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Project Title/Work Order Acceptability of Bettis Laboratories Waste Shipment to WHC Solid Waste.		EDT No. 608918 ECN No. N/A

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ENGINEERING DATA TRANSMITTAL

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1. EDT 608918

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Approval Designator (F)		Reason for Transmittal (G)			Disposition (H) & (I)
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Reason	Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	Reason	Disp.
1	1	Cog.Eng. K.M. McDonald	<i>K.M. McDonald</i>	4/14/95	T4-03	A.L. Ramble	<i>A.L. Ramble</i>	4/14/95	H4-64	1	1
1	1	Cog. Mgr. D.B. Powell	<i>D.B. Powell</i>	4/14/95	T4-03						
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1	1	Safety R.J. Kolt	<i>R.J. Kolt</i>	4/14/95							
		Env.									
1	1	Peer Review E.M. Miller	<i>E.M. Miller</i>	4-14-95	H4-64						

18. Signature of EDT Originator <i>K.M. McDonald</i> Date 4/14/95	19. Authorized Representative for Receiving Organization Date	20. Cognizant Manager Date <i>DB Powell</i> 4/14/95	21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments
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RELEASE AUTHORIZATION

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

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5. Key Words Criticality Evaluation, Central Waste Complex	6. Author Name: K. M. McDonald <i>K.M. McDonald</i> 4/14/95 Signature Organization/Charge Code 87250/TH256	
7. Abstract The purpose of this document is to evaluate a potential discrepancy between the Solid Waste Management (SWM) Criticality Prevention Specifications and a proposed waste receipt from Bettis Laboratories. The analysis has been performed to determine the acceptability of the Bettis Laboratory Waste container with respect to SWM criticality requirements.		

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CSER 95-007

Title: ACCEPTABILITY OF BETTIS LABORATORIES WASTE SHIPMENT TO WHC SOLID WASTE

Prepared by: K.M. McDonald Date: 4/14/95
Criticality Safety Representative, Solid Waste

Reviewed by: Edward M. Miller Date: 4-14-95
Criticality Engineer, Consequence Analyses

Approved by: E.M. Miller Date: 4/14/95
Manager, Consequence Analyses

1. INTRODUCTION AND SUMMARY

This analysis resolves an apparent discrepancy between two different requirements of the Central Waste Complex and 200 Area Low-Level Burial Grounds Criticality Prevention Specifications (CPS-SW-149-00002 and CPS-SW-149-00003 respectively). The analysis is being performed to enable Solid Waste Management to accept a specific package from Bettis Laboratories. This package meets the requirements of section 2.1.1 in that the total fissile content of the drum is less than 200g and the waste occupies greater than 20% of the container volume. The package may not appear, however, to meet the requirements of section 2.1.5 for maximum enrichment of uranium bearing waste, as will be described below.

Based on this analysis for this specific package, the waste is shown to be critically safe under all conditions for which the 55-gallon drums (17C, 17H, or UN1A2) specification applies. This package can be accepted under the 55-gallon drum limitations on fissile quantity. No change to the CPS is required.

2. DESCRIPTION OF CONTAINER AND PACKAGING

The container of waste from Bettis consists of a 55-gallon drum (17C, 17H, or UN1A2), in which are contained 24 smaller containers (8 inch juice cans). One of the small cans contains 2.45g of uranium oxide powder enriched to 97% 235U. The remaining 23 small cans contain approximately 900g of uranium with enrichments varying between 3% and 17% 235U. Total amount of 235U in the entire container (55 gallon drum) is 81.25g. Figure 1 depicts the details of the fissile material and containers in the Bettis waste shipment evaluated.

3. APPLICABLE CRITICALITY PREVENTION SPECIFICATIONS

Two specific criticality limits could be made to apply to the Bettis package. The first is Section 2.1.1 (CPS-SW-149-00002) which allows 200g in a 55-gallon drum, if the fissile material occupies 20 percent or more of the container volume, and 100g if the fissile material occupies less than 20 percent of the container volume. The second limit which could be made to apply is Section

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2.1.5 (CPS-SW-149-00002) which sets maximum amounts of uranium based on enrichment. Of most significance to the Bettis package is the limit that requires a limit of 180g total uranium if the maximum enrichment (wt% 235U) is greater than 75.0. Given the specific situation, this latter limit is excessively conservative, as will be shown below.

4. EVALUATION OF LOADING LIMITS

Two methods have been used to show that the Bettis package is well within the criteria of Section 2.1.1. The first method is to sum the fractions of the maximum total uranium for each enrichment and show that the package is safer than the amounts allowed in the specification. The second is to equate all fissile uranium to plutonium and compare to the allowable drum limits.

4.1 Sum of Fractions

The sum of the fractions method is a simple arithmetic method to compare how closely a specific package approaches a limit when different components within that package are governed by different limits. It is commonly used in determining category 1 and category 3 limits for waste matrices based on limits for individual radionuclides. In this case the sum of the fractions will be to compare how closely the Bettis package comes to maximum total uranium limits given in the criticality specification.

The sum of the fractions method is used in the following manner. Total quantity of component A is divided by the limit for component A, yielding fraction A. Similarly for all other components, yielding a fraction for each component. The sum is then obtained for all fractions. If the sum of the fractions is greater than or equal to 1 then the limit has been exceeded. If the sum of the fractions is less than 1 then the limit has not been exceeded.

For the Bettis package we have the following: Component A, 2.45g total uranium, 97% enriched. Component B, 900g total uranium, 16% enriched. This is conservative for component B because the actual enrichment ranges from 5% to 16%. Based on the fact that there are only 81g of 235U, average enrichment of component B is closer to 9%. The limit for component A is 180 total uranium. The limit for component B is 1200g total uranium. The limit for component B is also conservative, since no limit is given explicitly for 16% enrichment, the limit for the next highest enrichment, 20%, is used.

Fraction A:
 $= 2.45\text{g}/180\text{g} = 0.0136.$

Fraction B:
 $= 900\text{g}/1200\text{g} = 0.75.$

The sum of the fractions:
 $= 0.75 + 0.0136 = 0.7636 < 1$

By the sum of the fractions the Bettis package is safer than the limits given for uranium bearing waste.

4.2 Comparison to allowable Pu gram loading in a 55 gallon drum.

The CPS allows 55 gallon drums which contain 200g fissile material if the material occupies greater than 20% of the container volume, and 100g fissile material if the material occupies less than 20% of the container volume.

The Bettis waste package contains a total of 81.25g ²³⁵U, which will be distributed over more than 20% of the container volume. This is less than the 200g limit. As an extra conservatism, it is less than the 100g limit. This comparison also neglects the fact that in the Bettis package there is the significant ²³⁸U which acts as a neutron poison. This would not be the case if the 200g fissile material were all Pu.

5. REVISION OF CPS LIMITS

Based on the fact that this package meets the 200g limit for 55 gallon drums, and by utilizing a sum of the fractions, it also meets the limits for uranium bearing waste, this package is within the criteria of the present CPS. No revision to the current CPS is required. This evaluation has been performed to document the status of the Bettis package.

6. REVIEWER COMMENTS

The independent technical review of the report, "CSER 95-007, ACCEPTABILITY OF BETTIS LABORATORIES WASTE SHIPMENT TO WHC SOLID WASTE" was done by E. M. Miller, a criticality engineer in the Consequence Analysis group. His comments are as follows.

This CSER justifies the acceptance of a drum containing more total uranium than is allowed by CPS's CPS-SW-149-00002 and CPS-SW-149-00003 for the highest uranium enrichment in the container, because the amount of highly enriched uranium is so small as to be insignificant for a criticality assessment. This reviewer concurs completely with the conclusion and approach taken for these small amounts of uranium that have large margins of safety. Note that if all the 81.25 grams of U-235 were in 97% enriched uranium ($81.25\text{g}/0.97 = 83.5\text{g}$), the total amount of uranium would be less than half the limit of 180 grams total uranium at an enrichment of greater than 75% specified in the CPS's. This barrels reactivity addition to a storage array is far less than the 200 or 100 grams fissile material allowed by the CPS's.

7. REFERENCES

SD-SQA-CSA-20121	"CSAR 80-021, Packaging, Storage and Disposal of Solid Waste (55-gallon drums, Unrestricted H/Pu Only)."
SD-SQA-CSA-20101	"CSAR 80-021 Addendum 5, 55-Gallon Drums and Boxes in Above Ground (Surface) Storage."
SD-SQA-CSA-20130	"CSAR 82-003, Packaging, Storage, and/or Disposal of Solid Wastes (Burial Containers and Uranic Burial)."
SDAR-69-1G-7EM-0401	Applicable Storage Disposal/Approval Record.

FIGURE 1

<u>Container ID</u>	<u>% U-enr</u>	<u>Gm U-235</u>
23061-01	9.40	7.98
23061-03	9.40	1.51
23061-04	9.40	0.63
23061-06	9.87	3.47
23040-01	9.40	0.50
23040-02	9.40	1.12
23040-03	9.40	0.72
23183-01	5.92	3.53
23183-02	5.86	4.21
23183-03	5.85	0.57
23170-04 or DI-37	5.85	2.14
23170-05 or DI-38	5.86	6.45
23170-06 or DI-39	5.98	4.74
23180-01	2.66	1.12
23180-02	2.66	0.59
15775-01	16.21	8.11
15775-02	16.21	1.25
15775-03	16.21	0.50
23179-01	16.72	5.67
23179-02	16.72	2.05
23179-03	16.72	1.06
18077-02	11.04	7.53
18077-01	11.03	13.41
DI-252 or K0103-01	97.59	2.39

TOTAL = 81.25