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Page 1 of 1
1. EDT 157937

2. To: (Receiving Organization) Plutonium Finishing Plant	3. From: (Originating Organization) Criticality and Radiological Analyses	4. Related EDT No.: N/A
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8. Originator Remarks: Transmittal of Criticality Safety Evaluation Report 94-015		9. Equip./Component No.: N/A
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	WHC-SD-SQA-CSA-20383		0	CSER 94-015, New Portable NDA	S	1,2		
				Equipment for Use in SNM Audits				

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1	1	Cog. Eng. AL Hess	<i>AL Hess</i>	11/18/94	H4-64						
1	1	Cog. Mgr. JW Daughtry	<i>JW Daughtry</i>	11-21-94	H4-64						
		QA N/A									
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18. AL Hess Signature of EDT Originator 11/18/94	19. LH Rodgers Authorized Representative 11/24/94	20. JW Daughtry Cognizant Project Engineer's Manager 11-21-94	21. DOE APPROVAL (if required) Ltr. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments
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SUPPORTING DOCUMENT		1. Total Pages 8
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<p style="text-align: center;">APPROVED FOR PUBLIC RELEASE</p> <p style="text-align: right;"><i>V. Burkland 12/12/94</i></p>		
7. Abstract A criticality safety review is presented for the use of two portable NDA detectors from Los Alamos during an IAEA inspection of the SNM at PFP. The units are an Active Well Coincidence Counter (AWCC) and a High Level Neutron Coincidence Counter (HLNCC). Approval for their employment is based on the inherent safety of the containers to be assayed, one at a time, and because their designs conform with the acceptability criteria which allow the other NDA detectors currently employed at the facility.		
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CSER 94-015

Title: New Portable NDA Equipment for Use in SNM Audits

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1. INTRODUCTION AND SUMMARY

The Criticality Prevention Specifications (CPS-Z-165-80120) governing the operations of NDA (Non-Destructive Analysis) equipment at PFP includes the control that "New or redesigned NDA detectors require evaluation by Criticality Engineering Analysis (CEA) before being used". This report documents such a review for two portable well-type coincidence counters from Los Alamos National Laboratory (LANL), which are to be used in a program of International Atomic Energy Agency (IAEA) inspections of Special Nuclear Material (SNM) inventories at PFP. The two units are a Active Well Coincidence Counter (AWCC) identified by LANL drawing set # 68Y-15582, and a High Level Neutron Coincidence Counter (HLNCC), per drawing set # 68Y-155607. Their use is approved based on the inherent safety of the containers to be assayed, one at a time, and because their designs conform with the acceptability criteria which allow the other NDA detectors currently employed at the facility.

2. DESCRIPTION OF COINCIDENCE COUNTERS AND ASSAY PACKAGES

Figure 1 illustrates the design features of the portable Active Well Coincidence Counter from Los Alamos. The assemblage of cylindrical and annular parts yields essentially a 21 inch diameter by 2 ft tall cylindrical block of polyethylene, with a central sample cavity surrounded by neutron detectors in vertical wells. As shown, the sample cavity is an 8 inch high by 6-to-8 and back to-6 inch diameter cylindrical void, with a lining of 0.032-in thick cadmium. The drum's outer annulus of polyethylene (from 12 to 21 inches diameter) has 42, 1.125-in. diameter, full-height vertical wells for placement of neutron detectors. The inside cylinder surface of this CH₂ ring is lined with 0.032-inch thick cadmium foil.

Figure 2 shows details of the LANL High Level Neutron Coincidence Counter. The basic geometry of the HLNCC is similar to that for the AWCC, but the sample cavity is taller and the polyethylene moderator ring is narrower and has vertical wells only for 18 neutron detectors. Again, the inside surface of the sample chamber is lined with cadmium foil, which serves to eliminate counting of neutrons from outside sources. The practical height of the sample cavity is limited to about 8 inches by the source probe tube shown, which is to accommodate insertion of a neutron source for assays of uranium loaded containers.

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Figure 1: CUTAWAY VIEW OF ACTIVE WELL COINCIDENCE COUNTER

Figure 2:
CUTAWAY VIEW OF HIGH LEVEL NEUTRON COINCIDENCE COUNTER

An assay package consists of a single fissile mass accumulation (as one item in a material accounting inventory) fully contained within an innermost can or polyjar which is enclosed inside of one or more sealed outer cans. Packages allowed in an NDA chamber or cavity are any sealed unit where the fissile content and nested container sizes conform with limits set forth in a Criticality Prevention Specifications document allowing storage of the unit in a room, vault, and/or gloveboxes of the Plutonium Finishing Plant. The maximum outer size of the package is of course limited by the interior dimensions of the assay chamber. At PFP, the largest overpack container for accountable, non-waste plutonium items is the "oversize can", of 4.75 inches diameter and 6.75 inches height, for a volume of 1.9 liters.

3. REVIEW OF PAST EVALUATIONS

NDA equipment has been employed for decades at PFP for accountability assays, and the criteria on criticality safety for use of such has remained essentially the same. A copy of the specifications in force in 1974 is appended.

Only one criticality safety evaluation about radiation-detection NDA equipment has been documented as a CSAR since the start of the CSAR issuances in 1978; this is CSAR 80-001 [REFERENCE 1] about the "*Barrel Counter for Nondestructive Analysis*". At the time CSAR 80-001 was issued, the list of other identified NDA equipment items included the following;

- NaI package counter,
- Ge(Li) package counter,
- Isotopic source assay system,
- segmented gamma scan system (SGSAS)
- neutron well coincidence counter,
- and neutron counters.

Additional studies for the calorimeter-type NDA equipment measurements were documented in CSAR 80-027 [REFERENCE 2], and number of calorimeter equipment changes have been analyzed addenda to this report.

The format and contents of the present CPS were adopted in Rev./ Mod. B-2 issued 9/6/89. The EQUIPMENT DESCRIPTION section then included the above list of 6 items plus the calorimeters and the following radiation-detection equipment;

- the NaI sludge counter,
- the Confirmatory Measurement Counter,
- the MEGAS and
- the HLNCC.

It is thus seen that the two types of detectors reviewed in this report have been approved for use before, only not of the same design.

4. SAFETY EVALUATION

For the well-type radiation detectors, like the two LANL portable units, the sample chamber only accommodates a single container so that criticality safety is assured by the well-subcritical condition of the package fissile loading and canning. Placement of a can into a detector chamber is permitted only if the fissile mass contents plus containerization conform with limits in any facility CPS for storage of such in rooms, vaults, bins or gloveboxes, or for transportation. The evaluations allowing fissile-bearing containers in storage show safe assessments with errors like doublebatching and full water reflection, combined, for a unit in an allowed array or isolated.

Within the detector, the fissile package is subject to less reflection than accounted for in the criticality safety analyses for the container storage under flooding contingency modes. The polyethylene (CH_2) enclosures around the sample cavity in the well type detectors has moderation and reflection properties almost the same as for water. But the counter CH_2 rings include a fair amount of void space for detectors, so the effective scatterer and moderator density is less than for water.

The CPS limits require NDA equipment spacings so as to maintain 3-ft separations, minimum, between the measurement chambers of different units (with exceptions for calorimeters). The diameters of the two new portable units are about half of the spacing rule requirement, so that compliance becomes an administrative concern. However, the issue with these well counters is somewhat moot considering that the cadmium liners employed to eliminate counts of outside source neutrons provides adequate isolation of chambers.

Container fissile loadings in excess of their pertinent storage CPS limit are likely to be found by the NDA in a small fraction of cases. However, overbatching by a factor of two is very unlikely, considering that most containers have been assayed several times before. A mass limit nonconformance does not count as an infraction of the NDA CPS, but rather as a pre-existing infraction against the pertinent storage CPS. Event recovery and repackaging must then be carried out according to procedures for such (before return to storage).

5. REVISION OF CPS

For the present, the use of the two portable well-type coincidence counters from Los Alamos may be considered authorized under the category NEUTRON WELL COINCIDENCE COUNTERS (NWCC AND HLNCC) in the Typical equipment list in CPS-Z-165-80120, Rev./Mod. B-3.

However, the review of the past evaluations and CPS texts suggests that an overhaul of the current CPS is warranted, to clarify some of the anomalies with previous requirements. At the same time, the listing of allowed NDA equipment could be more formalized, with identifications by drawing or part No., and provisions could be added about approvals for new units by ECNs to the CPS.

6. REFERENCES

1. WHC-SD-SQA-CSA-20220: "CSAR 80-001, Barrel Counter for Nondestructive Analysis", S. J. Altschuler, April 16, 1980. SD issue date January 19, 1990.
2. WHC-SD-SQA-CSA-20243: "CSAR 80-027: "CSAR 80-027, Calorimeter in Room 221-B, 234-5Z Building", S. J. Altschuler, December 23, 1980. Supporting document released Jan. 19, 1990.

CRITICALITY PREVENTION SPECIFICATION -
NONDESTRUCTIVE ASSAY

An essential part of material control and accountability at Z Plant involves nondestructive assay (NDA). Nondestructive assay operations involve the measurement of heat and radiation evolved from radioactive material.

Limits

- A. Nondestructive assay measurements which do not increase the moderation/reflection of a system above routine levels may be performed on any system approved by any other criticality prevention specification.
- B. Nondestructive assay measurements which do increase moderation/reflection shall be conducted on one container at a time. The container and mass limits shall be obtained from any other criticality prevention specification. Such NDA measurements must maintain three feet between sample chambers with the exception that any two calorimeter sample chambers may be operated within one foot of each other.

APPENDIX A

**COPY OF OLD CRITICALITY PREVENTION
SPECIFICATIONS FOR NDA OPERATIONS**