ADDENDUM 2 TO CSAR 79-028

Title: SECURITY BAR ADDITION TO PEDESTAL STORAGE RACKS IN ROOM 3
IN 2736-Z BUILDING

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The Plutonium Finishing Plant (PFP) is installing security bars on plutonium storage racks in Room 3 in 2736-Z Building to meet International Atomic Energy Agency (IAEA) material control requirements. Figures 1, 2, and 3 show the existing arrangement and design of the security bars. The security bars are to be fabricated of aluminum or carbon steel. The detailed fabrication sketches are reproduced in Appendix C. The security bars are to be installed close to the cans of plutonium so a determination of their effect on criticality safety needs to be made.

The addition of security bars to the storage array of 2.5 kg plutonium buttons in Room 3 can effect reactivity by reflecting neutrons back into the plutonium in the storage cans, by absorbing neutrons, and by moderating neutrons between stored plutonium buttons. The small amount of metal added by the storage bars in comparison to the amount of concrete in the walls and aluminum in the shelf monitors already in place would not significantly increase the k_{eff} of the storage array. Several computer calculations in previous analyses show that the security bars will have a negligible affect on reactivity.

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for
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FIGURE 1 ROOM 3 PLUTONIUM STORAGE RACK CELL

ANALYTICAL CALCULATIONS

Page 1 of 1

Subject 2736-Z IAEA SUPPORT

Originator Sgt D. ELLINGSON

Date _____

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Date _____

FIGURE 2 PICTURE OF ROOM 3 PLUTONIUM STORAGE RACK CELL WITH DOORS OPEN

FIGURE 3 DESIGN OF IAEA SECURITY BAR FOR ROOM 3 PLUTONIUM STORAGE RACK

SDG 10-25-94

FIELD INSTALLATION REFERENCE

PAGE 1 OF 1

Addendum to CSAR 79-028, entitled: "Out of Hood Storage (Rooms 3 and 4, 2736-Z Building)", by S. J. Altschuler, dated 3/31/82 (WHC-SD-SQA-CSA-20196), analyzed the storage array for the addition of aluminum Sandia shelf monitors and is included as Appendix A. The monitors were approximated as cylinders 4.21" OD, 1.75" high, with 0.155" thick walls and a 0.065" thick base with the stored 2.5 kg plutonium button (2.8" OD, 1.28" high) inside the cylinder. The plutonium pedestal storage array in Room 3 was modelled as two infinitely tall racks per cell in an infinite horizontal array of pedestal cells. The cells are basically that shown in Figure 1, including half the concrete wall thickness on three sides and the doors and half the corridor width on the fourth. Specular reflection is used on six sides to model the cell as an infinite array of infinitely tall racks. The computer results for the infinite array was that the added aluminum did not make a detectable difference in the k_{eff} and that the k_{eff} was less than the allowable value. The model was safely subcritical.

The metal being added close to the plutonium storage cans is the 1" high, 1/4" thick, and 3.54" long "U" restraints and the 2"x1/4"x4-1/2" top restraint detailed in Appendix C. The "U" restraint volume is 1.29 in³ and the top restraint beyond the 2"x1" rectangular tubing is 1.25 in³. The top storage can would see both restraints. But the combined volume is only 2.54 in³ which is less than the 2.60 in³ modelled for the Sandia shelf monitors. The new restraints are not as close to the buttons as the Sandia shelf monitors were modelled and they have less volume. The negligible affect of the Sandia shelf model on reactivity shows that the new aluminum security bars would also have a negligible affect.

The CSAR 78-022 (WHC-SD-SQA-CSA-20163) by R. D. Carter ran computer models of numerous configurations applicable to storage of plutonium buttons in Room 3 of 2736-Z Building. Section 5 entitled "Effect of Thick Iron Around Units" from the Results part of CSAR 78-022 found that 1/8" thick iron cylinders decreased the k_{eff} about 0.01 for a tight cylinder around the 2.5 kg plutonium buttons of radius of 1.4" and caused a decrease of about 0.02 when the iron cylinder was further away at a radius of 2". Appendix B reproduces Section 5 from CSAR 78-022. The security bars would be even further away from the buttons, because the buttons are canned inside 4-1/4" dia. 7 inch cans or larger diameter cans. The use of carbon steel for the security bars would decrease reactivity. Iron has an order of magnitude larger neutron absorption cross section than aluminum, so a negative effect on reactivity for aluminum was not seen in the computer runs referenced above.

The present Criticality Prevention Specification CPS-Z-165-80100, Rev./Mod. J-1, does not require revision to accommodate the addition of security bars to plutonium storage racks in Room 3 of the 2736-Z building.

REVIEWER'S COMMENTS

The reactivity of an individual unit stored is low. From ARH-600, II.B.1-12&13, the maximum reactivity of a unit corresponds to a k -effective value of about 0.82. The reflection due to the IAEA restraints on the can containing the unit is negligible even if made of carbon steel with a scattering cross-section 8 times that of aluminum. It is not sufficiently thick neither does it cover a large enough portion of the unit's surface.

APPENDIX A ADDENDUM TO CSAR 79-028

Addendum to CSAR 79-028, "Out of Hood Storage (Rooms 3 and 4, 2736-Z Building)"
Criticality Prevention Specification 80.10

Prepared by: S. J. Altschuler *S. J. Altschuler* Date: 3/31/82
Reviewed by: R. D. Carter *R. D. Carter* Date: 3/31/82
Approved by: C. L. Brown *C. L. Brown* Date: 3/31/82

Recommended for Approval by the Nuclear
Criticality Safety Committee
Approved by the Approval Authority

NCSC-82-016 Date: 4-26-82
NCSC-82-017 Date: 4-27-82

Monte Carlo calculations using KENO IV and PICTURE were made with and without the Sandia shelf monitors. The shelf monitors were approximated as aluminum cylinders 4.21 in. O.D., 1.75 in. high, with 0.155 in. thick walls, and a 0.065 in. thick base. The shelves of the cubicles contained a standard 2.5 kg button (3.55 cm radius, 3.244 cm high) of alpha plutonium (19.7 g/cm^3) at each position. Tiers were spaced 1 ft apart. Walls are 4 in. thick concrete with specular reflection on three sides. The remaining side had a 8 in. thick concrete door and an 18 inch thick void for the half thickness of the aisle followed by specular reflection. The composition of the "Magnuson" concrete was 02a as given in ANL-5800.

Specular reflection was also used on the top and bottom so that the tiers in a cell were infinite rather than 7 high. Unfortunately, the bottom of the Pu buttons were only 1 in. above the bottom of the cuboid so that specular reflection gave essentially all buttons doublebatched and separated by only 2 in. of void and a double thickness of shelf monitor bottom (0.13 in. of aluminum). This accounted for k-effective values about 0.09 greater than those calculated for CSAR 79-028 with and without the shelf monitors. Any effect due to the shelf monitors is insignificant compared to the standard error of the calculations and the margin of safety against the possibility of an accidental criticality remains satisfactory. No changes were required in the Criticality Prevention Specification.

APPENDIX B RESULTS SECTION 5 FROM CSAR 78-022

CSAR For CPS 80.10-2
Page 11
May 10, 1978

WHC-SD-SQA-CSA-20163
REVISION 0
PAGE 11

5. Effect of Thick Iron Around Units

The effect of one-eighth inch iron around the fissile units was investigated to provide information on the possible future use of thick-walled containers which may be required to meet safeguards or contamination control requirements. The array in the first two cases was 45 pedestals in a 5x9 array of 2.5-kilogram plutonium buttons with one unit double batched and no loading unit. The last two cases had 36 pedestals loaded in a 4x9 array, plus one loading unit, with no double batched unit. The buttons were placed as close to each other as the pedestal design and the pineapple can dimensions would allow.

<u>Case</u>		<u>k-effective</u>
18	Bare Button	0.9097 $\pm$.0074
20	One-Eighth Inch Iron Immediately Next to Button	0.8968 $\pm$.0068
27	Bare Buttons	0.9159 $\pm$.0093
31	One-Eighth Inch Iron at Can Boundary	0.8874 $\pm$.0070

The calculations indicate that a one-eighth inch iron wall at some distance from the fissile material has a negative effect on the reactivity, but a tight-fitting enclosure causes enough added reflection or has enough less iron that it balances the neutron absorption. While the loose-fitting enclosure would be representative of button storage, a tight-fitting enclosure might be more representative of low-density plutonium oxide storage. Other calculations have shown that a one-eighth inch iron wall would negate the reactivity increase due to low-density water fog in the array. This effect was not verified for these arrays.

**APPENDIX C FABRICATION SKETCHES OF SECURITY BARS FOR PLUTONIUM STORAGE RACKS
IN ROOM 3 OF PFP 2736-Z BUILDING**

FABRICATION NOTES

1. Material...The material of preference is aluminum. If aluminum cannot be obtained quick enough to meet schedule requirements, carbon steel may be substituted. All material except the 2x1 tubing should be available in WHC stores. Plate may be substituted for bar stock. The 2x1 tubing is available at Twin City Metals in both aluminum and carbon steel (reference).
2. Tolerances should be held to a minimum. A +/-1/16" is desired.
3. Avoid excess heat during welding to minimize warpage.
4. Weld per AWS D1.1/2.1 as required. No inspection required.
5. Break all sharp edges. If carbon steel is employed, degrease and wire brush final assembly to remove oil, scale and rust.
6. No QC inspection is required due to time constraints but it is essential that the depicted configurations be obtained.
7. Any concerns, problems or questions can and should be brought to the attention of the design engineer immediately; Scott Ellingson 372-2035 (wk) 783-1685 (hm).

WHC-SD-SQA-CSA-20382, Rev. 0
Page 9

DIMENSIONS ARE
TO BOTTOM OF 1/4
BAR (REF)

ASSEMBLY 1

ASSEMBLY 2

WHC-SD-SQA-CSA-20382, Rev. 0
Page 10

SIDE - ELEVATION - FRONT

ASSEMBLY 4

FRONT - ELEVATION - SIDE

ASSEMBLY 3

WHC-SD-SQA-CSA-20382, Rev. 0

Page 11

PLAN

ELEVATION

VIEW A-A

SUB-ASSY 5

WHC-SD-SQA-CSA-20382, Rev. 0
Page 12

SUB-ASSY 6

WHC-SD-SQA-CSA-20382, Rev. 0
Page 13

SECTION B-B
SUB-ASSY 5

INSERT THE BAR HANGERS OF
ASSY 3 FULLY INTO THE SLOTS
OF ASSY 1. POSITION TO ACHIEVE
THE 1/4" NOMINAL GAP SHOWN.
DRILL 3 HOLES, 3 PLACES.

DETAIL 1

ASSEMBLY 1 & 3 SHOWN. ASSEMBLY
2 & 4 ARE OPPOSITE HAND AND HOLE ARGMT.

DISTRIBUTION SHEET

To Distribution	From Criticality & Radiological Analyses	Page 1 of 1
		Date 11/15/94
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1. EDT 157944

2. To: (Receiving Organization) Distribution		3. From: (Originating Organization) Criticality & Radiological Analyses		4. Related EDT No.: N/A	
5. Proj./Prog./Dept./Div.: PFP		6. Cog. Engr.: E. M. Miller		7. Purchase Order No.: N/A	
8. Originator Remarks: CSER 79-028, Addendum 2: Security Bar Addition to Pedestal Storage Racks in Room 3 in 2736-Z Building				9. Equip./Component No.: N/A	
				10. System/Bldg./Facility: 2736-Z/PFP	
11. Receiver Remarks:				12. Major Assm. Dwg. No.: N/A	
				13. Permit/Permit Application No.: N/A	
				14. Required Response Date: 11-94	

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	WHC-SD-SQA-CSA-20382		0	CSER 79-028, Addendum 2: Security Bar Addition to Pedestal Storage Racks in Room 3 in 2736-Z Building	S	1,2	2	

16. KEY					
Approval Designator (F)		Reason for Transmittal (G)		Disposition (H) & (I)	
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)		1. Approval	4. Review	1. Approved	4. Reviewed no/comment
		2. Release	5. Post-Review	2. Approved w/comment	5. Reviewed w/comment
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RELEASE AUTHORIZATION

Document Number: WHC-SD-SQA-CSA-20382, Rev. 0

Document Title: CSER 79-028, Addendum 2: Security Bar Addition to Pedestal Storage Racks in Room 3 in 2736-Z Building

Release Date: 11/18/94

This document was reviewed following the procedures described in WHC-CM-3-4 and is:

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SUPPORTING DOCUMENT		1. Total Pages 14
2. Title CSER 79-028, Addendum 2: Security Bar Addition to Pedestal Storage Racks in Room 3 in 2736-Z Building	3. Number WHC-SD-SQA-CSA-20382	4. Rev No. 0
5. Key Words PFP, 2736-Z building, security bar, plutonium, CSER	6. Author Name: E. M. Miller <i>Edward M. Miller</i> Signature Organization/Charge Code 8D150/E23314	
7. Abstract <p>This addendum concludes that the IAEA security bars to be added close to the plutonium storage cans on the storage racks in Room 3 of the 2736-Z Building have too little material to affect the reactivity of the system significantly and allows their installation without revision of CPS-Z-165-80100, Rev./Mod. J-1.</p>		
		8. RELEASE STAMP <div style="border: 1px solid black; padding: 10px; margin-top: 20px;"> OFFICIAL RELEASE BY WHC DATE NOV 18 1994 35 STATION 21 </div>