
 4 3
* Part 2, The rest of the model
NEST 4
1 CUBOID  P1  30.480 60.960 10.000   -0.000  -0.000  0.000
2 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000  0.000
3 CUBOID   2  30.480 60.960 60.960   -0.000  -0.000 -0.480
4 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54      1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54      4 3.550  1.270
```

```
3 ZROD    ORIGIN 0.0 0.0 0.0      1 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0      4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 10.00  -15.240 -15.240 0.0
* Part 4, Other Pu Button and no H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54     1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54     5 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0      1 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0      5 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 10.00  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5        1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AN003

```
* 21AN003     MONK6B model for HC-21A
* Normal Condition Analysis
* button in tuna can, 2.5 kg, R=3.550, H=2.540
*                              R=2.601, H=1.270
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat     No. of nuc
      5              5
*
* Mat #1       Pu Metal (19.6 g/cm3)
* Mat #2       PuO2+H2O (H/X=20)
* Mat #3       Carbon Steel (7.86 g/cm3)
* Mat #4       Water (1.00 g/cc)
* Mat #5       Air (0.0001 H2O)
NUCNAMES

ATOM 19.6    PU239 1.00
ATOM  2.214  PU239 1.00            O 12.00       HINH2O 20.00
CONC            FE 0.083491        C 0.003921
ATOM  1.00   HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0             O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 1
 4 3
```

```
* Part 2, The rest of the model
NEST 4
1 CUBOID  P1  30.480 60.960 10.000    -0.000  -0.000  0.000
2 CUBOID   5  30.480 60.960 60.960    -0.000  -0.000  0.000
3 CUBOID   2  30.480 60.960 60.960    -0.000  -0.000 -0.480
4 CUBOID   4  60.960 91.440 63.500    -2.540  -2.540 -5.540
* Part 3, Pu Button and no H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54     1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54     5 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0      1 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0      5 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 10.00  -15.240 -15.240 0.0
* Part 4, Other Pu Button and no H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54     1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54     5 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0      1 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0      5 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 10.00  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5        1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AN004

```
* 21AN004     MONK6B model for HC-21A
* Normal Condition Analysis
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat     No. of nuc
      5              5
*
* Mat #1       PuO2+H2O (H/X=17.54)
* Mat #2       PuO2+H2O (H/X=20)
* Mat #3       Carbon Steel (7.86 g/cm3)
* Mat #4       Water (1.00 g/cc)
* Mat #5       Air (0.0001 H2O)
NUCNAMES

ATOM  2.362  PU239 1.00          O 10.77      HINH2O 17.54
ATOM  2.214  PU239 1.00          O 12.00      HINH2O 20.00
```

```
CONC            FE 0.083491        C 0.003921
ATOM  1.00  HINH2O 2.00            O 1.00
ATOM 0.0001 HINH2O 2.0             O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 1
4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  30.480 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  30.480 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  30.480 60.960 15.970   -0.000  -0.000 -2.540
4 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000 -2.540
5 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3,  Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0      1 6.710  13.43
2 ZROD    ORIGIN 0.0 1.5 0.0      4 9.250  15.97
3 ZROD    ORIGIN 0.0 1.5 0.0      5 9.500  15.97
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 15.97  -15.240 -15.240 0.0
* Part 4,  Other Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0      1 6.710  13.43
2 ZROD    ORIGIN 0.0 1.5 0.0      4 9.250  15.97
3 ZROD    ORIGIN 0.0 1.5 0.0      5 9.500  15.97
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 15.97  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AN005

```
* 21AN005     MONK6B model for HC-21A
* Normal Condition Analysis
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat    No. of nuc
      5             5
*
* Mat #1      PuO2+H2O (H/X=17.54)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Carbon Steel (7.86 g/cm3)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.0001 H2O)
NUCNAMES

ATOM  2.362  PU239 1.00             O 10.77      HINH2O 17.54
ATOM  2.214  PU239 1.00             O 12.00      HINH2O 20.00
CONC            FE 0.083491         C 0.003921
ATOM  1.00  HINH2O 2.00             O 1.00
ATOM 0.0001 HINH2O 2.0              O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 1
4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  30.480 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  30.480 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  30.480 60.960 15.970   -0.000  -0.000 -2.540
4 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000 -2.540
5 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3,  Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0      1 6.710  13.43
2 ZROD    ORIGIN 0.0 1.5 0.0      4 9.250  15.97
3 ZROD    ORIGIN 0.0 1.5 0.0      5 9.500  15.97
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 15.97  -15.240 -15.240 0.0
* Part 4,  Other Pu Oxide and no H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0      1 6.710  13.43
2 ZROD    ORIGIN 0.0 1.5 0.0      5 9.250  15.97
3 ZROD    ORIGIN 0.0 1.5 0.0      5 9.500  15.97
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 15.97  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AN006

```
* 21AN006     MONK6B model for HC-21A
* Normal Condition Analysis
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
```

```
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat    No. of nuc
      5             5
*
* Mat #1       PuO2+H2O (H/X=17.54)
* Mat #2       PuO2+H2O (H/X=20)
* Mat #3       Carbon Steel (7.86 g/cm3)
* Mat #4       Water (1.00 g/cc)
* Mat #5       Air (0.0001 H2O)
NUCNAMES

ATOM  2.362  PU239 1.00            O 10.77      HINH2O 17.54
ATOM  2.214  PU239 1.00            O 12.00      HINH2O 20.00
CONC             FE 0.083491       C 0.003921
ATOM  1.00  HINH2O 2.00            O 1.00
ATOM 0.0001 HINH2O 2.0             O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 1
4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  30.480 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  30.480 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  30.480 60.960 15.970   -0.000  -0.000 -2.540
4 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000 -2.540
5 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3,  Pu Oxide and no H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0      1 6.710  13.43
2 ZROD    ORIGIN 0.0 1.5 0.0      5 9.250  15.97
3 ZROD    ORIGIN 0.0 1.5 0.0      5 9.500  15.97
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 15.97  -15.240 -15.240 0.0
* Part 4,  Other Pu Oxide and no H20
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0      1 6.710  13.43
2 ZROD    ORIGIN 0.0 1.5 0.0      5 9.250  15.97
3 ZROD    ORIGIN 0.0 1.5 0.0      5 9.500  15.97
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 15.97  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5        1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5    0.0   19.0     15.5  91.0  19.0     15.5    0.0   -2.0
* Top View
  0.0  60.9    2.0     30.5  60.9    2.0      0.0    0.0    2.0
END
```

21AN007

```
* 21AN007      MONK6B model for HC-21A
* Normal Condition Analysis
* Button, 2.5 kg, R=3.550, H=2.540
*                 R=2.601, H=1.270
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat    No. of nuc
      5             3
*
* Mat #1       PuO2+H2O (H/X=17.54)
* Mat #2       PuO2+H2O (H/X=20)
* Mat #3       Pu (19.6 g/cc)
* Mat #4       Water (1.00 g/cc)
* Mat #5       Air (0.0001 H2O)
NUCNAMES

ATOM  2.362  PU239 1.00            O 10.77      HINH2O 17.54
ATOM  2.214  PU239 1.00            O 12.00      HINH2O 20.00
ATOM 19.6     PU239 1.0
ATOM  1.00  HINH2O 2.00            O 1.00
ATOM 0.0001 HINH2O 2.0             O 1.00
*
CM
*
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  30.480 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  30.480 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  30.480 60.960 15.970   -0.000  -0.000 -3.000
4 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0      1 6.710  13.430
2 ZROD    ORIGIN 0.0 1.5 0.0      4 9.250  15.970
3 ZROD    ORIGIN 0.0 1.5 0.0      5 9.500  15.970
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 15.97  -15.240 -15.240 0.0
* Part 4, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54     3 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54     4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0      3 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0      4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 15.97  -15.240 -15.240 0.0
* End of model
*
```

```
* Control Data
 SUPERHIST        5        1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5    0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AN008

```
* 21AN008     MONK6B model for HC-21A
* Normal Condition Analysis
* Button, 2.5 kg, R=3.550, H=2.540
*                  R=2.601, H=1.270
* Oxide in Boat, 2.5 kg , V=2131, H/X = 20
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat     No. of nuc
       5              3
*
* Mat #1       PuO2+H2O (H/X=17.54)
* Mat #2       PuO2+H2O (H/X=20)
* Mat #3       Pu (19.6 g/cc)
* Mat #4       Water (1.00 g/cc)
* Mat #5       Air (0.0001 H2O)
NUCNAMES

ATOM  2.362  PU239 1.00            O 10.77      HINH2O 17.54
ATOM  2.214  PU239 1.00            O 12.00      HINH2O 20.00
ATOM 19.6    PU239 1.0
ATOM  1.00  HINH2O 2.00            O 1.00
ATOM 0.0001 HINH2O 2.0             O 1.00
*
CM
*
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  34.000 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  34.000 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  34.000 60.960 15.970   -0.000  -0.000 -3.000
4 CUBOID   5  34.000 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  64.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Oxide in boat, nominal H2O
NEST 3
1 CUBOID  2  13.97   6.35   6.006  -13.97   -6.35   0.00
2 CUBOID  4  16.51   8.89   8.546  -16.51   -8.89   0.00
3 CUBOID  5  17.00  15.24  15.97   -17.00  -15.24   0.00
* Part 4, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54     3 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54     4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0      3 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0      4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 17.000 15.240 15.97  -17.000 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5        1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5    0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

Off-Normal Condition Input Files

21AC001

```
* 21AC001     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* button in tuna can, 2.5 kg, R=3.550, H=2.540
*                             R=2.601, H=1.270
* 1.0 kg oxide H/X=20, layer
* Extra Button in one can
*
FISSION
* No. of mat    No. of nuc
      5             5
*
* Mat #1      Pu Metal (19.6 g/cm3)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Carbon Steel (7.86 g/cm3)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.0001 H2O)
NUCNAMES

ATOM 19.6    PU239 1.00
ATOM  2.214  PU239 1.00          O 12.00      HINH2O 20.00
CONC           FE 0.083491       C 0.003921
ATOM  1.00  HINH2O 2.00          O 1.00
ATOM 0.0001 HINH2O 2.0           O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 4
6 3 5 4 7 4 7 5
* Part 2, The rest of the model
NEST 4
1 CUBOID  P1  30.480 60.960 10.160   -0.000  -0.000  0.000
2 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000  0.000
3 CUBOID   2  30.480 60.960 60.960   -0.000  -0.000 -0.460
4 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Top of Pu Button and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 0.0 1.27     1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 0.0      4 6.090  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0      5 9.348  2.540
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 4, Bottom of Pu Button and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 0.0 0.0      1 3.550  2.540
2 ZROD    ORIGIN 0.0 0.0 0.0      4 6.090  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0      5 9.348  2.540
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 5, Top of Pu Button and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 0.0 0.0      1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 0.0      4 6.090  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0      5 9.348  2.540
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 6, Bottom of Pu Button and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 0.0 0.0      1 3.550  2.540
2 ZROD    ORIGIN 0.0 0.0 0.0      4 6.090  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0      5 9.348  2.540
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 7, Empty space
NEST 1
1 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5        1.0
 -5      25      1000      0       STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC011

```
* 21AC011     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
* Overbatch in a can H/X=7.46, 5.0 kg
*
FISSION
* No. of mat    No. of nuc
      6             5
*
* Mat #1      PuO2+H2O (H/X=17.54)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Carbon Steel (7.86 g/cm3)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.0001 H2O)
* Mat #6      PuO2+H2O (H/X=7.46)
NUCNAMES

ATOM  2.362  PU239 1.00          O 10.77      HINH2O 17.54
ATOM  2.214  PU239 1.00          O 12.00      HINH2O 20.00
CONC           FE 0.083491       C 0.003921
ATOM  1.00  HINH2O 2.00          O 1.00
ATOM 0.0001 HINH2O 2.0           O 1.00
ATOM  3.723  PU239 1.00          O  5.743     HINH2O  7.46
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 2
```

```
4 6 3 5
* Part 2, The rest of the model
NEST 4
1 CUBOID  P1  30.480 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000  0.000
3 CUBOID   2  30.480 60.960 60.960   -0.000  -0.000 -0.460
4 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Top of Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0       1 6.710   8.35
2 ZROD    ORIGIN 0.0 1.5 0.0       4 9.250  10.89
3 ZROD    ORIGIN 0.0 1.5 0.0       5 9.500  10.89
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 10.89  -15.240 -15.240 0.0
* Part 4, Bottom of Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0       1 6.710  5.080
2 ZROD    ORIGIN 0.0 1.5 0.0       4 9.250  5.080
3 ZROD    ORIGIN 0.0 1.5 0.0       5 9.500  5.080
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 5.080  -15.240 -15.240 0.0
* Part 5, Top of Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 -1.5 0.0      6 6.710   8.35
2 ZROD    ORIGIN 0.0 -1.5 0.0      4 9.250  10.89
3 ZROD    ORIGIN 0.0 -1.5 0.0      5 9.500  10.89
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 10.89  -15.240 -15.240 0.0
* Part 6, Bottom of Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 -1.5 0.0      6 6.170  5.080
2 ZROD    ORIGIN 0.0 -1.5 0.0      4 9.250  5.080
3 ZROD    ORIGIN 0.0 -1.5 0.0      5 9.500  5.080
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 5.080  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5        1.0
 -5     25      1000      0       STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC012

```
* 21AC012     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
* Extra Can
*
FISSION
* No. of mat    No. of nuc
        5              5
*
* Mat #1      PuO2+H2O (H/X=17.54)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Carbon Steel (7.86 g/cm3)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.0001 H2O)
NUCNAMES

ATOM  2.362  PU239 1.00            O 10.77      HINH2O 17.54
ATOM  2.214  PU239 1.00            O 12.00      HINH2O 20.00
CONC          FE 0.083491          C 0.003921
ATOM   1.00  HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0             O 1.00
*
CM
*
* Part 1, Array of cans
ARRAY 1 2 1
3  5
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  37.200 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  37.200 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  37.200 60.960 15.970   -0.000  -0.000 -2.540
4 CUBOID   5  37.200 60.960 60.960   -0.000  -0.000 -2.540
5 CUBOID   4  67.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3,  Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 -1.5 0.0      1 6.710   13.43
2 ZROD    ORIGIN 0.0 -1.5 0.0      4 9.250   15.97
3 ZROD    ORIGIN 0.0 -1.5 0.0      5 9.500   15.97
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 18.600 15.240 15.97  -18.600 -15.240 0.0
* Part 4,  Other Pu Oxide and nominal H2O
NEST 2
1 ZROD    ORIGIN 0.0 0.0 0.0      1 6.710  13.43
2 ZROD    ORIGIN 0.0 0.0 0.0      4 9.250  15.97
* Part 5, Two cans side by side
CLUSTER 3
1 ZROD    ORIGIN -9.30 1.5 0.0  P4  9.250 15.970
2 ZROD    ORIGIN  9.30 1.5 0.0  P4  9.250 15.970
3 CUBOID   5 18.60 20.00 15.97  -18.60 -10.48 0.00
* End of model
*
* Control Data
 SUPERHIST        5        1.0
 -5     25      1000      0       STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  -0.0  70.9   2.0    50.5  70.9   2.0    -0.0  -10.0   2.0
END
```

21AC013

```
* 21AC013     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Button, 2.5 kg, R=3.550, H=2.540
*                  R=2.643, H=1.270
* Oxide in Boat, 5.0 kg , V=2300, H/X = 9.58
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat    No. of nuc
      5              3
*
* Mat #1      PuO2+H2O (H/X=9.58)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Pu (19.47 g/cc)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.0001 H2O)
NUCNAMES

ATOM  3.250  PU239 1.00           O  6.79      HINH2O  9.58
ATOM  2.214  PU239 1.00           O 12.00      HINH2O 20.00
ATOM 19.47   PU239 1.0
ATOM  1.00  HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0            O 1.00
*
CM
*
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  34.000 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  34.000 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  34.000 60.960 15.970   -0.000  -0.000 -3.000
4 CUBOID   5  34.000 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  64.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Oxide in boat, nominal H2O
NEST 3
1 CUBOID  1  13.97   6.35   6.482  -13.97   -6.35   0.00
2 CUBOID  4  16.51   8.89   9.022  -16.51   -8.89   0.00
3 CUBOID  5  17.00  15.24  15.97   -17.00  -15.24   0.00
* Part 4, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54      3 2.643  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54      4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0       3 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0       4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 17.000 15.240 15.97  -17.000 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST          5         1.0
 -5       25      1000       0      STDV 0.0020      -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0     15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0      0.0   0.0   2.0
END
```

21AC014

```
* 21AC014     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Button, 2.5 kg, R=3.550, H=2.540
*                  R=2.643, H=1.270
* Oxide in Stacked Boats 5.0 kg , V=4262.8, H/X = 20.00
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat    No. of nuc
      5              3
*
* Mat #1      PuO2+H2O (H/X=20.00)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Pu (19.47 g/cc)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.0001 H2O)
NUCNAMES

ATOM  2.214  PU239 1.00           O 12.00      HINH2O 20.00
ATOM  2.214  PU239 1.00           O 12.00      HINH2O 20.00
ATOM 19.47   PU239 1.0
ATOM  1.00  HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0            O 1.00
*
CM
*
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  34.000 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  34.000 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  34.000 60.960 15.970   -0.000  -0.000 -3.000
4 CUBOID   5  34.000 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  64.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Oxide in boat, nominal H2O
NEST 3
1 CUBOID  1  13.97   6.35  12.013  -13.97   -6.35   0.00
2 CUBOID  4  16.51   8.89  14.553  -16.51   -8.89   0.00
3 CUBOID  5  17.00  15.24  15.97   -17.00  -15.24   0.00
* Part 4, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54      3 2.643  1.270
```

```
2 ZROD    ORIGIN 0.0 0.0 2.54      4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0       3 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0       4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 17.000 15.240 15.97  -17.000 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5        1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC021

```
* 21AC021     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Button, 2.5 kg, R=3.550, H=2.540
*                 R=2.601, H=1.270
* Button and Oxide in Boat, 2.5 kg , V=2131, H/X = 20.00
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat     No. of nuc
       5              3
*
* Mat #1      PuO2+H2O (H/X=9.58)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Pu (19.6 g/cc)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.0001 H2O)
NUCNAMES

ATOM  2.214  PU239 1.00           O 12.00       HINH2O 20.00
ATOM  2.214  PU239 1.00           O 12.00       HINH2O 20.00
ATOM 19.6    PU239 1.0
ATOM  1.00  HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0            O 1.00
*
CM
*
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  34.000 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  34.000 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  34.000 60.960 15.970   -0.000  -0.000 -3.000
4 CUBOID   5  34.000 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  64.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Oxide in boat, nominal H2O
NEST 4
1 ZROD  ORIGIN 10.42  2.80  0.00   3  3.550  3.244
2 CUBOID  1  13.97   6.35   6.368  -13.97   -6.35   0.00
3 CUBOID  4  16.51   8.89   8.908  -16.51   -8.89   0.00
4 CUBOID  5  17.00  15.24  15.97   -17.00  -15.24   0.00
* Part 4, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54      3 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54      4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0       3 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0       4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 17.000 15.240 15.97  -17.000 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5        1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC022

```
* 21AC022     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Button, 2.5 kg, R=3.550, H=2.540
*                 R=2.601, H=1.270
* Brit Button and Oxide in Boat, 2.5 kg , V=2131, H/X = 20.00
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat     No. of nuc
       5              3
*
* Mat #1      PuO2+H2O (H/X=9.58)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Pu (19.6 g/cc)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.0001 H2O)
NUCNAMES

ATOM  2.214  PU239 1.00           O 12.00       HINH2O 20.00
ATOM  2.214  PU239 1.00           O 12.00       HINH2O 20.00
ATOM 19.6    PU239 1.0
ATOM  1.00  HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0            O 1.00
```

```
*
CM
*
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  34.000 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  34.000 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  34.000 60.960 15.970   -0.000  -0.000 -3.000
4 CUBOID   5  34.000 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  64.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Oxide in boat, nominal H2O
NEST 4
1 ZROD  ORIGIN 11.23  3.61  0.00   3  2.734  5.468
2 CUBOID  1   13.97   6.35   6.368  -13.97   -6.35   0.00
3 CUBOID  4   16.51   8.89   8.908  -16.51   -8.89   0.00
4 CUBOID  5   17.00  15.24  15.97   -17.00  -15.24   0.00
* Part 4, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54      3 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54      4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0       3 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0       4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 17.000 15.240 15.97  -17.000 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5     25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC101

```
* 21AC101     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* button in tuna can, 2.5 kg, R=3.550, H=2.540
*                             R=2.601, H=1.270
* 1.0 kg oxide H/X=20, layer
* Interspersed moderation
*
FISSION
* No. of mat     No. of nuc
      5              5
*
* Mat #1      Pu Metal (19.6 g/cm3)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Carbon Steel (7.86 g/cm3)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Interspersed (0.01 H2O)
NUCNAMES

ATOM 19.6    PU239 1.00
ATOM  2.214  PU239 1.00            O 12.00      HINH2O 20.00
CONC            FE 0.083491        C 0.003921
ATOM  1.00  HINH2O 2.00            O 1.00
ATOM  0.01  HINH2O 2.0             O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 2
6 4 5 3
* Part 2, The rest of the model
NEST 4
1 CUBOID  P1  30.480 60.960  5.080   -0.000  -0.000  0.000
2 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000  0.000
3 CUBOID   2  30.480 60.960 60.960   -0.000  -0.000 -0.460
4 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Top of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0       1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 0.0       5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0       4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0       5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 4, Bottom of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0       1 3.550  2.540
2 ZROD    ORIGIN 0.0 0.0 0.0       5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0       4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0       5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 5, Top of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0       1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 0.0       5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0       4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0       5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 6, Bottom of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0       1 3.550  2.540
2 ZROD    ORIGIN 0.0 0.0 0.0       5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0       4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0       5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5     25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 4 /
END
```

```
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC102

```
* 21AC102     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* button in tuna can, 2.5 kg, R=3.550, H=2.540
*                             R=2.601, H=1.270
* 1.0 kg oxide H/X=20, layer
* Interspersed moderation
*
FISSION
* No. of mat     No. of nuc
     5              5
*
* Mat #1      Pu Metal (19.6 g/cm3)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Carbon Steel (7.86 g/cm3)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Interspersed (0.05 H2O)
NUCNAMES

ATOM 19.6    PU239 1.00
ATOM  2.214  PU239 1.00           O 12.00       HINH2O 20.00
CONC            FE 0.083491       C 0.003921
ATOM  1.00  HINH2O 2.00           O 1.00
ATOM  0.05  HINH2O 2.0            O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 2
6 4 5 3
* Part 2, The rest of the model
NEST 4
1 CUBOID  P1  30.480 60.960  5.080   -0.000  -0.000  0.000
2 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000  0.000
3 CUBOID   2  30.480 60.960 60.960   -0.000  -0.000 -0.460
4 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Top of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0      1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 0.0      5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0      4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0      5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 4, Bottom of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0      1 3.550  2.540
2 ZROD    ORIGIN 0.0 0.0 0.0      5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0      4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0      5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 5, Top of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0      1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 0.0      5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0      4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0      5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 6, Bottom of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0      1 3.550  2.540
2 ZROD    ORIGIN 0.0 0.0 0.0      5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0      4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0      5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5       1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 4 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC103

```
* 21AC103     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* button in tuna can, 2.5 kg, R=3.550, H=2.540
*                             R=2.601, H=1.270
* 1.0 kg oxide H/X=20, layer
* Interspersed moderation
*
FISSION
* No. of mat     No. of nuc
     5              5
*
* Mat #1      Pu Metal (19.6 g/cm3)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Carbon Steel (7.86 g/cm3)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Interspersed (0.10 H2O)
NUCNAMES

ATOM 19.6    PU239 1.00
ATOM  2.214  PU239 1.00           O 12.00       HINH2O 20.00
CONC            FE 0.083491       C 0.003921
ATOM  1.00  HINH2O 2.00           O 1.00
```

```
ATOM  0.10  HINH2O 2.0           O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 2
6 4 5 3
* Part 2, The rest of the model
NEST 4
1 CUBOID  P1  30.480 60.960  5.080   -0.000  -0.000  0.000
2 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000  0.000
3 CUBOID   2  30.480 60.960 60.960   -0.000  -0.000 -0.460
4 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Top of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0       1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 0.0       5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0       4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0       5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 4, Bottom of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0       1 3.550  2.540
2 ZROD    ORIGIN 0.0 0.0 0.0       5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0       4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0       5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 5, Top of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0       1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 0.0       5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0       4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0       5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 6, Bottom of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0       1 3.550  2.540
2 ZROD    ORIGIN 0.0 0.0 0.0       5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0       4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0       5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5      25     1000       0      STDV 0.0020      -1
FISSILE REGION 1 IN PART 4 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0     15.5  91.0  19.0     15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0     30.5  60.9   2.0      0.0   0.0   2.0
END
```

21AC104

```
* 21AC104      MONK6B model for HC-21A
* Off-Normal Condition Analysis
* button in tuna can, 2.5 kg, R=3.550, H=2.540
*                             R=2.601, H=1.270
* 1.0 kg oxide H/X=20, layer
* Interspersed moderation
*
FISSION
* No. of mat     No. of nuc
      5               5
*
* Mat #1      Pu Metal (19.6 g/cm3)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Carbon Steel (7.86 g/cm3)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Interspersed (0.20 H2O)
NUCNAMES

ATOM 19.6    PU239 1.00
ATOM  2.214  PU239 1.00              O 12.00      HINH2O 20.00
CONC            FE 0.083491          C 0.003921
ATOM  1.00  HINH2O 2.00              O 1.00
ATOM  0.20  HINH2O 2.0               O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 2
6 4 5 3
* Part 2, The rest of the model
NEST 4
1 CUBOID  P1  30.480 60.960  5.080   -0.000  -0.000  0.000
2 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000  0.000
3 CUBOID   2  30.480 60.960 60.960   -0.000  -0.000 -0.460
4 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Top of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0       1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 0.0       5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0       4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0       5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 4, Bottom of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0       1 3.550  2.540
2 ZROD    ORIGIN 0.0 0.0 0.0       5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0       4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0       5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 5, Top of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0       1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 0.0       5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0       4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0       5 9.348  2.540
```

```
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 6, Bottom of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0      1 3.550  2.540
2 ZROD    ORIGIN 0.0 0.0 0.0      5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0      4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0      5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5       1.0
 -5     25     1000      0       STDV 0.0020     -1
FISSILE REGION 1 IN PART 4 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC105

```
* 21AC105     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* button in tuna can, 2.5 kg, R=3.550, H=2.540
*                             R=2.601, H=1.270
* 1.0 kg oxide H/X=20, layer
* Interspersed moderation
*
FISSION
* No. of mat     No. of nuc
     5               5
*
* Mat #1       Pu Metal (19.6 g/cm3)
* Mat #2       PuO2+H2O (H/X=20)
* Mat #3       Carbon Steel (7.86 g/cm3)
* Mat #4       Water (1.00 g/cc)
* Mat #5       Interspersed (0.50 H2O)
NUCNAMES

ATOM 19.6    PU239 1.00
ATOM  2.214  PU239 1.00           O 12.00      HINH2O 20.00
CONC              FE 0.083491     C 0.003921
ATOM  1.00   HINH2O 2.00          O 1.00
ATOM  0.50   HINH2O 2.0           O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 2
6 4 5 3
* Part 2, The rest of the model
NEST 4
1 CUBOID  P1  30.480 60.960  5.080   -0.000  -0.000  0.000
2 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000  0.000
3 CUBOID   2  30.480 60.960 60.960   -0.000  -0.000 -0.460
4 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Top of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0      1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 0.0      5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0      4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0      5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 4, Bottom of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0      1 3.550  2.540
2 ZROD    ORIGIN 0.0 0.0 0.0      5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0      4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0      5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 5, Top of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0      1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 0.0      5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0      4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0      5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 6, Bottom of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0      1 3.550  2.540
2 ZROD    ORIGIN 0.0 0.0 0.0      5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0      4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0      5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5       1.0
 -5     25     1000      0       STDV 0.0020     -1
FISSILE REGION 1 IN PART 4 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC106

```
* 21AC106     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* button in tuna can, 2.5 kg, R=3.550, H=2.540
*                             R=2.601, H=1.270
* 1.0 kg oxide H/X=20, layer
* Interspersed moderation
*
```

```
FISSION
* No. of mat    No. of nuc
      5            5
*
* Mat #1       Pu Metal (19.47 g/cm3)
* Mat #2       PuO2+H2O (H/X=20)
* Mat #3       Carbon Steel (7.86 g/cm3)
* Mat #4       Water (1.00 g/cc)
* Mat #5       Interspersed (1.00 H2O)
NUCNAMES

ATOM 19.6    PU239 1.00
ATOM  2.214  PU239 1.00          O 12.00      HINH2O 20.00
CONC            FE 0.083491      C 0.003921
ATOM  1.00  HINH2O 2.00          O 1.00
ATOM  1.00  HINH2O 2.0           O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 2
6 4 5 3
* Part 2, The rest of the model
NEST 4
1 CUBOID  P1  30.480 60.960  5.080   -0.000  -0.000  0.000
2 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000  0.000
3 CUBOID   2  30.480 60.960 60.960   -0.000  -0.000 -0.460
4 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Top of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0        1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 0.0        5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0        4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0        5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 4, Bottom of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0        1 3.550  2.540
2 ZROD    ORIGIN 0.0 0.0 0.0        5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0        4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0        5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 5, Top of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0        1 2.601  1.270
2 ZROD    ORIGIN 0.0 0.0 0.0        5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0        4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0        5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* Part 6, Bottom of Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 0.0        1 3.550  2.540
2 ZROD    ORIGIN 0.0 0.0 0.0        5 4.286  2.540
3 ZROD    ORIGIN 0.0 0.0 0.0        4 6.826  2.540
4 ZROD    ORIGIN 0.0 0.0 0.0        5 9.348  2.540
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 2.540  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5        1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 4 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC201

```
* 21AC201      MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
* Interspresed Moderation
*
FISSION
* No. of mat    No. of nuc
      5            5
*
* Mat #1       PuO2+H2O (H/X=17.54)
* Mat #2       PuO2+H2O (H/X=20)
* Mat #3       Carbon Steel (7.86 g/cm3)
* Mat #4       Water (1.00 g/cc)
* Mat #5       Interspersed (0.01 H2O)
NUCNAMES

ATOM  2.362  PU239 1.00          O 10.77      HINH2O 17.54
ATOM  2.214  PU239 1.00          O 12.00      HINH2O 20.00
CONC            FE 0.083491      C 0.003921
ATOM  1.00  HINH2O 2.00          O 1.00
ATOM 0.010  HINH2O 2.0           O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 2
6 4 5 3
* Part 2, The rest of the model
NEST 4
1 CUBOID  P1  30.480 60.960 13.430   -0.000  -0.000  0.000
2 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000  0.000
3 CUBOID   2  30.480 60.960 60.960   -0.000  -0.000 -0.460
4 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Top of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0        1 6.710   8.35
2 ZROD    ORIGIN 0.0 1.5 0.0        5 9.250   8.35
3 ZROD    ORIGIN 0.0 1.5 0.0        5 9.500   8.35
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240  8.35  -15.240 -15.240 0.0
```

```
* Part 4, Bottom of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0      1 6.710  5.080
2 ZROD    ORIGIN 0.0 1.5 0.0      5 9.250  5.080
3 ZROD    ORIGIN 0.0 1.5 0.0      5 9.500  5.080
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 5.080  -15.240 -15.240 0.0
* Part 5, Top of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 -1.5 0.0      1 6.710   8.35
2 ZROD    ORIGIN 0.0 -1.5 0.0      5 9.250   8.35
3 ZROD    ORIGIN 0.0 -1.5 0.0      5 9.500   8.35
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240  8.35  -15.240 -15.240 0.0
* Part 6, Bottom of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 -1.5 0.0      1 6.710  5.080
2 ZROD    ORIGIN 0.0 -1.5 0.0      5 9.250  5.080
3 ZROD    ORIGIN 0.0 -1.5 0.0      5 9.500  5.080
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 5.080  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5       1.0
 -5      25      1000     0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC202

```
* 21AC202     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
* Interspersed Moderation
*
FISSION
* No. of mat     No. of nuc
       5              5
*
* Mat #1      PuO2+H2O (H/X=17.54)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Carbon Steel (7.86 g/cm3)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Interspersed (0.05 H2O)
NUCNAMES

ATOM  2.362  PU239 1.00          O 10.77      HINH2O 17.54
ATOM  2.214  PU239 1.00          O 12.00      HINH2O 20.00
CONC           FE 0.083491       C 0.003921
ATOM  1.00  HINH2O 2.00          O 1.00
ATOM 0.050  HINH2O 2.0           O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 2
6 4 5 3
* Part 2, The rest of the model
NEST 4
1 CUBOID  P1  30.480 60.960 13.430   -0.000  -0.000  0.000
2 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000  0.000
3 CUBOID   2  30.480 60.960 60.960   -0.000  -0.000 -0.460
4 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Top of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0      1 6.710   8.35
2 ZROD    ORIGIN 0.0 1.5 0.0      5 9.250   8.35
3 ZROD    ORIGIN 0.0 1.5 0.0      5 9.500   8.35
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240  8.35  -15.240 -15.240 0.0
* Part 4, Bottom of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0      1 6.710  5.080
2 ZROD    ORIGIN 0.0 1.5 0.0      5 9.250  5.080
3 ZROD    ORIGIN 0.0 1.5 0.0      5 9.500  5.080
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 5.080  -15.240 -15.240 0.0
* Part 5, Top of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 -1.5 0.0      1 6.710   8.35
2 ZROD    ORIGIN 0.0 -1.5 0.0      5 9.250   8.35
3 ZROD    ORIGIN 0.0 -1.5 0.0      5 9.500   8.35
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240  8.35  -15.240 -15.240 0.0
* Part 6, Bottom of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 -1.5 0.0      1 6.710  5.080
2 ZROD    ORIGIN 0.0 -1.5 0.0      5 9.250  5.080
3 ZROD    ORIGIN 0.0 -1.5 0.0      5 9.500  5.080
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 5.080  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5       1.0
 -5      25      1000     0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC203

```
* 21AC203     MONK6B model for HC-21A
* Off-Normal Condition Analysis
```

```
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
* Interspersed Moderation
*
FISSION
* No. of mat    No. of nuc
      5             5
*
* Mat #1      PuO2+H2O (H/X=17.54)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Carbon Steel (7.86 g/cm3)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Interspersed (0.10 H2O)
NUCNAMES

ATOM  2.362  PU239 1.00           O 10.77       HINH2O 17.54
ATOM  2.214  PU239 1.00           O 12.00       HINH2O 20.00
CONC            FE 0.083491       C 0.003921
ATOM   1.00  HINH2O 2.00          O 1.00
ATOM 0.100  HINH2O 2.0            O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 2
6 4 5 3
* Part 2, The rest of the model
NEST 4
1 CUBOID  P1  30.480 60.960 13.430   -0.000  -0.000  0.000
2 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000  0.000
3 CUBOID   2  30.480 60.960 60.960   -0.000  -0.000 -0.460
4 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Top of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0       1 6.710   8.35
2 ZROD    ORIGIN 0.0 1.5 0.0       5 9.250   8.35
3 ZROD    ORIGIN 0.0 1.5 0.0       5 9.500   8.35
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240  8.35  -15.240 -15.240 0.0
* Part 4, Bottom of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0       1 6.710  5.080
2 ZROD    ORIGIN 0.0 1.5 0.0       5 9.250  5.080
3 ZROD    ORIGIN 0.0 1.5 0.0       5 9.500  5.080
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 5.080  -15.240 -15.240 0.0
* Part 5, Top of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 -1.5 0.0       1 6.710   8.35
2 ZROD    ORIGIN 0.0 -1.5 0.0       5 9.250   8.35
3 ZROD    ORIGIN 0.0 -1.5 0.0       5 9.500   8.35
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240  8.35  -15.240 -15.240 0.0
* Part 6, Bottom of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 -1.5 0.0       1 6.710  5.080
2 ZROD    ORIGIN 0.0 -1.5 0.0       5 9.250  5.080
3 ZROD    ORIGIN 0.0 -1.5 0.0       5 9.500  5.080
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 5.080  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5       1.0
 -5      25      1000      0       STDV 0.0020      -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC204

```
* 21AC204      MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
* Interspersed Moderation
*
FISSION
* No. of mat     No. of nuc
      5              5
*
* Mat #1      PuO2+H2O (H/X=17.54)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Carbon Steel (7.86 g/cm3)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Interspersed (0.20 H2O)
NUCNAMES

ATOM  2.362  PU239 1.00           O 10.77       HINH2O 17.54
ATOM  2.214  PU239 1.00           O 12.00       HINH2O 20.00
CONC            FE 0.083491       C 0.003921
ATOM   1.00  HINH2O 2.00          O 1.00
ATOM 0.200  HINH2O 2.0            O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 2
6 4 5 3
* Part 2, The rest of the model
NEST 4
1 CUBOID  P1  30.480 60.960 13.430   -0.000  -0.000  0.000
2 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000  0.000
3 CUBOID   2  30.480 60.960 60.960   -0.000  -0.000 -0.460
4 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Top of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0       1 6.710   8.35
2 ZROD    ORIGIN 0.0 1.5 0.0       5 9.250   8.35
3 ZROD    ORIGIN 0.0 1.5 0.0       5 9.500   8.35
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240  8.35  -15.240 -15.240 0.0
```

```
* Part 4, Bottom of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0       1 6.710  5.080
2 ZROD    ORIGIN 0.0 1.5 0.0       5 9.250  5.080
3 ZROD    ORIGIN 0.0 1.5 0.0       5 9.500  5.080
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 5.080  -15.240 -15.240 0.0
* Part 5, Top of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 -1.5 0.0       1 6.710   8.35
2 ZROD    ORIGIN 0.0 -1.5 0.0       5 9.250   8.35
3 ZROD    ORIGIN 0.0 -1.5 0.0       5 9.500   8.35
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240  8.35  -15.240 -15.240 0.0
* Part 6, Bottom of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 -1.5 0.0       1 6.710  5.080
2 ZROD    ORIGIN 0.0 -1.5 0.0       5 9.250  5.080
3 ZROD    ORIGIN 0.0 -1.5 0.0       5 9.500  5.080
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 5.080  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5       1.0
 -5     25     1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0     15.5  91.0  19.0     15.5    0.0  -2.0
* Top View
  0.0  60.9   2.0     30.5  60.9   2.0      0.0    0.0   2.0
END
```

21AC205

```
* 21AC205     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
* Interspersed Moderation
*
FISSION
* No. of mat     No. of nuc
      5              5
*
* Mat #1      PuO2+H2O (H/X=17.54)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Carbon Steel (7.86 g/cm3)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Interspersed (0.50 H2O)
NUCNAMES

ATOM  2.362  PU239 1.00            O 10.77      HINH2O 17.54
ATOM  2.214  PU239 1.00            O 12.00      HINH2O 20.00
CONC            FE 0.083491        C 0.003921
ATOM   1.00  HINH2O 2.00           O 1.00
ATOM 0.500  HINH2O 2.0             O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 2
6 4 5 3
* Part 2, The rest of the model
NEST 4
1 CUBOID  P1  30.480 60.960 13.430   -0.000  -0.000  0.000
2 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000  0.000
3 CUBOID   2  30.480 60.960 60.960   -0.000  -0.000 -0.460
4 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Top of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0       1 6.710   8.35
2 ZROD    ORIGIN 0.0 1.5 0.0       5 9.250   8.35
3 ZROD    ORIGIN 0.0 1.5 0.0       5 9.500   8.35
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240  8.35  -15.240 -15.240 0.0
* Part 4, Bottom of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0       1 6.710  5.080
2 ZROD    ORIGIN 0.0 1.5 0.0       5 9.250  5.080
3 ZROD    ORIGIN 0.0 1.5 0.0       5 9.500  5.080
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 5.080  -15.240 -15.240 0.0
* Part 5, Top of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 -1.5 0.0       1 6.710   8.35
2 ZROD    ORIGIN 0.0 -1.5 0.0       5 9.250   8.35
3 ZROD    ORIGIN 0.0 -1.5 0.0       5 9.500   8.35
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240  8.35  -15.240 -15.240 0.0
* Part 6, Bottom of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 -1.5 0.0       1 6.710  5.080
2 ZROD    ORIGIN 0.0 -1.5 0.0       5 9.250  5.080
3 ZROD    ORIGIN 0.0 -1.5 0.0       5 9.500  5.080
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 5.080  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5       1.0
 -5     25     1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0     15.5  91.0  19.0     15.5    0.0  -2.0
* Top View
  0.0  60.9   2.0     30.5  60.9   2.0      0.0    0.0   2.0
END
```

21AC206

```
* 21AC206     MONK6B model for HC-21A
* Off-Normal Condition Analysis
```

```
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
* Interspersed Moderation
*
FISSION
* No. of mat    No. of nuc
      5             5
*
* Mat #1      PuO2+H2O (H/X=17.54)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Carbon Steel (7.86 g/cm3)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Interspersed (1.00 H2O)
NUCNAMES

ATOM  2.362  PU239 1.00            O 10.77      HINH2O 17.54
ATOM  2.214  PU239 1.00            O 12.00      HINH2O 20.00
CONC              FE 0.083491      C 0.003921
ATOM   1.00  HINH2O 2.00           O 1.00
ATOM 1.000   HINH2O 2.0            O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 2
6 4 5 3
* Part 2, The rest of the model
NEST 4
1 CUBOID  P1  30.480 60.960 13.430   -0.000  -0.000  0.000
2 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000  0.000
3 CUBOID   2  30.480 60.960 60.960   -0.000  -0.000 -0.460
4 CUBOID   4  60.960 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Top of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0       1 6.710   8.35
2 ZROD    ORIGIN 0.0 1.5 0.0       5 9.250   8.35
3 ZROD    ORIGIN 0.0 1.5 0.0       5 9.500   8.35
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240  8.35  -15.240 -15.240 0.0
* Part 4, Bottom of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0       1 6.710  5.080
2 ZROD    ORIGIN 0.0 1.5 0.0       5 9.250  5.080
3 ZROD    ORIGIN 0.0 1.5 0.0       5 9.500  5.080
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 5.080  -15.240 -15.240 0.0
* Part 5, Top of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 -1.5 0.0       1 6.710   8.35
2 ZROD    ORIGIN 0.0 -1.5 0.0       5 9.250   8.35
3 ZROD    ORIGIN 0.0 -1.5 0.0       5 9.500   8.35
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240  8.35  -15.240 -15.240 0.0
* Part 6, Bottom of Pu Oxide and interspersed H2O
NEST 4
1 ZROD    ORIGIN 0.0 -1.5 0.0       1 6.710  5.080
2 ZROD    ORIGIN 0.0 -1.5 0.0       5 9.250  5.080
3 ZROD    ORIGIN 0.0 -1.5 0.0       5 9.500  5.080
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 5.080  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5        1.0
 -5      25      1000      0       STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC401

```
* 21AC401      MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
* H/X=20 in one can to exceed 1.9L volume
*
*
FISSION
* No. of mat    No. of nuc
      5             5
*
* Mat #1      PuO2+H2O (H/X=17.54)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Carbon Steel (7.86 g/cm3)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.0001 H2O)
NUCNAMES

ATOM  2.362  PU239 1.00            O 10.77      HINH2O 17.54
ATOM  2.214  PU239 1.00            O 12.00      HINH2O 20.00
CONC              FE 0.083491      C 0.003921
ATOM   1.00  HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0             O 1.00
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 1
3  4
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  30.480 60.960 16.488   -0.000  -0.000  0.000
2 CUBOID   2  30.480 60.960 16.488   -0.000  -0.000 -0.460
3 CUBOID   4  30.480 60.960 16.488   -0.000  -0.000 -2.540
4 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000 -2.540
5 CUBOID   4  60.960 91.440 63.560   -2.540  -2.540 -5.540
* Part 3,  Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0       1 6.710   13.43
2 ZROD    ORIGIN 0.0 1.5 0.0       4 9.250   15.97
```

```
3 ZROD    ORIGIN 0.0 1.5 0.0      5 9.500  15.97
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 16.488  -15.240 -15.240 0.0
* Part 4,  Other Pu Oxide and nominal H2O, 2.13L
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0      2 6.974  13.948
2 ZROD    ORIGIN 0.0 1.5 0.0      4 9.514  16.488
3 ZROD    ORIGIN 0.0 1.5 0.0      5 9.999  16.488
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 16.488  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5        1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC501

```
* 21AC501     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
* One can with increasing H/X, Decreasing Mass
*
*
FISSION
* No. of mat    No. of nuc
      6            5
*
* Mat #1      PuO2+H2O (H/X=17.54)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Carbon Steel (7.86 g/cm3)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.0001 H2O)
* Mat #6      PuO2+H2O (H/X=19.78)
NUCNAMES

ATOM  2.362  PU239 1.00          O 10.77       HINH2O 17.54
ATOM  2.214  PU239 1.00          O 12.00       HINH2O 20.00
CONC             FE 0.083491     C 0.003921
ATOM   1.00  HINH2O 2.00         O 1.00
ATOM 0.0001  HINH2O 2.0          O 1.00
ATOM  2.226  PU239 1.00          O 11.89       HINH2O 19.78
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 1
4  3
```

```
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  30.480 60.960 13.430   -0.000  -0.000  0.000
2 CUBOID   2  30.480 60.960 13.430   -0.000  -0.000 -0.460
3 CUBOID   4  30.480 60.960 13.430   -0.000  -0.000 -2.540
4 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000 -2.540
5 CUBOID   4  60.960 91.440 63.560   -2.540  -2.540 -5.540
* Part 3,  Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0      1 6.710  13.43
2 ZROD    ORIGIN 0.0 1.5 0.0      4 9.250  13.43
3 ZROD    ORIGIN 0.0 1.5 0.0      5 9.500  13.43
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 13.43  -15.240 -15.240 0.0
* Part 4,  Other Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0      6 6.710  13.43
2 ZROD    ORIGIN 0.0 1.5 0.0      4 9.250  13.43
3 ZROD    ORIGIN 0.0 1.5 0.0      5 9.500  13.43
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 13.43  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5        1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC502

```
* 21AC502     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
* One can with increasing H/X, Decreasing Mass
*
*
FISSION
* No. of mat    No. of nuc
      6            5
*
* Mat #1      PuO2+H2O (H/X=17.54)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Carbon Steel (7.86 g/cm3)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.0001 H2O)
* Mat #6      PuO2+H2O (H/X=22.59)
NUCNAMES

ATOM  2.362  PU239 1.00          O 10.77       HINH2O 17.54
```

```
ATOM  2.214  PU239 1.00           O 12.00      HINH2O 20.00
CONC              FE 0.083491     C 0.003921
ATOM  1.00  HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0            O 1.00
ATOM  2.089  PU239 1.00           O 13.295     HINH2O 22.590
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 1
4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  30.480 60.960 13.430   -0.000  -0.000  0.000
2 CUBOID   2  30.480 60.960 13.430   -0.000  -0.000 -0.460
3 CUBOID   4  30.480 60.960 13.430   -0.000  -0.000 -2.540
4 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000 -2.540
5 CUBOID   4  60.960 91.440 63.560   -2.540  -2.540 -5.540
* Part 3,  Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0       1 6.710  13.43
2 ZROD    ORIGIN 0.0 1.5 0.0       4 9.250  13.43
3 ZROD    ORIGIN 0.0 1.5 0.0       5 9.500  13.43
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 13.43  -15.240 -15.240 0.0
* Part 4,  Other Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0       6 6.710  13.43
2 ZROD    ORIGIN 0.0 1.5 0.0       4 9.250  13.43
3 ZROD    ORIGIN 0.0 1.5 0.0       5 9.500  13.43
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 13.43  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5        1.0
 -5     25     1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC503

```
* 21AC503     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
* One can with increasing H/X, Decreasing Mass
*
*
FISSION
* No. of mat    No. of nuc
      6             5
*
* Mat #1      PuO2+H2O (H/X=17.54)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Carbon Steel (7.86 g/cm3)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.0001 H2O)
* Mat #6      PuO2+H2O (H/X=26.19)
NUCNAMES

ATOM  2.362  PU239 1.00           O 10.77      HINH2O 17.54
ATOM  2.214  PU239 1.00           O 12.00      HINH2O 20.00
CONC              FE 0.083491     C 0.003921
ATOM  1.00  HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0            O 1.00
ATOM  1.953  PU239 1.00           O 15.095     HINH2O 26.190
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 1
4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  30.480 60.960 13.430   -0.000  -0.000  0.000
2 CUBOID   2  30.480 60.960 13.430   -0.000  -0.000 -0.460
3 CUBOID   4  30.480 60.960 13.430   -0.000  -0.000 -2.540
4 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000 -2.540
5 CUBOID   4  60.960 91.440 63.560   -2.540  -2.540 -5.540
* Part 3,  Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0       1 6.710  13.43
2 ZROD    ORIGIN 0.0 1.5 0.0       4 9.250  13.43
3 ZROD    ORIGIN 0.0 1.5 0.0       5 9.500  13.43
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 13.43  -15.240 -15.240 0.0
* Part 4,  Other Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0       6 6.710  13.43
2 ZROD    ORIGIN 0.0 1.5 0.0       4 9.250  13.43
3 ZROD    ORIGIN 0.0 1.5 0.0       5 9.500  13.43
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 13.43  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5        1.0
 -5     25     1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC504

```
* 21AC504     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
* One can with increasing H/X, Decreasing Mass
*
*
FISSION
* No. of mat    No. of nuc
      6              5
*
* Mat #1       PuO2+H2O (H/X=17.54)
* Mat #2       PuO2+H2O (H/X=20)
* Mat #3       Carbon Steel (7.86 g/cm3)
* Mat #4       Water (1.00 g/cc)
* Mat #5       Air (0.0001 H2O)
* Mat #6       PuO2+H2O (H/X=30.99)
NUCNAMES

ATOM  2.362  PU239 1.00           O 10.77      HINH2O 17.54
ATOM  2.214  PU239 1.00           O 12.00      HINH2O 20.00
CONC              FE 0.083491     C 0.003921
ATOM  1.00  HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0            O 1.00
ATOM  1.817  PU239 1.00           O 17.495     HINH2O 30.990
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 1
4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  30.480 60.960 13.430   -0.000  -0.000  0.000
2 CUBOID   2  30.480 60.960 13.430   -0.000  -0.000 -0.460
3 CUBOID   4  30.480 60.960 13.430   -0.000  -0.000 -2.540
4 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000 -2.540
5 CUBOID   4  60.960 91.440 63.560   -2.540  -2.540 -5.540
* Part 3,  Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0       1 6.710  13.43
2 ZROD    ORIGIN 0.0 1.5 0.0       4 9.250  13.43
3 ZROD    ORIGIN 0.0 1.5 0.0       5 9.500  13.43
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 13.43  -15.240 -15.240 0.0
* Part 4,  Other Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0       6 6.710  13.43
2 ZROD    ORIGIN 0.0 1.5 0.0       4 9.250  13.43
3 ZROD    ORIGIN 0.0 1.5 0.0       5 9.500  13.43
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 13.43  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5        1.0
 -5       25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC505

```
* 21AC505     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
* One can with increasing H/X, Decreasing Mass
*
*
FISSION
* No. of mat    No. of nuc
      6              5
*
* Mat #1       PuO2+H2O (H/X=17.54)
* Mat #2       PuO2+H2O (H/X=20)
* Mat #3       Carbon Steel (7.86 g/cm3)
* Mat #4       Water (1.00 g/cc)
* Mat #5       Air (0.0001 H2O)
* Mat #6       PuO2+H2O (H/X=37.71)
NUCNAMES

ATOM  2.362  PU239 1.00           O 10.77      HINH2O 17.54
ATOM  2.214  PU239 1.00           O 12.00      HINH2O 20.00
CONC              FE 0.083491     C 0.003921
ATOM  1.00  HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0            O 1.00
ATOM  1.681  PU239 1.00           O 20.855     HINH2O 37.710
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 1
4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  30.480 60.960 13.430   -0.000  -0.000  0.000
2 CUBOID   2  30.480 60.960 13.430   -0.000  -0.000 -0.460
3 CUBOID   4  30.480 60.960 13.430   -0.000  -0.000 -2.540
4 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000 -2.540
5 CUBOID   4  60.960 91.440 63.560   -2.540  -2.540 -5.540
* Part 3,  Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0       1 6.710  13.43
2 ZROD    ORIGIN 0.0 1.5 0.0       4 9.250  13.43
3 ZROD    ORIGIN 0.0 1.5 0.0       5 9.500  13.43
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 13.43  -15.240 -15.240 0.0
```

```
* Part 4,  Other Pu Oxide and nominal H2O
NEST 4
1 ZROD     ORIGIN 0.0 1.5 0.0       6 6.710  13.43
2 ZROD     ORIGIN 0.0 1.5 0.0       4 9.250  13.43
3 ZROD     ORIGIN 0.0 1.5 0.0       5 9.500  13.43
4 CUBOID   ORIGIN 0.0 0.0 0.0 5 15.240 15.240 13.43  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5       25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC506

```
* 21AC506     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
* One can with increasing H/X, Decreasing Mass
*
*
FISSION
* No. of mat    No. of nuc
      6             5
*
* Mat #1       PuO2+H2O (H/X=17.54)
* Mat #2       PuO2+H2O (H/X=20)
* Mat #3       Carbon Steel (7.86 g/cm3)
* Mat #4       Water (1.00 g/cc)
* Mat #5       Air (0.0001 H2O)
* Mat #6       PuO2+H2O (H/X=47.80)
NUCNAMES

ATOM  2.362  PU239 1.00            O 10.77       HINH2O 17.54
ATOM  2.214  PU239 1.00            O 12.00       HINH2O 20.00
CONC              FE 0.083491      C 0.003921
ATOM   1.00  HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0             O 1.00
ATOM  1.545  PU239 1.00            O 25.900      HINH2O 47.800
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 1
4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  30.480 60.960 13.430   -0.000  -0.000  0.000
2 CUBOID   2  30.480 60.960 13.430   -0.000  -0.000 -0.460
3 CUBOID   4  30.480 60.960 13.430   -0.000  -0.000 -2.540
4 CUBOID   5  30.480 60.960 60.960   -0.000  -0.000 -2.540
5 CUBOID   4  60.960 91.440 63.560   -2.540  -2.540 -5.540
* Part 3,  Pu Oxide and nominal H2O
NEST 4
1 ZROD     ORIGIN 0.0 1.5 0.0       1 6.710  13.43
2 ZROD     ORIGIN 0.0 1.5 0.0       4 9.250  13.43
3 ZROD     ORIGIN 0.0 1.5 0.0       5 9.500  13.43
4 CUBOID   ORIGIN 0.0 0.0 0.0 5 15.240 15.240 13.43  -15.240 -15.240 0.0
* Part 4,  Other Pu Oxide and nominal H2O
NEST 4
1 ZROD     ORIGIN 0.0 1.5 0.0       6 6.710  13.43
2 ZROD     ORIGIN 0.0 1.5 0.0       4 9.250  13.43
3 ZROD     ORIGIN 0.0 1.5 0.0       5 9.500  13.43
4 CUBOID   ORIGIN 0.0 0.0 0.0 5 15.240 15.240 13.43  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5       25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC507

```
* 21AC507     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Oxide, H/X=17.54, 2.5 kg, V=1.9L (H/D=1) R=6.71 H=13.43
* 1.0 kg oxide H/X=20, layer
* One can with increasing H/X, Decreasing Mass
*
*
FISSION
* No. of mat    No. of nuc
      6             5
*
* Mat #1       PuO2+H2O (H/X=17.54)
* Mat #2       PuO2+H2O (H/X=20)
* Mat #3       Carbon Steel (7.86 g/cm3)
* Mat #4       Water (1.00 g/cc)
* Mat #5       Air (0.0001 H2O)
* Mat #6       PuO2+H2O (H/X=98.22)
NUCNAMES

ATOM  2.362  PU239 1.00            O 10.77       HINH2O 17.54
ATOM  2.214  PU239 1.00            O 12.00       HINH2O 20.00
CONC              FE 0.083491      C 0.003921
```

```
ATOM  1.00  HINH2O 2.00          O 1.00
ATOM 0.0001 HINH2O 2.0           O 1.00
ATOM  1.272  PU239 1.00          O 51.110     HINH2O 98.220
*
CM
*
* Part 1, Array of buttons
ARRAY 1 2 1
4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  30.480 60.960 13.430  -0.000  -0.000  0.000
2 CUBOID   2  30.480 60.960 13.430  -0.000  -0.000 -0.460
3 CUBOID   4  30.480 60.960 13.430  -0.000  -0.000 -2.540
4 CUBOID   5  30.480 60.960 60.960  -0.000  -0.000 -2.540
5 CUBOID   4  60.960 91.440 63.560  -2.540  -2.540 -5.540
* Part 3,  Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0      1 6.710  13.43
2 ZROD    ORIGIN 0.0 1.5 0.0      4 9.250  13.43
3 ZROD    ORIGIN 0.0 1.5 0.0      5 9.500  13.43
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 13.43  -15.240 -15.240 0.0
* Part 4,  Other Pu Oxide and nominal H2O
NEST 4
1 ZROD    ORIGIN 0.0 1.5 0.0      6 6.710  13.43
2 ZROD    ORIGIN 0.0 1.5 0.0      4 9.250  13.43
3 ZROD    ORIGIN 0.0 1.5 0.0      5 9.500  13.43
4 CUBOID  ORIGIN 0.0 0.0 0.0 5 15.240 15.240 13.43  -15.240 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5      25      1000       0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC601

```
* 21AC601      MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Button, 2.5 kg, R=3.550, H=2.540
*                 R=2.643, H=1.270
* Oxide in Boat, 2.5 kg , V=2300, H/X = 24.50
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat    No. of nuc
      5              3
*
* Mat #1      PuO2+H2O (H/X=24.54)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Pu (19.47 g/cc)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.0001 H2O)
NUCNAMES

ATOM  2.013  PU239 1.00          O 14.25      HINH2O 24.50
ATOM  2.214  PU239 1.00          O 12.00      HINH2O 20.00
ATOM 19.47   PU239 1.0
ATOM  1.00  HINH2O 2.00          O 1.00
ATOM 0.0001 HINH2O 2.0           O 1.00
*
CM
*
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  34.000 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  34.000 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  34.000 60.960 15.970   -0.000  -0.000 -3.000
4 CUBOID   5  34.000 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  64.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Oxide in boat, nominal H2O
NEST 3
1 CUBOID  1  13.97   6.35   6.482  -13.97   -6.35   0.00
2 CUBOID  4  16.51   8.89   9.022  -16.51   -8.89   0.00
3 CUBOID  5  17.00  15.24  15.97   -17.00  -15.24   0.00
* Part 4, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54     3 2.643  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54     4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0      3 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0      4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 17.000 15.240 15.97  -17.000 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5      25      1000       0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC602

```
* 21AC602      MONK6B model for HC-21A
```

```
* Off-Normal Condition Analysis

* Button, 2.5 kg, R=3.550, H=2.540
*                 R=2.643, H=1.270
* Oxide in Boat, 2.5 kg , V=2300, H/X = 27.89
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat    No. of nuc
     5              3
*
* Mat #1      PuO2+H2O (H/X=27.89)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Pu (19.47 g/cc)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.0001 H2O)
NUCNAMES

ATOM  1.900  PU239 1.00           O 15.945     HINH2O 27.89
ATOM  2.214  PU239 1.00           O 12.00      HINH2O 20.00
ATOM 19.47   PU239 1.0
ATOM  1.00  HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0            O 1.00
*
CM
*
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  34.000 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  34.000 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  34.000 60.960 15.970   -0.000  -0.000 -3.000
4 CUBOID   5  34.000 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  64.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Oxide in boat, nominal H2O
NEST 3
1 CUBOID  1  13.97   6.35   6.482  -13.97   -6.35   0.00
2 CUBOID  4  16.51   8.89   9.022  -16.51   -8.89   0.00
3 CUBOID  5  17.00  15.24  15.97   -17.00  -15.24   0.00
* Part 4, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54     3 2.643  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54     4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0      3 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0      4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 17.000 15.240 15.97  -17.000 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5        1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC603

```
* 21AC603       MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Button, 2.5 kg, R=3.550, H=2.540
*                 R=2.643, H=1.270
* Oxide in Boat, 2.5 kg , V=2300, H/X = 32.25
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat    No. of nuc
     5              3
*
* Mat #1      PuO2+H2O (H/X=32.25)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Pu (19.47 g/cc)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.0001 H2O)
NUCNAMES

ATOM  1.788  PU239 1.00           O 18.125     HINH2O 32.25
ATOM  2.214  PU239 1.00           O 12.00      HINH2O 20.00
ATOM 19.47   PU239 1.0
ATOM  1.00  HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0            O 1.00
*
CM
*
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  34.000 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  34.000 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  34.000 60.960 15.970   -0.000  -0.000 -3.000
4 CUBOID   5  34.000 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  64.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Oxide in boat, nominal H2O
NEST 3
1 CUBOID  1  13.97   6.35   6.482  -13.97   -6.35   0.00
2 CUBOID  4  16.51   8.89   9.022  -16.51   -8.89   0.00
3 CUBOID  5  17.00  15.24  15.97   -17.00  -15.24   0.00
* Part 4, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54     3 2.643  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54     4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0      3 3.550  3.810
```

```
4 ZROD    ORIGIN 0.0 0.0 0.0      4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 17.000 15.240 15.97  -17.000 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5       1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC604

```
* 21AC604     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Button, 2.5 kg, R=3.550, H=2.540
*                 R=2.643, H=1.270
* Oxide in Boat, 2.5 kg , V=2300, H/X = 38.07
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat    No. of nuc
      5              3
*
* Mat #1      PuO2+H2O (H/X=38.07)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Pu (19.47 g/cc)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.0001 H2O)
NUCNAMES

ATOM  1.675  PU239 1.00           O 21.035     HINH2O 38.07
ATOM  2.214  PU239 1.00           O 12.00      HINH2O 20.00
ATOM 19.47   PU239 1.0
ATOM  1.00  HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0            O 1.00
*
CM
*
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  34.000 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  34.000 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  34.000 60.960 15.970   -0.000  -0.000 -3.000
4 CUBOID   5  34.000 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  64.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Oxide in boat, nominal H2O
NEST 3
1 CUBOID  1  13.97   6.35   6.482  -13.97   -6.35   0.00
2 CUBOID  4  16.51   8.89   9.022  -16.51   -8.89   0.00
3 CUBOID  5  17.00  15.24  15.97   -17.00  -15.24   0.00
* Part 4, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54      3 2.643  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54      4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0       3 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0       4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 17.000 15.240 15.97  -17.000 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST        5       1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC605

```
* 21AC605     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Button, 2.5 kg, R=3.550, H=2.540
*                 R=2.643, H=1.270
* Oxide in Boat, 2.5 kg , V=2300, H/X = 46.21
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat    No. of nuc
      5              3
*
* Mat #1      PuO2+H2O (H/X=46.21)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Pu (19.47 g/cc)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.0001 H2O)
NUCNAMES

ATOM  1.562  PU239 1.00           O 25.105     HINH2O 46.21
ATOM  2.214  PU239 1.00           O 12.00      HINH2O 20.00
ATOM 19.47   PU239 1.0
ATOM  1.00  HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0            O 1.00
*
CM
*
```

```
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  34.000 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  34.000 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  34.000 60.960 15.970   -0.000  -0.000 -3.000
4 CUBOID   5  34.000 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  64.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Oxide in boat, nominal H2O
NEST 3
1 CUBOID  1  13.97   6.35   6.482  -13.97   -6.35   0.00
2 CUBOID  4  16.51   8.89   9.022  -16.51   -8.89   0.00
3 CUBOID  5  17.00  15.24  15.97   -17.00  -15.24   0.00
* Part 4, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54     3 2.643  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54     4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0      3 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0      4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 17.000 15.240 15.97  -17.000 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC606

```
* 21AC606     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Button, 2.5 kg, R=3.550, H=2.540
*                 R=2.643, H=1.270
* Oxide in Boat, 2.5 kg , V=2300, H/X = 58.41
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat    No. of nuc
      5             3
*
* Mat #1      PuO2+H2O (H/X=58.41)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Pu (19.47 g/cc)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.0001 H2O)
NUCNAMES
ATOM  1.450  PU239 1.00             O 31.205     HINH2O 58.41
ATOM  2.214  PU239 1.00             O 12.00      HINH2O 20.00
ATOM 19.47   PU239 1.0
ATOM  1.00  HINH2O 2.00             O 1.00
ATOM 0.0001 HINH2O 2.0              O 1.00
*
CM
*
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  34.000 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  34.000 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  34.000 60.960 15.970   -0.000  -0.000 -3.000
4 CUBOID   5  34.000 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  64.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Oxide in boat, nominal H2O
NEST 3
1 CUBOID  1  13.97   6.35   6.482  -13.97   -6.35   0.00
2 CUBOID  4  16.51   8.89   9.022  -16.51   -8.89   0.00
3 CUBOID  5  17.00  15.24  15.97   -17.00  -15.24   0.00
* Part 4, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54     3 2.643  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54     4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0      3 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0      4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 17.000 15.240 15.97  -17.000 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC607

```
* 21AC607     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Button, 2.5 kg, R=3.550, H=2.540
*                 R=2.643, H=1.270
* Oxide in Boat, 2.5 kg , V=2300, H/X = 119.45
* 1.0 kg oxide H/X=20, layer
*
```

```
*
FISSION
* No. of mat    No. of nuc
       5              3
*
* Mat #1       PuO2+H2O (H/X=119.45)
* Mat #2       PuO2+H2O (H/X=20)
* Mat #3       Pu (19.47 g/cc)
* Mat #4       Water (1.00 g/cc)
* Mat #5       Air (0.0001 H2O)
NUCNAMES

ATOM  1.225  PU239 1.00           O 61.725     HINH2O 119.45
ATOM  2.214  PU239 1.00           O 12.00      HINH2O 20.00
ATOM 19.47   PU239 1.0
ATOM  1.00  HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0            O 1.00
*
CM
*
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  34.000 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  34.000 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  34.000 60.960 15.970   -0.000  -0.000 -3.000
4 CUBOID   5  34.000 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  64.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Oxide in boat, nominal H2O
NEST 3
1 CUBOID  1  13.97   6.35   6.482  -13.97   -6.35   0.00
2 CUBOID  4  16.51   8.89   9.022  -16.51   -8.89   0.00
3 CUBOID  5  17.00  15.24  15.97   -17.00  -15.24   0.00
* Part 4, Pu Button and nominal H20
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54     3 2.643  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54     4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0      3 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0      4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 17.000 15.240 15.97  -17.000 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST          5        1.0
 -5       25       1000       0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0     15.5  91.0  19.0     15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0     30.5  60.9   2.0      0.0   0.0   2.0
END
```

21AC701

```
* 21AC701      MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Button, 2.5 kg, R=3.550, H=2.540
*                  R=2.643, H=1.270
* Oxide in Boat, 2.5 kg , V=2300, H/X = 21.79
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat    No. of nuc
     5              3
*
* Mat #1       PuO2+H2O (H/X=24.54)
* Mat #2       PuO2+H2O (H/X=20)
* Mat #3       Pu (19.47 g/cc)
* Mat #4       Water (1.00 g/cc)
* Mat #5       Air (0.01 H2O)
NUCNAMES

ATOM  2.125  PU239 1.00           O 12.895     HINH2O 21.79
ATOM  2.214  PU239 1.00           O 12.00      HINH2O 20.00
ATOM 19.47   PU239 1.0
ATOM  1.00  HINH2O 2.00           O 1.00
ATOM 0.01   HINH2O 2.0            O 1.00
*
CM
*
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  34.000 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  34.000 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  34.000 60.960 15.970   -0.000  -0.000 -3.000
4 CUBOID   5  34.000 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  64.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Oxide in boat, nominal H2O
NEST 3
1 CUBOID  1  13.97   6.35   6.482  -13.97   -6.35   0.00
2 CUBOID  4  16.51   8.89   9.022  -16.51   -8.89   0.00
3 CUBOID  5  17.00  15.24  15.97   -17.00  -15.24   0.00
* Part 4, Pu Button and nominal H20
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54     3 2.643  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54     4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0      3 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0      4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 17.000 15.240 15.97  -17.000 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST          5        1.0
 -5       25       1000       0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
```

```
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0     15.5  91.0  19.0     15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0     30.5  60.9   2.0      0.0   0.0   2.0
END
```

21AC702

```
* 21AC702     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Button, 2.5 kg, R=3.550, H=2.540
*                 R=2.643, H=1.270
* Oxide in Boat, 2.5 kg , V=2300, H/X = 21.79
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat    No. of nuc
      5              3
*
* Mat #1      PuO2+H2O (H/X=24.54)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Pu (19.47 g/cc)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.05 H2O)
NUCNAMES

ATOM  2.125  PU239 1.00            O 12.895     HINH2O 21.79
ATOM  2.214  PU239 1.00            O 12.00      HINH2O 20.00
ATOM 19.47   PU239 1.0
ATOM  1.00  HINH2O 2.00            O 1.00
ATOM 0.05   HINH2O 2.0             O 1.00
*
CM
*
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  34.000 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  34.000 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  34.000 60.960 15.970   -0.000  -0.000 -3.000
4 CUBOID   5  34.000 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  64.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Oxide in boat, nominal H2O
NEST 3
1 CUBOID  1  13.97   6.35   6.482  -13.97   -6.35   0.00
2 CUBOID  4  16.51   8.89   9.022  -16.51   -8.89   0.00
3 CUBOID  5  17.00  15.24  15.97   -17.00  -15.24   0.00
* Part 4, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54      3 2.643  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54      4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0       3 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0       4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 17.000 15.240 15.97  -17.000 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST         5         1.0
 -5        25      1000      0       STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0     15.5  91.0  19.0     15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0     30.5  60.9   2.0      0.0   0.0   2.0
END
```

21AC703

```
* 21AC703     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Button, 2.5 kg, R=3.550, H=2.540
*                 R=2.643, H=1.270
* Oxide in Boat, 2.5 kg , V=2300, H/X = 21.79
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat    No. of nuc
      5              3
*
* Mat #1      PuO2+H2O (H/X=24.54)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Pu (19.47 g/cc)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.10 H2O)
NUCNAMES

ATOM  2.125  PU239 1.00            O 12.895     HINH2O 21.79
ATOM  2.214  PU239 1.00            O 12.00      HINH2O 20.00
ATOM 19.47   PU239 1.0
ATOM  1.00  HINH2O 2.00            O 1.00
ATOM 0.10   HINH2O 2.0             O 1.00
*
CM
*
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  34.000 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  34.000 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  34.000 60.960 15.970   -0.000  -0.000 -3.000
```

```
4 CUBOID   5  34.000 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  64.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Oxide in boat, nominal H2O
NEST 3
1 CUBOID  1  13.97   6.35   6.482  -13.97   -6.35   0.00
2 CUBOID  4  16.51   8.89   9.022  -16.51   -8.89   0.00
3 CUBOID  5  17.00  15.24  15.97   -17.00  -15.24   0.00
* Part 4, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54     3 2.643  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54     4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0      3 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0      4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 17.000 15.240 15.97  -17.000 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC704

```
* 21AC704     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Button, 2.5 kg, R=3.550, H=2.540
*                 R=2.643, H=1.270
* Oxide in Boat, 2.5 kg , V=2300, H/X = 21.79
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat    No. of nuc
      5              3
*
* Mat #1      PuO2+H2O (H/X=24.54)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Pu (19.47 g/cc)
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.20 H2O)
NUCNAMES

ATOM  2.125  PU239 1.00          O 12.895     HINH2O 21.79
ATOM  2.214  PU239 1.00          O 12.00      HINH2O 20.00
ATOM 19.47   PU239 1.0
ATOM  1.00  HINH2O 2.00          O 1.00
ATOM 0.20   HINH2O 2.0           O 1.00
*
CM
*
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  34.000 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  34.000 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  34.000 60.960 15.970   -0.000  -0.000 -3.000
4 CUBOID   5  34.000 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  64.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Oxide in boat, nominal H2O
NEST 3
1 CUBOID  1  13.97   6.35   6.482  -13.97   -6.35   0.00
2 CUBOID  4  16.51   8.89   9.022  -16.51   -8.89   0.00
3 CUBOID  5  17.00  15.24  15.97   -17.00  -15.24   0.00
* Part 4, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54     3 2.643  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54     4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0      3 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0      4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 17.000 15.240 15.97  -17.000 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5      25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5   0.0  19.0    15.5  91.0  19.0    15.5   0.0  -2.0
* Top View
  0.0  60.9   2.0    30.5  60.9   2.0     0.0   0.0   2.0
END
```

21AC705

```
* 21AC705     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Button, 2.5 kg, R=3.550, H=2.540
*                 R=2.643, H=1.270
* Oxide in Boat, 2.5 kg , V=2300, H/X = 21.79
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat    No. of nuc
      5              3
*
* Mat #1      PuO2+H2O (H/X=24.54)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Pu (19.47 g/cc)
```

```
* Mat #4      Water (1.00 g/cc)
* Mat #5      Air (0.50 H2O)
NUCNAMES

ATOM  2.125  PU239 1.00             O 12.895     HINH2O 21.79
ATOM  2.214  PU239 1.00             O 12.00      HINH2O 20.00
ATOM 19.47   PU239 1.0
ATOM  1.00  HINH2O 2.00             O 1.00
ATOM 0.50   HINH2O 2.0              O 1.00
*
CM
*
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  34.000 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  34.000 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  34.000 60.960 15.970   -0.000  -0.000 -3.000
4 CUBOID   5  34.000 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  64.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Oxide in boat, nominal H2O
NEST 3
1 CUBOID  1  13.97   6.35   6.482  -13.97   -6.35    0.00
2 CUBOID  4  16.51   8.89   9.022  -16.51   -8.89    0.00
3 CUBOID  5  17.00  15.24  15.97   -17.00  -15.24    0.00
* Part 4, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54     3 2.643  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54     4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0      3 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0      4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 17.000 15.240 15.97  -17.000 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5       25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5    0.0   19.0     15.5   91.0   19.0     15.5    0.0   -2.0
* Top View
  0.0   60.9    2.0     30.5   60.9    2.0      0.0    0.0    2.0
END
```

21AC706

```
* 21AC706     MONK6B model for HC-21A
* Off-Normal Condition Analysis
* Button, 2.5 kg, R=3.550, H=2.540
*                 R=2.643, H=1.270
* Oxide in Boat, 2.5 kg , V=2300, H/X = 21.79
* 1.0 kg oxide H/X=20, layer
*
*
FISSION
* No. of mat     No. of nuc
     5               3
*
* Mat #1       PuO2+H2O (H/X=24.54)
* Mat #2       PuO2+H2O (H/X=20)
* Mat #3       Pu (19.47 g/cc)
* Mat #4       Water (1.00 g/cc)
* Mat #5       Air (1.00 H2O)
NUCNAMES

ATOM  2.125  PU239 1.00             O 12.895     HINH2O 21.79
ATOM  2.214  PU239 1.00             O 12.00      HINH2O 20.00
ATOM 19.47   PU239 1.0
ATOM  1.00  HINH2O 2.00             O 1.00
ATOM 1.00   HINH2O 2.0              O 1.00
*
CM
*
* Part 1, Array of oxide and button
ARRAY 1 2 1
 4  3
* Part 2, The rest of the model
NEST 5
1 CUBOID  P1  34.000 60.960 15.970   -0.000  -0.000  0.000
2 CUBOID   2  34.000 60.960 15.970   -0.000  -0.000 -0.460
3 CUBOID   4  34.000 60.960 15.970   -0.000  -0.000 -3.000
4 CUBOID   5  34.000 60.960 60.960   -0.000  -0.000 -3.000
5 CUBOID   4  64.480 91.440 63.500   -2.540  -2.540 -5.540
* Part 3, Oxide in boat, nominal H2O
NEST 3
1 CUBOID  1  13.97   6.35   6.482  -13.97   -6.35    0.00
2 CUBOID  4  16.51   8.89   9.022  -16.51   -8.89    0.00
3 CUBOID  5  17.00  15.24  15.97   -17.00  -15.24    0.00
* Part 4, Pu Button and nominal H2O
NEST 5
1 ZROD    ORIGIN 0.0 0.0 2.54     3 2.643  1.270
2 ZROD    ORIGIN 0.0 0.0 2.54     4 3.550  1.270
3 ZROD    ORIGIN 0.0 0.0 0.0      3 3.550  3.810
4 ZROD    ORIGIN 0.0 0.0 0.0      4 6.090  6.350
5 CUBOID  ORIGIN 0.0 0.0 0.0 5 17.000 15.240 15.97  -17.000 -15.240 0.0
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5       25      1000      0      STDV 0.0020     -1
FISSILE REGION 1 IN PART 2 /
END
CODE 5
PUCWA
* Side View
 15.5    0.0   19.0     15.5   91.0   19.0     15.5    0.0   -2.0
* Top View
  0.0   60.9    2.0     30.5   60.9    2.0      0.0    0.0    2.0
END
```

Seismic Analysis Input Files

21AE001

```
* 21AE001     MONK6B model for HC-21A
* Seismic Analysis
* 1 button, 2.5 kg, R=3.550, H=2.540
*                   R=2.601, H=1.270
* with 1.0 kg Pu in oxide, sphere around button
* fully reflected 30.48 cm all sides
*
FISSION
* No. of mat     No. of nuc
      4              3
*
* Mat #1        Pu Metal (19.6 g/cm3)
* Mat #2        PuO2+H2O (H/X=20)
* Mat #3        Water (1.00 g/cc)
* Mat #4        Air (0.0001 H2O)
NUCNAMES

ATOM 19.6    PU239 1.00
ATOM  2.214  PU239 1.00            O 12.00      HINH2O 20.00
ATOM  1.00  HINH2O 2.00            O 1.00
ATOM 0.0001 HINH2O 2.0             O 1.00
*
CM
*
* Part 1, Pu Button w/oxide sphere and full H2O
NEST 5
1 ZROD     ORIGIN 0.0 0.0 2.54     1 2.601  1.270
2 ZROD     ORIGIN 0.0 0.0 2.54     2 3.550  1.270
3 ZROD     ORIGIN 0.0 0.0 0.0      1 3.550  3.810
4 SPHERE   ORIGIN 0.0 0.0 1.91     2 6.162
5 SPHERE   ORIGIN 0.0 0.0 1.91     3 36.642
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5       25      1000      0     STDV 0.0030     -1
FISSILE REGION 3 IN PART 1 /
 END
 CODE 4
PUWA
* Side View
-12.0 0.0 19.0    12.0 0.0 19.0    -12.0 0.0 -2.0
* Top View
-12.0 12.0 3.0    12.0 12.0 3.0    -12.0 -12.0 3.0
END
```

21AE002

```
* 21AE002     MONK6B model for HC-21A
* Seismic Analysis
* 1 button, 2.5 kg, R=3.550, H=2.540
*                   R=2.601, H=1.270
* with 1.5 kg Pu in oxide, sphere around button
* fully reflected 30.48 cm all sides
*
FISSION
* No. of mat     No. of nuc
      4              3
*
* Mat #1        Pu Metal (19.6 g/cm3)
* Mat #2        PuO2+H2O (H/X=20)
* Mat #3        Water (1.00 g/cc)
* Mat #4        Air (0.0001 H2O)
NUCNAMES

ATOM 19.6    PU239 1.00
ATOM  2.214  PU239 1.00            O 12.00      HINH2O 20.00
ATOM  1.00  HINH2O 2.00            O 1.00
ATOM 0.0001 HINH2O 2.0             O 1.00
*
CM
*
* Part 1, Pu Button w/oxide sphere and full H2O
NEST 5
1 ZROD     ORIGIN 0.0 0.0 2.54     1 2.601  1.270
2 ZROD     ORIGIN 0.0 0.0 2.54     2 3.550  1.270
3 ZROD     ORIGIN 0.0 0.0 0.0      1 3.550  3.810
4 SPHERE   ORIGIN 0.0 0.0 1.91     2 6.950
5 SPHERE   ORIGIN 0.0 0.0 1.91     3 37.430
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5       25      1000      0     STDV 0.0030     -1
FISSILE REGION 3 IN PART 1 /
 END
 CODE 4
PUWA
* Side View
-12.0 0.0 19.0    12.0 0.0 19.0    -12.0 0.0 -2.0
* Top View
-12.0 12.0 3.0    12.0 12.0 3.0    -12.0 -12.0 3.0
END
```

21AE011

```
* 21AE011     MONK6B model for HC-21A
* Seismic Analysis
* 1 british button, 2.5 kg, R=2.728, H=5.456
* with 1.0 kg Pu in oxide, sphere around button
* full reflected 30.48 cm all sides
*
FISSION
* No. of mat     No. of nuc
      4              3
*
```

```
* Mat #1      Pu Metal (19.6 g/cm3)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Water (1.00 g/cc)
* Mat #4      Air (0.0001 H2O)
NUCNAMES

ATOM 19.6    PU239 1.00
ATOM  2.214  PU239 1.00           O 12.00      HINH2O 20.00
ATOM  1.00  HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0            O 1.00
*
CM
*
* Part 1, British Pu Button w/oxide and full H2O
NEST 3
1 ZROD    ORIGIN  0.0 0.0 -2.728   1 2.728  2.728
2 SPHERE  ORIGIN  0.0 0.0  0.0     2 6.162
3 SPHERE  ORIGIN  0.0 0.0  0.0     3 36.642
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5      25      1000      0      STDV 0.0030     -1
FISSILE REGION 1 IN PART 1 /
 END
 CODE 4
PUWA
* Side View
-12.0 0.0 12.0    12.0 0.0 12.0    -12.0 0.0 -12.0
* Top View
-12.0 12.0 3.0    12.0 12.0 3.0    -12.0 -12.0 3.0
END
```

21AE012

```
* 21AE012     MONK6B model for HC-21A
* Seismic Analysis
* 1 british button, 2.5 kg, R=2.728, H=5.456
* with 1.5 kg Pu in oxide, sphere around button
* full reflected 30.48 cm all sides
*
FISSION
* No. of mat    No. of nuc
       4            3
*
* Mat #1      Pu Metal (19.6 g/cm3)
* Mat #2      PuO2+H2O (H/X=20)
* Mat #3      Water (1.00 g/cc)
* Mat #4      Air (0.0001 H2O)
NUCNAMES

ATOM 19.6    PU239 1.00
ATOM  2.214  PU239 1.00           O 12.00      HINH2O 20.00
ATOM  1.00  HINH2O 2.00           O 1.00
ATOM 0.0001 HINH2O 2.0            O 1.00
*
CM
*
* Part 1, British Pu Button w/oxide and full H2O
NEST 3
1 ZROD    ORIGIN  0.0 0.0 -2.728   1 2.728  2.728
2 SPHERE  ORIGIN  0.0 0.0  0.0     2 6.950
3 SPHERE  ORIGIN  0.0 0.0  0.0     3 37.430
* End of model
*
* Control Data
 SUPERHIST         5        1.0
 -5      25      1000      0      STDV 0.0030     -1
FISSILE REGION 1 IN PART 1 /
 END
 CODE 4
PUWA
* Side View
-12.0 0.0 12.0    12.0 0.0 12.0    -12.0 0.0 -12.0
* Top View
-12.0 12.0 3.0    12.0 12.0 3.0    -12.0 -12.0 3.0
END
```

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	FDNW Criticality and Shielding	Date 10/07/98
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