Department of Energy

Washington, DC 20585

March 27, 2000

The Honorable John T. Conway
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, N.W.
Suite 700
Washington, D.C. 20004

Dear Mr. Chairman:

Enclosed is a copy of the Department's pit storage container surveillance program plan. This surveillance plan is a deliverable to you under Commitment 5.3.1 of the Department's Recommendation 99-1 Implementation Plan (IP). As discussed in the IP, the surveillance plan provides the technical basis for verifying that the new pit storage container meets pit storage design specifications.

If you h ve any questions concerning this information, please contact me at (202) 586-4879 or Marty Schoenbauer at (202) 586-1730.

Sincerely,

David E. Beck
Assistant Deputy Administrator
for Military Application and
Stockpile Operations
Defense Programs

Enclosure

cc w/enclosure:
Mark B. Whitaker, S-3.1

C.D. CALDWELL 980 PX
J.L. ADDINGTON 850 PX
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GENERAL SPECIFICATION, AL-R8 SEALED INSERT SURVEILLANCE PLAN(U)

CHANGE HISTORY

CONTROL NUMBER	ISSUE	RELEASE/CHANGE	DATE
BB706035-000	A	CER 980041 Rev 3	2/00
	B	ACO 000019PX Rev 0	3/00

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1. GENERAL

1.1 Introduction.

DOE's current planning requires pits to remain in storage at Pantex for periods up to 30 years. Currently the pits are staged in the AL-R8, consisting of carbon steel drums, Celotex inserts and either carbon steel or stainless steel holding fixtures. Packaging in a new storage container, AL-R8 SI (Sealed Insert), has been implemented at Pantex.

1.2 Scope.

The surveillance plan will include the AL-R8 SI containers, only. The surveillance effort will continue for the life of the container program.

1.3 Purpose.

The Pit Container Surveillance Program is intended to monitor pit containers in storage to ensure the storage configuration continues to provide protection for the pits. This plan covers both new material (short term) evaluation and stockpile (long term) evaluation of the AL-R8 SI container as follows:

New material evaluation is the test and inspection of randomly selected samples of newly produced containers to emphasize detection of significant design, production, or assembly defects to permit their early correction. Traditionally, new material samples are selected from the completed units prior to shipping off-site to the final customer. The goal of new material evaluation is to monitor for potential static assembly/process defects.

Stockpile evaluation is the periodic testing and inspection of randomly selected samples of containers that have experienced stockpile handling and storage environments to detect and evaluate any defects or degradation that might have occurred to change the reliability, safety, or use features of the stockpile. Traditionally, stockpile samples are selected from the customer off-site and shipped to Pantex for evaluation. The goal of stockpile evaluation is to monitor for dynamic failure mechanisms in the stockpile.

As the AL-R8 SI container is an "on-site use only" container, there is no off-site customer and the difference between stockpile samples and new material samples becomes a matter of time in the staging area. Based on this difference, sampling activities during the initial five (5) year surveillance run are considered new material evaluation for evaluating design, production, or assembly defects. Sampling activities beyond the initial run are intended as stockpile samples for evaluating defects or degradation that may affect reliability, safety, or use. This does not preclude the use of early data from new material builds from aiding in the surveillance of the stockpile.

1.4 Definitions.

a.	Site Specific Criteria:	On Site Specifications.
b.	PA:	Production Agency.
c.	DA:	Design Agency.
d.	Pit DA:	LANL, LLNL.

e.	Container DA:	Mason and Hanger Corp., Dept. 850, Pantex Plant.
f.	AL-R8:	Original AL-R8 container.
g.	SI:	Sealed Insert, inner vessel.
h.	AL-R8 SI:	AL-R8 Upgrade to include the SI.
i.	Product Rule:	System reliability is the product of the individual component reliabilities. $P_S = P_1P_2 \ldots P_n$.
j.	Confidence limits:	Calculated from the data for a sample size, n, to define a "confidence" within which an established population percentage, P, lies.

1.5 Product Perspective.

The design intent of the Al-R8 Sealed Insert is to remove the pit from the potentially corrosive Celotex environment of the AL-R8 container (ref. CE706035, para. 1.4). The principle protection provided by the container is a controlled, sealed inert environment that limits the availability of moisture. This surveillance plan will validate the design features that protect the pit from the external environment for extended periods of time (ref. CE706035, para. 5.2, 5.10).

Postulated failure mechanisms for the container seal are the result of accident scenarios rather than normal handling and storage conditions as evaluated through the surveillance plan.

1.6 Sample Size Determination.

For the purposes of picking a statistical sample of containers in which to perform new material surveillance, there is no distinction made between the national security pits and excess pits. Therefore, the Pantex pit population is considered one population for container surveillance.

The sample size is determined using the Binomial Distribution and assuming an infinite population. This method looks for simple accept/reject criteria (ref. para. 3.5, 3.6, 3.8, 3.9, 4.3 in this document) under the assumption that the probability of a defect is constant on each independent evaluation of a container. A sample size of 92 per year provides 99% confidence and 95% reliability after one (1) year. The reliability will rise, reaching 99% reliability after five (5) years assuming no defects are found (ref. Appendix A).

Based on historical data from pits stored in the AL-R8 container, a container surveillance program that provides 99% confidence and 95% reliability after the first year is adequate to assure the quality and reliability of the pit population. This level of confidence and reliability provides for a container surveillance program that is economically feasible and does not significantly impact the container packaging production activities.

After the five (5) year build cycle, surveillance activities change from locating static assembly/process defects of new material to monitoring for potential dynamic failure mechanisms in an existing stockpile. The Binomial Distribution does not support this model well. From this point forward for the life of the program, a linear model is anticipated to best fit the population, with the assumption that the data will be normally distributed about the regression line for each variable. This model will be evaluated against the first five (5) year data set and, unless the data shows otherwise, this model will be used for activities beyond five (5) years.

The long-term surveillance activities will continue to assure with 99% confidence that the container meets its 30-year life expectancy. The data collected during the initial five (5) year effort for each critical design variable will be used to establish trends to predict the MTTF (Mean Time To Failure) for that variable for 99% of the population (ref. Figure 1). The component reliabilities will be combined using the Product Rule to establish a system MTTF for 99% of the population. The sample size will be chosen to provide the 99% confidence in the predicted MTTF.

If defects are found the sample size will be adjusted and/or the statistical confidence and reliability will be adjusted.

1.7 Document Overview.

This document has seven (7) major sections. Section one (1), this section, provides an overview of the entire BB document. Section two (2) provides a description of the governing documents and references. Section three (3) provides the general container surveillance activities for the AL-R8 SI container. Section four (4) provides the additional surveillance activities for inner inspection if the container is selected as a pit surveillance unit. Section five (5) delivers the actions required in the event of failure of a surveillance activity. Section six (6) provides direction for data collection and analysis. Finally, Section seven (7) provides direction for annual reporting of the surveillance data.

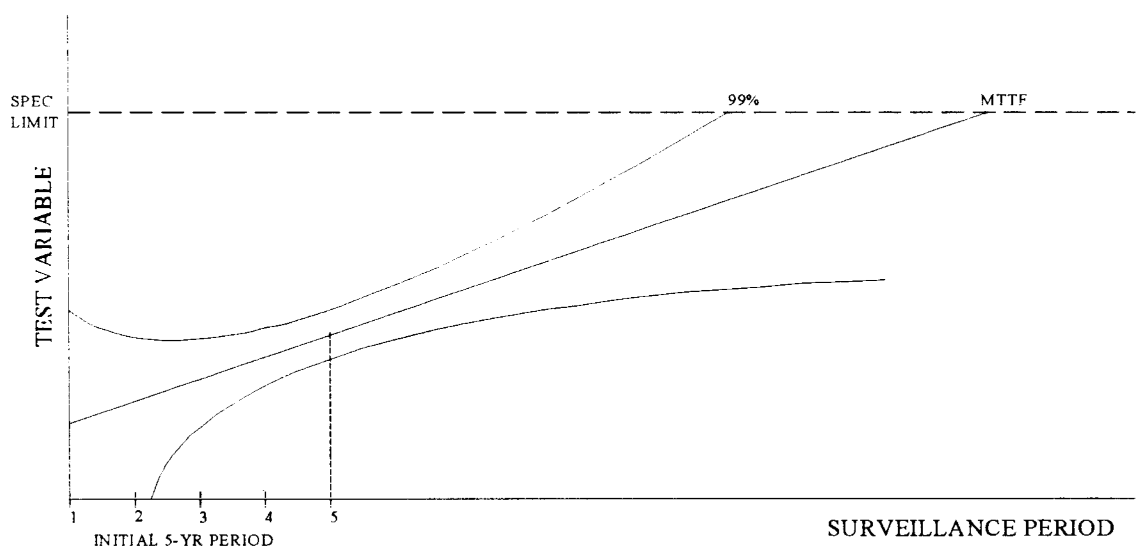

Figure 1. Expectation of MTTF for a typical test variable based on the initial five (5) year data set.

2. DOCUMENTS AND EQUIPMENT

2.1 Governing Documents.

a. SS706035 Specific Use Specifications, AL-R8 Sealed Insert.
b. 6450-01-P Environmental Impact Statement.

2.2 Reference Documents.

a. P33259 AL-R8 Drawing.
b. 706035 AL-R8 Sealed Insert Definition.
c. RM257919 Specification for the Storage of LANL & LLNL Pits.
d. CE706035 Technical Characteristics, AL-R8 Sealed Insert.
e. CER990092 Engineering Release for LLNL top-level AL-R8 SI pit packaging drawings.
f. CER990123 Engineering Release for LANL top-level AL-R8 SI pit packaging drawings.

2.3 Process Definition Documents.

The surveillance process will be defined and controlled using Pantex Operating Procedures. Procedures shall require the concurrence of the container DA and the pit DA's.

2.4 Data Collection.

The data collected during inspection and surveillance operations will be recorded using the Pantex Q-form format. All data will be forwarded to the container DA and, as requested, to the pit DA's.

2.5 Plan Implementation.

The AL-R8 SI container inspection will be performed in conjunction with the Pit Storage Surveillance Program. The Pit Storage Surveillance Program sample size population will be 38 pits in FY00, increasing to approximately 50 per year as directed by the pit DA.

As more pits are packaged into the AL-R8 SI containers, more pits in SI's will be selected as Pit Surveillance Storage Program samples and fewer pits in AL-R8's will be selected. This will allow the AL-R8 SI container surveillance activities to overlap with the Pit Storage surveillance activities.

Those pit surveillance samples that are packaged in AL-R8 SI containers will be counted as both Pit Surveillance Storage Program samples and AL-R8 SI Container Surveillance Plan samples. The balance of the yearly samples shall be Container Surveillance Plan samples and shall be selected randomly from the AL-R8 SI population at Pantex.

Screening shall be used to assure that no container is surveyed multiple times during the initial five (5) year activity.

Ninety-two (92) pits packaged in AL-R8 SI containers will be surveyed annually. The total sample size will b e 460 over five (5) years.

Derived Design Specifications	S1: Container Assembly	S2: Outer Drum	S3: Celotex Inserts	S4: Sealed Insert	S5: SI Leak Rate	S6: SI Moisture	S7: SI P&B Valve Seal	S8: SI Flange Bolts	S9: SI Gas Sample	S10-12: SI Interior	PRT Review Process
D1: AL-R8 SI Pit Cleanliness Criteria											X
D2: AL-R8 SI Materials Compatibility							X			X	
D3: AL-R8 SI Moisture Criteria						X				X	
D4: AL-R8 SI Pit Thermal Criteria					X		X		X		X
D5: AL-R8 SI Packaging Configuration	X									X	
D6: AL-R8 SI Backfill Gas Criteria									X		
D7: AL-R8 SI Imaging Criteria											X
D8: AL-R8 SI Contingency Criteria											X
D9: AL-R8 SI Review & Concurrence											X
D10: AL-R8 SI Criticality Criteria											X
D11: AL-R8 SI Shielding Criteria											X
D12: AL-R8 SI Drop Criteria											X
D13: SI Leak Rate Criteria					X		X				
D14: AL-R8 SI Inspection Criteria		X	X	X							
D15: AL-R8 SI Identification Criteria	X										
D16: AL-R8 SI Lifting Criteria											X
D17: AL-R8 SI Personnel Radiation Criteria											X
D18: AL-R8 SI Decontamination Criteria											X
D19: AL-R8 SI Vibration Criteria											X
D20: AL-R8 SI Safety Analysis Activities											X
D21: AL-R8 SI Test Plan Activities											X
D22: AL-R8 SI Qualification Plan Activities											X
D23: AL-R8 SI Environment Criteria									X		
D24: AL-R8 SI Storage Life								X			
D25: AL-R8 SI Use of Existing Materials											X
D26: SI Considerations for Transport											X
D27: SI Backfill Pressure									X		
D28: AL-R8 SI Safeguards Measurement											X
D29: AL-R8 SI Puncture Criteria											X
D30: AL-R8 SI Surveillance Specifications											X

Table 1: Surveillance Traceability Matrix summarizing verification of the design specifications through the surveillance plan.

3. AL-R8 SI CONTAINER SURVEILLANCE REQUIREMENTS

The AL-R8 SI Container Surveillance Program is designed to verify the design basis for the AL-R8 SI container as defined in the container requirements document, SS706035, and in the container design specification, CE706035.

Table 1 contains the traceability matrix that shows the Surveillance Activities (SA) vs. Design Specifications (Derived Hardware Specifications, DHS). The format allows for a traceable path from the requirements in the governing document, SS706035, through to the design specifications in the derived document, CE706035, then to the surveillance plan documented here. This matrix provides an easy visual indicator of where a specification is verified.

The Pantex Production Agency shall prepare detailed written operating procedures to assure that the requirements of this specification are met. The container and pit DA's shall review the procedures, associated fixtures, and equipment prior to first use. Significant changes to the procedures, fixtures and equipment after initial concurrence shall require a review by the DA's. The following specific requirements shall be included in the procedure.

3.1 S1: Container Assembly.

Disassembly shall be as governed by the AL-R8 SI Assembly Procedure, AF706035, as implemented in Pantex Operating Procedures. As the AL-R8 SI containers are disassembled, each container will be inspected for proper original assembly. Any anomalies shall be recorded.

3.2 S2: Outer Drum.

The outer drum will be visually inspected for degradation such as (but not limited to) non-designed through holes, dents that prevent removal of inserts, and excessive rust. Any damage or anomalies shall be recorded.

3.3 S3: Celotex Inserts.

The Celotex inserts will be visually inspected for degradation such as (but not limited to) loss of material, presence of cracks that penetrate the inserts, delamination, and water damage. Any damage or anomalies shall be recorded.

3.4 S4: Sealed Insert.

The exterior of the Sealed Insert will be visually inspected. Any damage or anomalies shall be recorded.

3.5 S5: SI Leak Test.

A whole-body leak test will be performed on the Sealed Insert. The leak test criteria is a leak rate less than 1×10^{-7} cc/sec. (air) and the data shall be recorded. If the leak rate level exceeds 1×10^{-7} cc/sec. (air), the container DA shall be notified.

3.6 S6: SI Moisture Sample.

The interior atmosphere of the Sealed Insert will be analyzed for moisture. Prior to performing this test, the SI shall be allowed to reach thermal equilibrium for 24 hours. The water content of the internal SI environment shall be recorded. If the moisture level exceeds 500 ppmV, the pit DA owning the pit shall be notified.

3.7 S7: SI Purge & Backfill Valve Seal.

The purge and backfill valve silver-coated metal seal (NI-8-VCR-2) will be inspected for corrosion or damage to the gasket sealing surface.

3.8 S8: SI Flange Bolts.

Two bolts (approximately 180° apart) will be removed from each inspected SI flange and sent to laboratories at Pantex for inspection. The following shall be performed on each bolt:

a. S8.1: Breaking torque recorded.

b. S8.2: Tensile strength and/or hardness and the data recorded. The requirements, based on a grade 8 (SAE) cap screw, are tensile strength 150 kpsi minimum and core hardness, Rockwell, minimum C33/maximum C38.

c. S8.3: Inspected for corrosion and indications of corrosion recorded.

d. S8.4: If applicable, zinc plating inspection.

3.9 S9: SI Gas Sample.

A gas sample will be extracted from the interior of the SI and analyzed by the Pantex Gas Laboratory for its principle constituents. Prior to extracting the sample and measuring the pressure, the SI shall be allowed to reach thermal equilibrium.

a. S9.1: The final gas content of the SI interior environment shall be 97% helium, minimum.

b. S9.2: The backfill gas pressure and facility temperature shall be measured and recorded.

4. SI CONTAINER INNER INSPECTION.

If a pit packaged in an AL-R8 SI is selected as a Pit Storage Surveillance Sample, the SI will be completely disassembled. In addition to the activities of Section three (3), perform the following:

4.1 S10: SI Interior.

The interior of the SI will be visually inspected for anomalies.

4.2 S11: Copper Gasket Analysis.

The copper gasket (FG-1650-C1) will be analyzed for corrosion and damage.

4.3 S12: Desiccant Analysis.

The desiccant shall be analyzed for moisture content and remaining moisture capacity.

5. RESPONSE TO FAILURE OF INSPECTIONS

If any abnormalities are detected in the AL-R8 SI surveillance activities of Section three (3), the container DA shall be contacted and, at their discretion, the remaining SI flange bolts will be removed and tested per Para. 3.8. Additionally, the container DA may require the SI interior to be visually inspected and the copper gasket and desiccant analyzed per Section four (4). The container DA, the pit DA, and DOE/AAO shall be notified of the results of these additional activities.

6. DATA COLLECTION

The surveillance data will be collected using the Pantex Q-form format. Data is in the form of both qualitative (pass/fail) data and quantitative data. The quantitative data will be maintained in a database. Where feasible, automated test processes and data collection are preferred.

Time series trend analysis shall be performed on the quantitative data for leak rate, moisture content, flange bolt breaking torque, helium content of backfill gas, and container backfill pressure. This analysis will provide a mechanism for identifying persistent patterns, seasonal variations, and cyclical components of the data over time. Trend projection may then be used to statistically forecast for short- and long-term planning and control of the container population.

7. REPORTING PLAN

An annual report summarizing the container surveillance program including actual sample size, pit types in the containers and container damage, and/or anomalies found will be transmitted to the pit DA and the container DA with courtesy copies forwarded to DOE/AAO and DOE/AL.

The annual report will include a statistical statement based on the sample size and results for the single year. The quantitative results of the surveillance program will be analyzed to show trends in the condition of the containers over time.

APPENDIX A. STATISTICAL BASIS.

Statistical Basis.

Assume a large ("infinite") population containing both defective and non-defective items. If a random sample is chosen from the population, then the sampling distribution is binomial and the probability function is:

$$f(x) = \frac{n!}{x!(n-x)!} p^x (1-p)^{n-x} \qquad x = 0,1,2,\ldots,n \qquad 0 < p < 1$$

Where n = the sample size,

x = the number of defects in the sample,

and p = the proportion of defects in the population.

Hence f(x) is the probability of observing x defects in the sample. If no defects are observed in the sample, then x = 0 and the equation reduces to:

$$f(0) = \frac{n!}{0!n!} p^0 (1-p)^n = (1-p)^n$$

A one-sided confidence limit for p is found by setting f(0) to a desired significance level (α) and solving for p. Thus giving:

$$\alpha = (1-p)^n$$

which leads to:

$$1 - p = \alpha^{1/n}$$

Since the quantity 1-p is the reliability (r), the reliability can be expressed as a percentage with the equation:

$$r = 100\alpha^{1/n}$$

Application to the AL-R8 SI Container.

Use the sample size of 92 and assume no defects are observed. Using the above derived equation, $\alpha = 0.10$ for 90% confidence level, $\alpha = 0.05$ for a 95% confidence level, and $\alpha = 0.01$ for 99% confidence level.

For a desired confidence level of 95%, then r = 96.796%. This allows stating with 95% confidence that the reliability of the population is 96.796% or better.

Five-Year Plan.

A sample size of 460 with no defects states with 99% confidence that the reliability of the population is 99% or better. The sample is to be taken over the five-year packaging period, so the rate is 92 containers per year. The following table shows, at three different confidence levels, how the reliabilities will change during the sampling period. For example, at the end of the first year 92 containers will have been tested. Assuming no defects, this states with 99% confidence that the reliability of the population is 95.118% or better.

		Confidence (%)		
Year	n	90	95	99
1	92	97.528	96.796	95.118
2	184	98.756	98.385	97.528
3	276	99.169	98.920	98.345
4	368	99.376	99.189	98.756
5	460	99.501	99.351	99.004

Defects.

The occurrence of defects result in a statistical loss of reliability. Two methods are available to address defect occurrence: accept the loss of reliability or increase the sample size. The sample size increase may be substantial to return to the original reliability, and, if the reliability number of the population is real, will only result in detection of more defect occurrences. Accepting the loss in reliability may be the more cost effective strategy.