71-9284

ESP Eco-Pak Specialty Packaging Division of CBC

Intermediate Bulk Containers for Chemicals & Liquids
UF_6 and UO_2 Packaging

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August 27, 1999

Mr. David H. Tiktinsky, Project Manager
Licensing Section, Spent Fuel Project Office
Office of Nuclear Material Safety and Safeguards
United States Nuclear Regulatory Commission
11545 Rockville Pike
Rockville, MD 20852

Re: Response to the April 21, 1999 Questions from the Review of the Model No. ESP-30X Package Application
Docket No. 71-9284

Dear Mr. Tiktinsky,

Eco-Pak Specialty Packaging (ESP), a division of the Columbiana Boiler Company, would like to express our appreciation of your patience for our response to the aforementioned questions. There was extensive testing to accomplish prior to this submittal. Please find attached the response (Attachment 1) in the form of the NRC questions in bold and the subsequent ESP answers.

In the process of preparing this response and the completion of Revision 1 to the *Safety Analysis Report for the Model ESP-30X Protective Shipping Package for 30-inch UF^6 Cylinders*, we discovered further areas of this application to amend. Each amended page is marked with vertical lines in the right margin next to the modified sentences, and they are described as follows:

Title Page	Added "Revision 1" and date. Changed the address of Eco-Pak Specialty Packaging to "Columbiana, Ohio 44408."
Page ii	Page numbers needed to be corrected as they were submitted with the wrong page numbers in the Table of Contents.
Page iii	Added two parts to Section 3, 3.5.10 "Partial Load Requirement" and 3.8.2 "Law Engineering Report of Cylinder Pressure Evaluation."
Page iv	Removed 7.1.2 "Final Cylinder Inspection" and added 7.1.2 "Cylinder Inspection" and 7.1.3 "Additional Type B Requirements for Cylinder Inspection."
Page 1-1	Removed "Fissile Class II" and amended as necessary after re-calculating the leak rate calculations in Section 4, Containment.

1/1

NTOI

Att. Encl.

change: LA 4 0
PM 1 0

Page 1-2 Amended the reference to the ESP-30X drawing.

Page 1-4 Amended Section 1.2.3 per your *Contents* question.

Page 1-5 Amended the reference to the ESP-30X drawing.

Appendix 1.3.1 Revised and simplified the ESP-30X drawing per your *Drawings* questions.

Page 2-ii Page numbers needed to be corrected as they were submitted with the wrong page numbers in the Table of Contents.

Page 2-1 Amended the reference to the ESP-30X drawing.

Page 2-3 Amended the closed cell content to display a range consistent with our OP-TU application (71-9288).

Page 2-4 Revised Section 2.4.4 per your *Structural No. 3* question.

Appendix 2.10.1 Amended the decay heat calculation to be consistent with the changes affected by the leak rate calculations in Section 4, Containment.

Appendix 2.10.2 Revised this specification per your *Structural No. 2* question.

Appendix 2.10.3 Revised this appendix per your *Structural No. 3* question.

Appendix 2.10.5 Revised this appendix per your *Structural No. 4* question.

Page 2.10.8-4 Revised a typographical error discovered from your *Containment No. 7* question.

Page 3-i. Page number changes and addition of Section 3.10.5 per your *Thermal No. 1* question.

Page 3-12 Section 3.10.5 has been added as a result of your *Thermal No. 1* question.

Appendix 3.8.2 This appendix has been added as support for our answer to your *Thermal No. 1* question.

Page 4-2 Sections 4.2.1 and 4.2.3 have been revised per your *Containment* questions.

Page 4-3 Section 4.3.2 has been revised as a result of the amendment of the leak rate calculations in Appendix 4.4.2.

Appendix 4.4.1 Amended to reflect ANSI N14.5-1997 per your *Containment* questions.

Appendix 4.4.2	Amended to reflect ANSI N14.5-1997 per your *Containment* questions.
Page 7-i.	Amended the names of Sections 7.1.1 and 7.1.2.
Page 7-1 thru 7-3	The majority of Section 7 has been amended per your *Operating Procedures* questions, and these changes are explained in our response in Attachment 1.
Page 8-i.	Amended the names of Sections 8.1.3 and 8.2.3.
Page 8-1 thru 8-4	The majority of Section 8 has been amended per your *Maintenance Procedures and Acceptance Tests* questions, and these changes are explained in our response in Attachment 1.

If you need additional information or have further questions, please contact me at the following address and phone/fax numbers:

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A Division of The Columbiana Boiler Company
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Phone: (330) 482-3373
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Very truly yours,

William M. Arnold

William M. Arnold
ESP President

WMA/hl

ATTACHMENT 1

The ESP Response

DRAWINGS

1. Simplify the drawings to include only the level of detail of the package design which affects the evaluation under 10 CFR Part 71.

1A. These simplifications limit the drawing to four sheets, which include a general notes sheet, a general arrangement sheet, and two design detail sheets. They are illustrated on the revised Drawing No. 30X-SAR, Sheet 1 through 4, located in Appendix 1.3.1 of the safety analysis report.

2. The text on the drawings is illegible. Revise the drawings so that the text can be easily read.

2A. We are submitting less dense drawings on 11" x 17" size paper.

3. Revise the drawings to include the following:

a. A general tolerance block.
b. Torque requirements for the closure bolts.
c. Maximum weights of the package and contents.
d. Codes and standards for welds.
e. Location of tamper evident seals.
f. Packaging markings.
g. The epoxy primer used on surfaces contacting the foam.

3A. These changes are found in Drawing No. 30X-SAR on the following sheets:

a. Sheet 1, Note 8
b. Sheet 1, Note 11
c. Sheet 1, Note 1
d. Sheet 1, Notes 5 and 6
e. Sheet 3
f. Sheet 1, Note 10 and 30X-SAR, Sheet 2
g. Sheet 1, Note 3

4. Revise Drawing No. 30X-12, Sheet 12 of 12 as follows:

a. Correct the package name (i.e. Model No. ESP-30X).
b. Remove the note related to substitution of trade name materials.
c. Change the foam specification to ESP-PF-1.
d. Include minimum and maximum foam density.

4A. These changes are found on the revised Drawing No. 30X-SAR, Sheet 1 and the following notes:

a. Note 1
b. Removed

c. Note 19
d. Note 19

5. As was previously discussed in a pre-application meeting, provide a letter stating that the drawings may be released to the public. Revise the application to delete the notes regarding reproduction of the drawings.

5A. The notes regarding reproduction of the drawings have been deleted.

STRUCTURAL

1. **The test report in Appendix 2.10.8 stated that the cylinder passed the leak tests (air pressure, helium, and hydrostatic) performed before and after the physical testing of the package. However, in Appendix D of the test report, the log book contains the notation that the valve connection (for S/N 002) showed signs of leakage during the hydrostatic and helium leak tests. Explain this negative test result, and justify the conclusion that the package will maintain a leak-tight containment system under normal and accident conditions. Provide further information regarding the testing S/N 002 including an explanation of why this discrepant test result was not included as part of the test report, and was not discussed in the safety analysis report (SAR).**

A1. The following response is taken from a recent Southwest Research Institute (SwRI) report (Attachment 1):

> The initial air pressure soap bubble leakage test performed on the ESP-30X, SN 002 (30B cylinder identified as CB-1871-7) on March 11, 1999 resulted in a leak being detected at the valve. Inspection of the valve found the torque to be 110 ft-lb. instead of 200-400 ft-lb. recommended in the installation procedure. A custom made valve tool was used to turn the valve one full turn tighter with a maximum torque of 215 ft-lb., just slightly above the minimum torque requirement. The air pressure soap bubble leakage test was repeated and no leaks were detected. Subsequent helium and hydrostatic leakage tests were successful. See QA Surveillance Report 98-SR-050 for Project No. 01-1680-101 (attached).
>
> Page D-1 of Appendix D of the referenced report records leakage test results for a completely different package, identified as OPM-1, SN 002, which was tested with the ESP-30X but is not part of the application for ESP-30X package design. ESP-30X, SN 002 (30B cylinder CB-1871-7) was not fire tested.

2. **Revise the ESP-PF-1 foam specification to include the following:**

> **a. The tests to measure the density of the foam.**
> **b. The tests and limits for flame retardancy.**
> **c. The maximum and minimum foam strengh.**
> **d. Thermal characteristics including specific heat.**
> **e. Tests and limits for water absorption.**
> **f. Chemical composition of the foam.**
> **g. Specifications and application techniques for the epoxy primer to be used on surfaces contacting the foam.**

A2. Phenolic foam specification ESP-PF-1 has been revised to include the following:

> A2a. An outside engineering test laboratory utilized ASTM D-1622 on phenolic foam samples with densities within the 9.5 - 12.5 pcf required range.

A2b. ASTM F-501 was used as a guideline for flame retardancy testing of this phenolic foam for the 9.5 - 12.5 pcf density range.

A2c. Compressive Strength testing was conducted on both 9.5 and 12.5 pcf foam samples per ASTM D-1621.

A2d. Specific Heat was determined at room temperature for 9.5 and 12.5 pcf foam samples via a DSC (Differential Scanning Calorimeter). Thermal Conductivity was also determined for both minimum and maximum densities per ASTM C-518.

A2e. Water absorption was determined by utilizing ASTM C-209 Section 14 as prescribed in ASTM C-1126.

A2f. An elemental composition has been added to the revised ESP-PF-1 foam specification.

A2g. The coating and its application technique has been described in the revised ESP-PF-1 foam specification.

3. Demonstrate that there will be no significant chemical, galvanic or other reactions among or between the foam, the structural components, and the epoxy primer that are applied to these components. In the analysis, consider and evaluate, specifically, the following effects on the integrity of the package over its useful service lifetime: (1) water or moisture entering the outer container, (2) any chemical vapors of liquids that are leached from the foam, and (3) the contact of the foam to the carbon steel inner and outer container.

A3. This question has been completely answered in Section 2.4.4 of the safety analysis report and Appendix 2.10.3, Accelerated Laboratory Testing of Carbon Steel Samples by Law Engineering and Environmental Services, Inc. (LEES).

4. Revise the application to include foam properties (Appendix 2.10.5) that are consistent with the foam density specified for the package.

A4. The purpose of Appendix 2.10.5, as well as Appendix 2.10.4, was to provide the basis for conditioning the test package to -20°F prior to hypothetical accident conditions drop testing. We originally tested a foam sample with a density of 8 lb/ft^3. As a result of this question, LEES conducted more testing, Appendix 2.10.5 has been revised, and the test results reflect the specified density range of 9.5 - 12.5 lb/ft^3 consistent with the ESP-PF-1 foam specification.

5. Revise the application to include the following related to the SwRI performance evaluation under hypothetical accident conditions (Appendix 2.10.9).

A5. The following responses are taken from Attachment 1:

a. Provide the basis for determining that the reduction of pressure from 20 psig to 13 psig in 23 hours for the post-fire fluorescent dye pressure test of the UF6 cylinder was due to environmental conditions and not due to leakage (page 16 of 35).

A5a. Following the successful post-fire helium leakage test on the 30B cylinder (identified as CB-1871-2, ESP-30X SN 001), the hydrostatic test was initiated. As stated on pages 16 and D1 of the referenced report, at 10-40 a.m. on March 24, 1998 the 30B cylinder was completely filled with water containing a fluorescent dye and pressurized to 20 psig. At 8:47 a.m. on March 25, 1998 the internal pressure was noted to be 13 psig and the 30B cylinder was inspected for leaks. There were no visible traces of leaks from any of the openings which would have been evident from the fluorescent dye. The drop in pressure was attributed to the drop in temperature of the cylinder and contents. The drop in pressure is directly proportional to the change in temperature.

b. Provide the details of all of the tests that were performed on test specimen S/N 002 including photographs.

A5b. The details of all of tests performed on SN 002 including photographs are provided in Section 2.7 and Appendix 2.10.8, *Compliance Testing of the ESP-30X Package*, as reported by ESP. SwRI also verifies this with *ESP-30X SN 002/30B Cylinder No. CB-1871-7 Test Results* attached to their response found in Attachment 1.

c. Clarify whether the test specimen undergoing the pool fire test was fully engulfed for 30 minutes. Note that the table on page 23 of 35 appears to show a duration of less than 30 minutes.

A5c. Table 9-3 of Southwest Research Institute Performance Evaluation of UF6 Shipping Containers Under Hypothetical Accident Conditions Specified In Title 10 CFR Part 71.73 (Appendix 2.10.9) stated at 30 min, "Flames subsiding. Residual burning allowed to self extinguish." This statement was not meant to imply that the package was not fully engulfed at 30 min. Review of the video tape and test data indicates that the package was fully engulfed for 30 min.

d. Provide a legible copy of the calibration certificate of the mass spectrometer leak detector (page B-5).

A5d. Refer to Figure 2 (Attachment 1) for calibration certificate for Veeco Mass Spectrometer Leak Detector Model 7MS40.

e. Describe any differences between the test specimens design drawings and the drawings and the ESP-30X package design (Appendix C). Justify that test specimens adequately represent the ESP-30X package design.

A5e. SwRI received preliminary drawings of the test articles for test item preparation purposes prior to conducting the test program and completing the final report. These preliminary drawings were for information only to set up the test plan. The design drawings in Appendix 1.3.1 of the safety analysis report represent the package tested.

f. Justify why a reduction of pressure from 100 psig to 99 psig in 22 minutes for the air bubble/leak test as shown on the data sheet for S/N 001 does not represent leakage (page D-1).

A5f. Following the successful fire test, the 30B cylinder (CB-1871-2) was removed from the overpack, pressurized with shop air at 100 ± 1 psig and the soap bubble leak test was performed. The soap bubble leak test was repeated several times over the next 22 minutes and no leakage was detected. At the conclusion of the soap bubble leak test the internal pressure reading was 99 psig, within the original tolerance. Furthermore, subsequent helium leakage test results determined no leakage at any connections on the cylinder.

g. Provide an explanation of why the leak test data for S/N 002 on the data sheet shows leakage from the cylinder. Also explain why it is shown that the test was performed after a burn test when it is stated in the application that only S/N 001 was fire tested (page D-1).

A5g. Appendix D, page D-1 refers to a different design package (OPM-1 SN 002) which was tested but is not part of the application for ESP-30X package design. The ESP-30X SN 002 with 30B cylinder CB-1871-7 was not subjected to the fire test, whereas the OPM-1 SN 002 was subjected to a fire test during the same timeframe.

h. Provide an explanation of why the data sheet shows that bubbles were detected for S/N 002 at the valve during the leak test.

A5h. The initial air pressure and soap bubble leak test on the ESP-30X, SN 002 was performed on March 11, 1998 and resulted in a leak being detected at the valve. Inspection of the valve found the torque to be 110 ft-lb., well below the recommended value of 200-400 ft-lb. A custom made valve tool was used to turn the valve one full turn tighter with a maximum torque of 215 ft-lbs. The air pressure and soap bubble leak test was repeated and no leaks were detected. See QA Surveillance Report 98-SR-050 for Project No. 01-1680-101 (attached). Subsequent leakage tests resulted in no leakage.

CONTENTS

Section 1.2.3 of the application specifies radionuclide concentration limits for the UF_6 contents. Revise section 1.2.3 to clarify how ASTM C787 and ASTM C996 apply to this list of radionuclide concentrations. Note that the listed concentration for Tc-99, U-234 and U-236 exceed the limits for UF_6 specified in ASTM C787.

Section 1.2.3 has been revised to show that the list of radionuclide concentration limits apply to enriched reprocessed UF_6 in accordance with ASTM C996.

THERMAL

1. Revise the application to show that any mass of UF_6, up to the maximum load, will not cause the cylinder to exceed the maximum allowable pressure under the hypothetical accident condition fire test.

A1. This answer is provided in the revised Section 3, page 3-13 and Appendix 3.8.2. The conclusion of the analysis provided in Appendix 3.8.2 is "that any mass of UF_6 up to the maximum load, will not cause the cylinder to exceed the maximum allowable pressure of 115 psia under the hypothetical accident condition fire test."

2. Revise the application to describe the condition of the temperature labels after the fire test and whether they agreed with the temperatures provided by the thermocouples.

A2. The following response is taken from Attachment 1:

> Table 9-4 on page 28 of the report shows the maximum temperature reading recorded by the thermocouples during the 30 minute fire exposure period and during the cool down period following the pool fire. Figure 9-11 on page 34 shows the maximum temperature readings indicated by the temperature tags for the duration of the 30-minute fire exposure and cool down period. Temperature tags and post test thermocouple measurements are in agreement. Some of the labels delaminated from the cylinder and no temperature measurements were available.

CONTAINMENT

1. **Revise the test report to describe the details of the leak testing performed on the test packages. The description should describe how the containment boundary was tested (including both the valve and the plug connections). Include, as a minimum, the following information:**

A1. The following responses are taken from Attachment 1:

a. For the bubble test, describe how the package was pressurized.

A1a. The initial air pressure soap bubble leakage test performed on the 30B cylinder involved pressurizing the cylinder to 100 ± 1 psig using shop air via a fitting installed at the plug connection. All connections were then checked with a soap solution.

b. For the helium test, describe how the package was evacuated, and how the package was monitored for leakage of helium, and how the leakage rate was quantified.

A1b. The helium leak test was performed by evacuating the 30B cylinder with a ruffing vacuum pump via a fitting installed at the plug connection. The Veeco 7MS40 was connected to the 30B cylinder via the plug fitting. A plastic bag was placed over the plug fitting and flooded with helium to confirm that the fitting did not leak and establish the background helium leakage rate. The bag was then placed over the valve and flooded with helium. Following a minimum 10 minute period the helium leakage rate was recorded.

c. For the hydrostatic test, describe how the water in the package was pressurized.

A1c. The 30B cylinder was completely filled with water containing a fluorescent dye and pressurized to 100 ± 1 psig using shop air via a fitting installed at the plug connection.

2. **The maximum allowable leak rate for the package is calculated in Appendix 4.4.1 and 4.4.2, based upon release of UF6 from the package. Revise the application to specify the maximum allowable leak rate needed to exclude water under normal conditions of transport and hypothetical accident conditions. Revise the application to specify that the most restrictive of the two leak rates is used as the allowable value. Note that the criticality safety of the package relies upon exclusion of water from the containment system.**

A2. The criticality safety of the package is maintained in part by assuring the package is leaktight. A rigorous quality assurance program insures that package leakage is

maintained less than the maximum release rate specified for the package. Thus, the potential for water inleakage is very small. However, should inleakage occur, UF_6 reacts immediately and vigorously with water, producing considerable heat and UO_2F_2. The combined heat and UO_2F_2 will plug even sizable leaks, as demonstrated in practice throughout the industry. Since water inleakage events are immediately self-extinguished, the specified maximum leak rate based on normal and hypothetical accident conditions are the more restrictive criteria. This approach is consistent with published analyses for UF6 cylinders[1]. Sections 4.2.1 and 4.2.3 of the package application have been revised to include this information.

3. Revise the analyses in Appendix 4.4.1 and 4.4.2 to incorporate the methods in the revised ANSI N14.5 Standard (ANSI N14.5-1997). For example, equations for choked flow are not included in ANSI N14.5-1997.

A3. Appendices 4.4.1 and 4.4.2 have been revised to reflect ANSI N14.5-1997.

4. The calculations in Appendix 4.4.1 and 4.4.2 assume a radioactivity concentration of $1150A_2/1540$ kg UF_6. Revise the application to show that the radioactivity concentration would not exceed $1150A_2/1540$ kg UF_6 for the contents listed in Section 1.2.3.

A4. Appendices 4.4.1 and 4.4.2 have been revised to reflect ANSI N14.5-1997; therefore, this radioactivity concentration ($1150A_2/1540$ kg UF_6) is no longer used. The revised radioactivity concentration is provided in Appendix 4.4.1 and 4.4.2 and Section 1.2.3.

5. Section 4.2.3 states that prior to first use and at periodic intervals the cylinder is tested using a pressurized soap bubble leak test. Revise this section to clarify the leak rate sensitivity of this test, and show that it satisfies ANSI N14.5.

A5. Section 4.2.3 has been revised to clarify the leak rate sensitivity of the pressurized soap bubble leak test and to show that this test satisfies ANSI N14.5.

6. It is not clear that the plug end of the cylinder was leak tested. The application states that helium was introduced into the region surrounding the valve. Revise the application to show that the UF6 cylinder remains leak tight.

A6. The complete 30B cylinder and all fittings, including the valve and plug connection, remained leaktight after the initial leakage tests and after post-fire helium and hydrostatic leak tests.

7. The application states that prior to leak testing the test package, the valve was torqued to 300 ft-lbs. Justify that if the valve had been torqued to 200 ft-lbs, the minimum allowed in ANSI N14.1-1987, the cylinder would reliably preclude inleakage of water. In addition, show that valve installation procedure for the

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[1] Broadhead, B., Criticality Safety Review of 2 1/2-, 10- and 14-ton UF6 Cylinders," ORNL/TM-11947.

hypothetical accident condition tests is representative of the procedure performed on a cylinder normally in service.

A7. The only reference to a 300 ft-lb torque is in ESP's report of testing located in Appendix 2.10.8, *Compliance Testing of the ESP-30X Package.* In 2.10.8.5, we state that, "... the valves were tightened to a minimum torque of 300 ft-lbs..." That is a typographical error.

OPERATING PROCEDURES

1. Revise the application to describe the leak testing that will be performed on the loaded cylinder prior to each shipment. Show that the leak testing satisfies ANSI N14.5, including the minimum test sensitivity.

A1. Section 7.1.2.b(ii) and 7.1.3.d have been added to describe the leak testing and minimum test sensitivity per ANSI N14.5.

2. Revise the application to include a contamination survey prior to each shipment.

A2. *Procedures for Loading the ESP-30X Overpack* (Section 7.1.6.7) has been revised to state, "Complete radiation and surface contamination survey in accordance with 10 CFR 71.87 (i.) and (j)."

3. Revise the application to address the requirements of 10 CFR 71.87.

A3. Section 7 has been revised to address the requirements of 10 CFR 71.87. Specifically, these requirements are addressed as follows:

10 CFR 71.87 (a): The package is proper for the contents to be shipped;
A(a): Section 7.1.2.a & 7.1.3.a
(b): The package is in unimpaired physical condition except for superficial defects such as marks and dents;
A(b): Section 7.1.2.b & 7.1.5.a,b,c,e,h
(c): Each closure device of the packaging, including any required gasket, is properly installed and secured and free of defects;
A(c.) Section 7.1.2.b & 7.1.5.d,h
(d): Any system for containing liquid is adequately sealed and has adequate space or other specified provision for expansion of the liquid;
A(d): Section 7.1.2.b & 7.1.3.d
(e): Any pressure relief device is operable and set in accordance with written procedures;
A(e): Not applicable
(f): The package has been loaded and closed in accordance with written procedures;
A(f): Section 7.1.6
(g): For fissile material, any moderator or neutron absorber, if required, is present and in proper condition;
A(g): Not applicable
(h): Any structural part of the package that could be used to lift or tie down the package during transport is rendered inoperable for that purpose, unless it satisfies the design requirements of Sec. 71.45;
A(h): Not applicable

(i): The level of non-fixed (removable) radioactive contamination on the external surfaces of each package offered for shipment is as low as reasonably achievable, and within the limits specified in DOT regulations in 49 CFR 173.443;

A(i.): Section 7.1.6.7 & 7.3.2

(j): External radiation levels around the package and around the vehicle, if applicable, will not exceed the limits specified in Sec. 71.43(g) at any time during transportation; and

A(j): Section 7.1.6.7 & 7.3.2

(k): Accessible package surface temperatures will not exceed the limits specified in Sec. 71.43(g) at any time during transportation.

A(k): Section 7.1.6.9

MAINTENANCE PROCEDURES AND ACCEPTANCE TESTS

1. **Revise the application to describe the leak testing performed on the containment system prior to first use of each packaging and periodically. Show that the leak testing satisfies ANSI N14.5, including minimum test sensitivity.**

A1. Additional requirements for Type B acceptance tests (Section 8.1.3) and maintenance (8.2.3) have been added to describe the leak testing and minimum test sensitivity per ANSI N14.5.

2. **Revise the application to specify that the carbon steel components are inspected prior to each shipment to assure that they are free from corrosion, pitting, pinholes, or other defects.**

A2. Pre-shipment acceptance tests (Section 8.2.1.1) have been added to satisfy this requirement.

GENERAL

Note the statement on page 4 of Appendix 2.10.9 that all test activities were controlled under the Southwest Research Institute's Nuclear Quality Assurance (QA) program manual. We have no record that shows that Southwest Research Institute has an approved Part 71 QA program. Show that the tests were conducted under an approved QA organization as specified in Subpart H of 10 CFR Part 71.

The test and quality assurance procedures were written by SwRI and the test activities were monitored by SwRI QA personnel. However, all procedures and activities were approved and witnessed by ESP personnel under ESP's NRC Approved Quality Assurance Program No. 0179, which meets the requirements of 10 CFR Part 71 Subpart H (see Attachment 1).

ATTACHMENT 2

The Southwest Research Institute (SwRI) Response

SOUTHWEST RESEARCH INSTITUTE

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July 20, 1999

Ms. Heather Little
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RE: ESP letter dated May 4, 1999 and SwRI Final Report No. 01-1680a

Dear Ms. Little:

This letter is provided in response to the U.S. Nuclear Regulatory Commission (NRC) questions regarding ESP's license application for the ESP-30X over pack. Each of the items listed in your letter is addressed and supporting documentation is attached to this letter.

STRUCTURAL No. 1:

The initial air pressure soap bubble leakage test performed on the ESP-30X, SN 002 (30B cylinder identified as CB-1871-7) on March 11, 1999 resulted in a leak being detected at the valve. Inspection of the valve found the torque to be 110 ft-lb instead of 200-400 ft-lb recommended in the installation procedure. A custom made valve tool was used to turn the valve one full turn tighter with a maximum torque of 215 ft-lb, just slightly above the minimum torque requirement. The air pressure soap bubble leakage test was repeated and no leaks were detected. Subsequent helium and hydrostatic leakage tests were successful. See QA Surveillance Report 98-SR-050 for Project No. 01-1680-101(attached).

Page D-1 of Appendix D of the referenced report records leakage test results for a completely different package, identified as OPM-1, SN 002, which was tested with the ESP-30X but is not part of the application for ESP-30X package design. ESP-30X, SN 002 (30B cylinder, CB-1871-7) was not fire tested.

STRUCTURAL No. 5:

Item a:

Following the successful post-fire helium leakage test on the 30B cylinder (identified as CB-1871-2, ESP-30X SN001), the hydrostatic test was initiated. As stated on pages 16 and D1 of the referenced report, at 10:40 a.m. on March 24, 1999, the 30B cylinder was completely filled with water containing a flourescent dye and pressurized to 20 psig. At 8:47 a.m. on March 25, 1999 the internal pressure was noted to be 13 psig and the 30B cylinder was inspected for leaks. There were no visible traces of leaks from any of the openings, which would have been evident from the flourescent dye. The drop in pressure was attributed to the drop in temperature of the cylinder and contents.

The drop in pressure is directly proportional to the change in temperature. Assume the initial condition was that the 30B cylinder was filled with steel short at 150°F. Cold water (containing a flourescent dye) was poured into the 30B cylinder and the pressure was set to 20 psig. The 30B cylinder and contents cooled to 70°F. This alone would account for a pressure drop of about 4 psig.

Item b:

The over pack marked as ESP-30X SN002 with 30B cylinder marked CB-1871-7 was subjected to leakage and drop tests only (refer to Attachment 2). Following all drop tests each over pack was inspected for damage and ESP-30X SN 001 was selected for the pool fire tests.

Item c:

Table 9-3 of *Southwest Research Institute Performance Evaluation Of UF6 Shipping Containers Under Hypothetical Accident Conditions Specified In Title 10 CFR Part 71.73* (Appendix 2.10.9) stated at 30 min, "Flames subsiding. Residual burning allowed to self extinguish." This statement was not meant to imply that the package was not fully engulfed at 30 min. Review of the video tape and test data indicates that the package was fully engulfed for 30 min.

Item d:

Refer to Figure 2 for calibration certificate for Veeco Mass Spectrometer Leak Detector Model 7MS40.

Item e:

SwRI received preliminary drawings of the test articles for test item preparation purposes prior to conducting the test program and completing the final report. ESP can provide the final detail drawings and comments concerning any differences between the test article and the final package design.

Item f:

Following the successful fire test, the 30B cylinder (CB-1871-2) was removed from the over pack, pressurized with shop air at 100± 1 psig and the soap bubble leak test was performed. The soap bubble leak test was repeated several times over the next 22 min and no leakage was detected. At the conclusion of the soap bubble leak test the internal pressure reading was 99 psig. Furthermore, subsequent helium leakage test results determined no leakage at any connections on the cylinder.

Item g:

Appendix D, page D-1 refers to a different design package (OPM-1, SN.002) which was tested but is not part of the application for ESP-30X package design. The ESP-30X SN 002 with 30B cylinder CB-1871-7 was not subjected to the fire test.

Item h:

The initial air pressure and soap bubble leak test on the ESP-30X, SN 002 was performed on March 11, 1998 and resulted in a leak being detected at the valve. Inspection of the valve found the torque to be 110 ft-lb, well below the recommended value of 200-400 ft-lb. A custom made valve tool was used to turn the valve 1 full turn tighter with a maximum torque of 215 ft-lb. The air pressure and soap bubble leak test was repeated and no leaks were detected. See QA Surveillance Report 98-SR-050 for Project No. 01-1680-101(attached). Subsequent leakage tests resulted in no leakage.

leak test was repeated and no leaks were detected. See QA Surveillance Report 98-SR-050 for Project No. 01-1680-101(attached). Subsequent leakage tests resulted in no leakage.

THERMAL No. 2:

Table 9 - 4 on page 28 of the report shows the maximum temperature reading recorded by the thermocouples during the 30-min fire exposure period and during the cool down period following the pool fire. Figure 9-11 on page 34 shows the maximum temperature readings indicated by the temperature tags for the duration of the 30-min fire exposure and cool down period. Temperature tags and post test thermocouple measurements are in agreement. Some of the labels delaminated from the cylinder and no temperature measurements were available.

CONTAINMENT No. 1:

a. The initial air pressure soap bubble leakage test performed on the 30B cylinder involved pressurizing the cylinder to 100 psig using shop air via a fitting installed at the plug connection. All connections were then checked with a soap solution.

b. The helium leak test was performed by evacuating the 30B cylinder with a ruffing vacuum pump via a fitting installed at the plug connection. The Veeco 7MS40 was connected to the 30B cylinder via the plug fitting. A plastic bag was placed over the plug fitting and flooded with helium to confirm that the fitting did not leak and establish the background helium leakage rate. The bag was then placed over the valve and flooded with helium. Following a minimum 10-min period the helium leakage rate was recorded.

c. The 30B cylinder was completely filled with water containing a flourescent dye and pressurized to 100 psig using shop air via a fitting installed at the plug connection.

CONTAINMENT No. 6:

The complete 30B cylinder and all fittings, including the valve and plug connection, remained leaktight after the initial leakage tests and after post-fire helium and hydrostatic leak tests.

GENERAL:

Section 4.0 of *Southwest Research Institute Performance Evaluation Of UF6 Shipping Containers Under Hypothetical Accident Conditions Specified In Title 10 CFR Part 71.73* (Appendix 2.10.9) should be revised as follows:

> All test and quality assurance procedures were written under Southwest Research Institute's Nuclear Quality Assurance Program Manual (NQAPM) and/or the Department of Fire Technology Quality Assurance Manual (DFTQAM). All test procedures and activities were approved under ESP's NRC Approved Quality Assurance Program (Certificate No. 0179), which meets the requirements of Title 10 CFR 71, Subpart H, and monitored by ESP personnel. The NQAPM and DFTQAM meet the requirements of Title 10 CFR 50, Appendix B. SwRI prepared a Project Quality Plan (PQP) Document No. NPQP-98-01-1680, which identified the specific sections of the NQAPM or DFTQAM which apply, and addressed specific requirements identified in the contract. SwRI Quality Assurance/Quality Control (QA/QC) personnel provided independent surveillance, quality checks, and inspections during the course of this program.

I trust that this information will be sufficient. Please feel free to contact me at (210)522-3716 or reach me by fax at (210)522-3377, or e-mail at jgriffith@swri.org if I can be of further assistance.

It has been my pleasure to work with you and I am looking forward to our next project.

Best regards,

James R. Griffith, Jr., P.E., FPE
Assistant Manager
Fire Resistance Section

Approved:

Alex B. Wenzel
Director
Department of Fire Technology

JRG/jrt
W:\fire\Jessica\eco-pacesp.ltr

Enclosures: Figure 1
Figure 2
Attachment 1
Attachment 2

CLIENT: ECO-PAK SPECIALTY PACKAGING
SwRI PROJECT No.: 01-1680-102
DATE: 21 MARCH 1998
FILE ID: 08030SXT.DAT

ESP-30X PACKAGE
AVERAGE FIRE TEMPERATURE

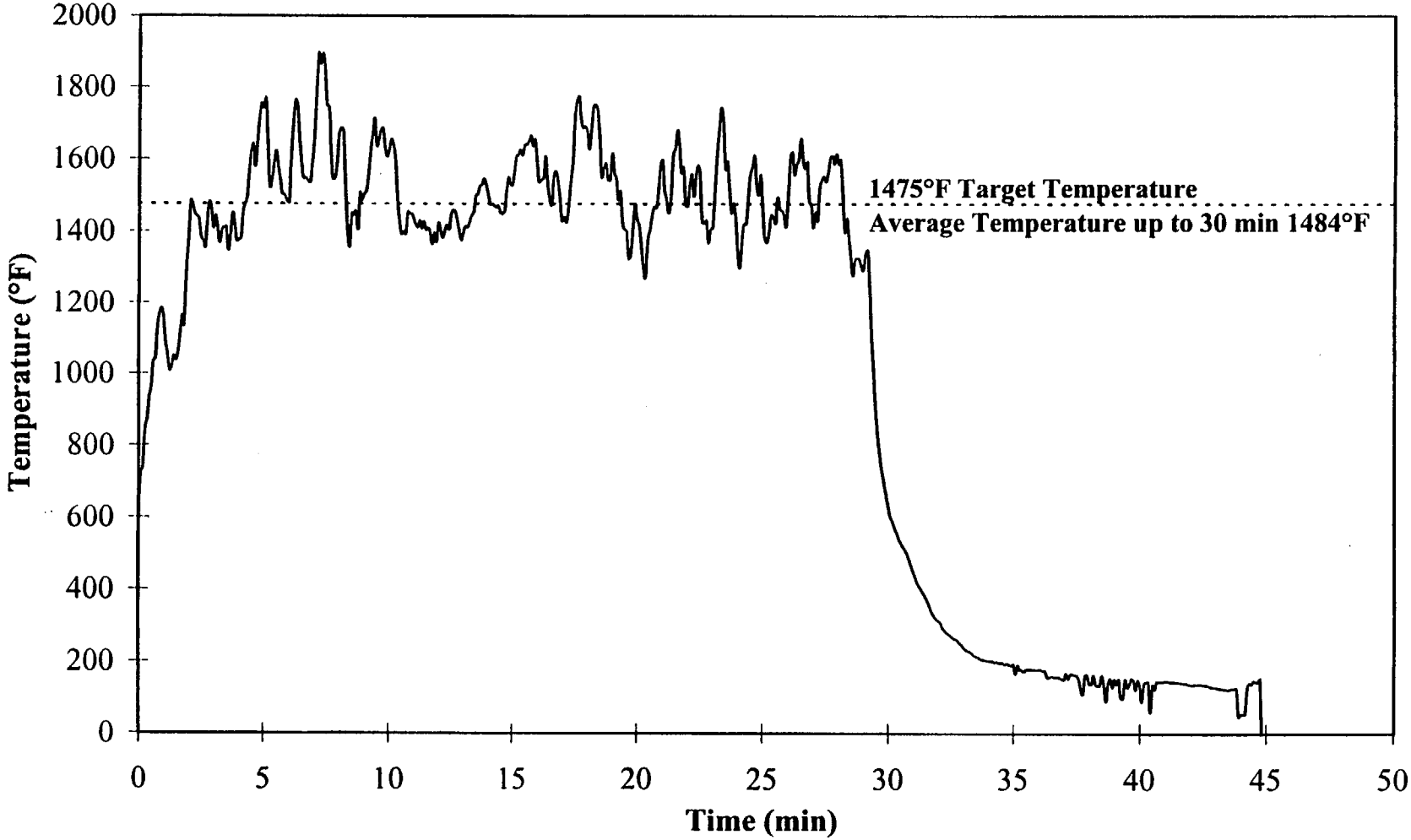

Figure 1

Terminal Drive, Plainview, NY 11803 516-349-4300 • Fax 516-349-7009

Veeco Instruments Inc.

CALIBRATION CERTIFICATE

incompliance with
ANSI/NCSL Z540-1-1994
ISO-10012-1:1992E

Veeco Instruments Inc. certifies the calibrated leak referenced below is accurate in accordance with measurement technique that compares, through the use of a Veeco Mass Spectrometer Leak Detector, each unit against a primary standard, serial number 0001* and / or 0003*. These standards are certified and calibrated by the National Institute of Standards and Technology (NIST). The reference Mass Spectrometer Leak Detector is continuously calibrated and becomes the instrument used to certify the Calibrated Leak. This instrument is maintained and calibrated in accordance with Veeco Standard Calibration Procedure for Helium Calibrators CP001-MS Rev. A.

We recommend the Calibrated Leak be returned to Veeco Instruments Inc. for recalibration annually.

NOTE: Calibrated Leaks should be stored and shipped with valve open.

MODEL: 7MS40 SERIAL NO: 0555

CAL DATE: 03/28/1997 CERTIFICATION NO: I.367607

The above sensitivity calibrator has been calibrated as of this date with the following results:

Helium Leak Rate:

0.0035 ± 10% Microm cu.ft/hr.
1.5 x 10⁻⁴ ± 10% Std. cc/sec.

Air Leak Rate Through Equivalent Leak:

0.0013 ± 10% Microm cu.ft/hr.
1.3 x 10⁻⁴ ± 10% Std. cc/sec.

Calibration Temperature: 22 °C

Temperature Coefficient = ± 3% per degree C Leak rate decreases less than 5% per year

Final Inspection By: _____
(Calibration Laboratory Technician)

This certificate shall not be reproduced except in full, without the written approval of Veeco Instruments Inc.

* NIST Test Number 251729-94R T144 In NIST Test Number: 253367-97 T140

Eco-Pak Specialty Packaging

SwRI Project No. 01-1680b

Figure 2

ATTACHMENT 1

INSTITUTE QUALITY ASSURANCE SURVEILLANCE REPORT

Project No.: 01-1680-101	Report No.: 98-SR-050	Page 1 of 5

Surveillance Scope:
Witness testing activities at SwRI and off-site for EcoPak

Reference Documents: NQAPM, Contract

Starting Date: March 11, 1998 **Ending Date:** Arpil 2, 1998

QA Representative: Kenneth R. Jones

Person(s) Conducting Test/Exam/Procedure: 01 - Jim Griffith and others, client reps
04 - Dan Pommerening and others, client reps

Satisfactory Findings:
Tests conducted in accordance with procedures using qualified personnel. Drop tests conducted on the drop pad behind building 128. Leak tests conducted in Firetech labs. Pool fires conducted off-site. At all times, qualified personnel were performing tests or handling test items. Calibrated equipment verified prior to testing. All calibrated equipment listed in test logs and test report.

Reference the attached surveillance logs.

Unsatisfactory Findings:

None

Nonconformance Report No.: None **CAR/SCAR No.:** None

Attachments: Surveillance log sheets.

Recommendations/Actions: None

Equipment Calibration: As listed in logs and test report.

Approved: R. Wh
Institute Quality Assurance

Date: 4/20/98

Distribution: Original - QA File
cc: Originator
Jim Griffith (01)
Dan Pommerening (04)

RECEIVED
APR 2 0 1998
DEPT. FIRE TECHNOLOGY

SwRI Form QA-125-1c

98-SR-50

SURVEILANCE LOG

	ECO-PAK 01-1680-101
3-11-98	WITNESS INITIAL PRESSURIZATION (AIR) OF ESP-30X
	S/N 001 + 002. TANK 002 LEAKED DURING
	THIS STEP.
	BEGAN VACUUM FOR HELIUM LEAK TEST
	OF TANK 001.
	ON ANALYSIS OF TANK 002 FOUND TORQUE
	OF VALVE TO BE 110 FT LBS INSTEAD OF
	200-400 FT LBS AS REQUIRED. TURNED
	VALVE ONE FULL TURN TIGHTER AND
	ACHIVED 215 FT LBS TORQUE. PRESSURIZATION
	TO 100 PSI PASSED.
	TANK 001 PASSED He TEST. TANK 002
	LEFT TO VACUUM OVER NIGHT.
3-12-98	TANK 10 PASSES He TEST. ~~IN~~
	INSPECTED THERMOCOUPLE INSTALLATION
	ON TANK 001, MONITOR INSTALLATION
	ONTO TANK 002.
	WITNESSED HELIUM LEAK TEST ON
	OPM-1 ~~TANK S/N 002~~ SYSTEM S/N 002.
	ALL FOUR TANKS REMOVED FOR He TEST.
	DATA RECORDED.
3-13-98	MEASURED STRING TO BE USED IN DROP
	TEST.

98-SR-50

SURVEILANCE LOG 3

3-13-98	MONITORED INSTALLATION OF T/C's
	ON OPM 1 S/N 002 AND REASSEMBLY.
3-16-98	WITNESS 30 FT DROP TEST + 1 METER
	PUNCTURE TEST AT 13° FROM VERTICLE ON
	ESP 30X S/N 001.
3-17-98	ESP 30X S/N 002. WITNESS DROP TEST FROM
	30' AT 30° FROM VERTICLE AND W/ 5° TWIST.
	ALSO 1 METER PUNCTURE TEST FROM HORIZONTAL
	ONTO SEAM.
	ESP 30X S/N 001. DROP TEST FROM 1 METER IN
	HORIZONTAL POSITION ONTO BARE SURFACE.
	(PUNCTURE TEST).
	NOTE THAT BOTH UNITS HAD BEEN PRE-
	CONDITIONED TO -30°C PRIOR TO ALL DROPS.
	OPM-1 S/N 002 REMOVED FROM CONDITIONING.
	WITNESS 30' DROP FLAT BOTTOM, 30' ONE
	TOP CORNER, 30' ONE TOP EDGE, 1 METER
	PUNCTURE.
	OPM-1 S/N 001 REMOVED FROM CONDITIONING.
	WITNESS 30' DROP ONE TOP EDGE, ONE
	1 METER PUNCTURE.

SURVEILANCE LOG	#
3-18	REMOVE COVER ON ESP 30X S/N 002.
	REMOVE TANK AND PERFORM 100 PSI PRESSURE
	TEST. BEGIN PUMP DOWN FOR HELIUM
	LEAK TEST.
	REMOVE COVERS FROM OPM 1 S/N 001.
	NOTE COVERS JAMMED FROM WARPING
	CAUSED BY DROPS. REMOVED CYLINDERS
	AND PERFORMED VISUAL INSPECTION.
3-19	PERFORM HELIUM LEAK TEST ON
	ESP 30X S/N 002
3-20	PERFORM POOL FIRE TEST ON OPM-1 S/N 002
3-21	PERFORM POOL FIRE TEST ON ESP-30X S/N 001
3-23	OPEN ESP-30X S/N 001 POST FIRE TEST. REMOVE
	CYLINDER. PERFORM PRESSURE TEST. START
	PUMP DOWN FOR HELIUM LEAK TEST.
3-24	PERFORM HELIUM LEAK TEST. START
	SOAK UNDER PRESSURE FOR HYDRO TEST.
	OPEN OPM-1 S/N 002 POST FIRE TEST.
	REMOVE CYLINDERS. HELIUM LEAK
	TEST. NOTE 2 OF 4 CYLINDERS FAIL.
3-25	VERIFY HYDRO. NO LEAKS.

SURVEILANCE LOG

3-25	DRILL + TAP LIDS ON 4 OPM CYLINDERS.
	HELIUM LEAK # 1 + 4.
	OPEN #1 TO LOOK AT O-RINGS.
3-26	HELIUM LEAK #2+3.
	NOTE #3 WOULD NOT HOLD VACUUM.
4-2	PERFORM POOL FIRE TEST OF OPM-1 S/N 001

ATTACHMENT 2

Test Results for ESP-30X SN 002/30B Cylinder CB-1871-7

ESP-30X SN 002/30B Cylinder No. CB-1871-7 Test Results

Sections 1.0 - 8.3 are equivalent to the original test report, *Southwest Research Institute Performance Evaluation Of UF6 Shipping Containers Under Hypothetical Accident Conditions Specified In Title 10 CFR Part 71.73* (Appendix 2.10.9). Section 8.4 is not applicable, since ESP-30X SN 001 was selected for the thermal test.

1.0 TEST RESULTS

1.1 Leakage and Hydrostatic Test Results

Initial soap bubble and helium leakage tests were performed on the 30B cylinder prior to conducting the drop tests and following completion of the pool fire exposure test. The preliminary soap bubble test was performed at 3:30 pm on March 11, 1998. For this test, the 30B cylinder was pressurized to 100 psi, and the soap bubble indicator fluid was directed to the region surrounding the valve assembly and monitored for signs of leakage. A leak was immediately detected. The acceptance criteria specified that any leakage greater than 1.0×10^{-7} std cc/sec of air is considered a failure. We checked the torque and found it to be low (110 ft-lbs), tightened the valve one full turn and met the minimum (215 ft-lbs) torque requirement.

The pre-drop helium leakage test was performed on March 12, 1998. At 4:37 pm on March 11, 1998 we started to evacuate the 30B cylinder with a ruffing vacuum pump to the required pressure of less than 1×10^{-3} atm (1×10^{-3} atm = .0147 psi = .761 Torr). At 8:40 am on March 12, the test port pressure was 76-81 MT. Leak rate background was 1.7×10^{-9} atm cc/sec. The helium flow into the mylar bag taped around the valve was started at 8:47 am, and at 8:50 am, the leak rate was 1.7×10^{-9} atm cc/sec.

Following completion of the drop testing on March 17, 1998, final post-drop soap bubble and helium leakage tests were performed on the 30B cylinder. The preliminary soap bubble test was performed March 18, 1998. The 30B cylinder was pressurized to 100 psi at 2:44 pm; and the soap bubble indicator fluid was directed to the valve assembly and monitored for signs of leakage. At 3:10 pm, no leakage was detected.

The post-drop helium leakage test was performed on March 19,1998. At 3:36 pm on March 18, a ruffing vacuum pump was used to evacuate the 30B cylinder to the required pressure, and the background helium leakage rate at 8:58 am on March 19 was 8.3×10.6^{-9} atm cc/sec, test port pressure 65-70MT. At 9:02 am, helium flow into the bag started. At 9:22 the rate was 8.2×10^{-9} atm cc/sec.

Following successful completion of the post-drop helium leakage test, the 30B cylinder was filled with water containing fluorescent indicator dye. The test item was placed horizontally with the valve in the 6 o'clock position. The plug opposite the valve end was replaced with a port allowing for pressurization of the 30B cylinder to approximately 20 psig. At 4:38 pm, the pressure was allowed to stabilize at 20 psi, and we started the hold period. At 8:30 am on March 20, tank pressure was 16 psi and there were no signs of leakage which would have been indicated by the dye.

Table 1.1 summarizes results for the pre-drop/post-drop preliminary soap bubble tests, pre-drop/post-drop helium leak tests, and post-drop hydrostatic leakage test. Data log sheets for all leakage and hydrostatic tests are found in Appendix D.

Table 1.1. Leakage and Hydrostatic Test Results

Test Item: ESP-30X, SN002 30B Cylinder, CB-1871-7

TEST PERFORMED	REQUIREMENT	MEASUREMENT	PASS/FAIL
Pre-Drop Soap Bubble	No Leaks	No Leaks	Pass
Pre-Drop Helium	$<1.0 \times 10^{-7}$ std cc/sec	1.7×10^{-9} std cc/sec	Pass
Post-Drop Soap Bubble	No Leaks	No Leaks	Pass
Post-Drop Helium	$< 1.0 \times 10^{-7}$ std cc/sec	8.2×10^{-9} std cc/sec	Pass
Post-Drop Hydrostatic	No Leaks	No Leaks	Pass

1.2 Drop Testing

The testing outlined in this section was designed to demonstrate the performance of the shipping configurations under hypothetical accident conditions.

The drop testing included the following major steps:

1. Conditioning to -20°F of ESP-30X SN002
2. 30 foot drop test of SN002 at 30° from horizontal on end closure bolt.
3. Physical inspections of over pack.
4. 40-in. puncture test of SN002 on center closure bolt.
5. Physical inspections of over pack.

Test facilities utilized for performance of the work under this project were adequate to accomplish the objectives of the project.

1.2.1 Assumptions

A basic assumption made for this testing was that the drops made are the worst case condition as required by 10 CFR Part 71.

1.2.2 Environmental Conditioning

The low temperature conditioning was done in a chamber to achieve the required test item temperature, -20°F (-29°C) on the over pack insulation. To measure this temperature a 2-in. deep hole was drilled in the over pack and a thermocouple installed. The thermocouple hole was sealed with RTV to prevent air infiltration. To accelerate cooling, the air temperature in the chamber was varied. A target air temperature was -40°F the minimum transportation temperature as defined in ANSI N14.1. In some cases the air temperature was set lower than this to accelerate the cooling. Because of the thermal mass and insulation of the test item, its response to changes in the air temperature was slow.

Conditioning was performed until the test item had reached the required temperature. During the testing process, which included: removal from the conditioning chamber, drop angle adjustments, drops, and physical inspection, the test item temperature rose. When not being tested, the test item was returned to the chamber to stabilize the temperature. This low temperature conditioning met the intent of the low temperature requirements of 10 CFR Part 71.

Plots of the chamber air temperature and test item temperatures are included in this report as Figure 6-1. Low temperature conditioning of the ESP-30X test items was started on March 13, 1998 at 13:28 p.m., Figure 2. During the first 24 hours of conditioning the chamber air temperature was set to a nominal

-40°C. At this time the test item temperatures were close to the required levels. To insure that they did not get too low the chamber temperature was raised to -30°C for the rest of the weekend. Sunday, March 15 at 16:30 p.m., the liquid nitrogen supply ran out. Since this occurred late in the day on Sunday it was not corrected until early Monday morning, March 16 at 6:07 a.m. During this time the chamber and test item temperatures rose. On Monday morning Dewars were connected to the chamber and the air temperature set to -40°C. These Dewars were used until the large tank was refilled and connected March 16 at 11:46 p.m. At that time the air temperature was set to -50°C, to try and drive the test item temperatures down to the required levels prior to testing.

On removal of ESP-30X SN001, which had a temperature of -31°C (-23°F) from the chamber March 16 at 13:31 p.m. the air temperature was set back to -40°C. Drop testing was performed on SN001 and it was returned to the chamber for additional conditioning over night. When placed back in the chamber the insulation temperature was -8°C (17°F). The temperature had risen 23°C during the 1 hr and 45 min of testing, about 1°C every 5 min.

Upon removal of ESP-30X SN002, with an insulation temperature of -34°C (-30°F), for drop testing March 17 at 7:39 a.m., the air temperature was reset to -30°C. At this time the two OPM-1 shipping containers were placed in the chamber and the temperature reset to -50°C. At 9:05 a.m. it was again reset to -60°C, in an attempt to quickly bring the OPM-1 containers down to the required temperature. ESP-30X SN002 was subject to two drops as required and not returned to the test chamber. ESP personnel considered testing of this item complete after the two drops.

At 9:38 a.m. ESP-30X SN001, which had an insulation temperature of -34°C (-30°F), was removed from the chamber. This was prior to the final puncture test on this test item, as specified by ESP personnel.

It was possible to keep the temperature at or below -20°F (-29°C) before the drop.

1.2.3 Drop Testing

Drop testing of the ESP-30X SN002 was performed on March 17, 1998. Immediately before opening the chamber, the test item temperature was -29°F (-34°C). Two tests were performed on ESP-30X SN002. The first was a 30-foot drop onto the fiat surface of the pad. The orientation of the test item, 30° from horizontal with a 5° rotation, with the impact at the forward closure bolt location, Figure 9. The damage to the over pack exterior was measured and recorded following this testing. The second was a 40-in. drop onto a puncture bar attached to the center of the steel plate. The orientation of the test item, horizontal with a 5° rotation, with the impact at the center closure bolt location, Figure 12. The damage to the over pack exterior was measured and recorded following this testing.

The testing performed on this test item is given in Table 1.2. All testing was completed.

Table 1.2 ESP-30X SN002 Testing Performed

Procedure	Dates	Comments
Conditioning Before Drop	3/13/98 3/17/98	-30°F on Over pack Insulation at End of Conditioning
30-ft Drop	3/17/98	Good Drop; 30° with 5° Rotation
Exterior Physical Measurements	3/17/98	By Division 01 Personnel
40-in. Puncture	3/17/98	Good Drop; Horizontal with 5° Rotation
Exterior Physical Measurements	3/17/98	By Division 01 Personnel

This drop testing was performed with the cooled and undamaged ESP-30X over pack. After low temperature conditioning, the test item was removed from the chamber and a wire rope sling was attached to the over pack to orient the test item for drops. The longitudinal axis of the package was at 30° from horizontal with a 5° rotation of the seam between the upper and lower halves of the over pack, Figure 9. This drop was to impact the closure bolt at one end of the test item and then slap-down onto the closure bolt on the opposite end.

The test item was then raised to the required drop height with the crane. The drop height was determined using the calibrated plumb bob attached to the first impact point on the test item. The release of the test item was by a pneumatically actuated quick-release mechanism. No guidance of the test item was provided during the drop. Drop testing was performed under conditions that did not affect the results of the test. The average wind speed was noted, and found to be sufficiently low so that the packaging did not rotate during testing.

For this drop the pre-test conditions were:

- Drop Angle — 30° from horizontal with a 5° rotation
- Drop Height — 30 feet at impact closure bolt
- Wind Speed — Acceptable

The test item was released cleanly and impacted the pad at the desired orientation. The test item impacted the drop pad and remained on its side. Videos were taken of the drop event. The condition of the over pack can be seen in Figures 9 to 11. As a result of the drop, the exterior of the over pack was damaged. Deformation data of the over packs was measured and recorded by Division 01 personnel. Color photographs showing the extent of damage were taken. The over pack was not opened after this test. All phases of this testing were witnessed by SwRI QA/QC and ESP personnel.

The loaded ESP-30X package was then dropped 40 in. onto a cylindrical 6-in. mild steel bar mounted on the unyielding surface. For this drop, the longitudinal axis of the package was horizontal with a 5° rotation with the seam between the upper and lower halves of the over pack. Figure 12 illustrates the package orientation. This orientation was to drive the puncture bar into a specified closure bolt and try and open the two halves of the over pack.

For this drop, the pre-test conditions were:

- Drop Angle — Horizontal with a 5° rotation
- Drop Height — 40 in. to closure bolt
- Wind Speed — Acceptable

The test item was released cleanly and the drop was made, Figure 12, with the impact in the proper location. Videos were taken of the drop event. Following the drop, the over pack was on its top and half off the drop pad. Deformation of the over pack was measured and recorded by Division 01 personnel. Color photographs showing the extent of damage were taken.

There was damage to the ESP-30X over pack as a result of this testing. The seam between the upper and lower halves of the over pack did not open noticeably. ESP personnel judged the performance of the test item.

2.0 SUMMARY OF TEST RESULTS

The test items were conditioned to the required -20°F before drop testing. The temperature considered was that of the insulation in the end of the over pack.

The free fall drops were completed successfully. Drops included 30 feet onto the impact surface and 40 in. onto the puncture bar. The wind speed was such that it did not adversely affect the fall of the test item. Video of the drops was obtained. Post test inspection indicated deformation of the over pack.

Test ESP-30X (SN 002)

- The test item was conditioned to -20°F before drop testing.
- All drop tests were completed successfully.
- The closures on the over pack functioned properly during the drops.
- Drops resulted in deformation of the over packs.
- Damage to the closure bolts was noted.

Performance of the test items was judged by ESP personnel.