TABLE OF CONTENTS

LIST OF TABLES

8.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

8.1 ACCEPTANCE TESTS

Per the requirements of 10CFR71.85, [1] this section discusses the inspections and acceptance tests to be performed prior to first use of the Traveller package.

8.1.1 Visual Inspections and Measurements

All Traveller packaging materials of construction and welds shall be examined in accordance with the requirements delineated in Table 2-2 of Section 2.

The Traveller STD, Traveller XL, and Traveller VVER packages have manufacturing drawings that are controlled within a quality assurance program. The drawings have quality control characteristics that must be inspected during the process. Source inspection and final release of the package will be performed by Westinghouse to verify the quality characteristics were inspected and that the package is acceptable. Any characteristic that is out of specification must be reported. It will then be dispositioned according to Westinghouse procedure.

8.1.2 Weld Examinations

All Traveller welds shall be examined to verify conformance with all applicable codes, standards and notes on each applicable drawing or specification.

8.1.3 Structural Tests

The Traveller packaging contains hoist rings, which require acceptance inspection.

8.1.4 Pressure Leak Tests

The Traveller packaging does not have any requirements for leak or pressure testing.

8.1.5 Component and Material Tests

8.1.5.1 Polyurethane Foam

The Traveller packaging utilizes a closed-cell, polyurethane foam and must be certified to meet the requirements and acceptance criteria for installation, inspection, and testing as defined in this section.

The finished foam product shall be greater than 85% closed cell polyurethane plastic foam of the self-extinguishing variety of the density specified. The closed cell configuration will ensure that the foam will not be susceptible to significant water absorption.

8.1.5.1.1 Density

Rigid polyurethane foam shall have a density per Table 8-1.

Table 8-1 Packaging Rigid Polyurethane Foam Density Requirements

Part	lb/ft^3 (pcf)
Endcap Impact Limiters	20.0 +/- 2.0
Outerpack Package Body	10.0 +/- 1.0
Inner Pillow Impact Limiters	6.0 +/- 1.0

Density shall be determined in accordance with ASTM D-1622 with the following exceptions:

a) A minimum of one specimen per pour shall be taken, distributed regularly throughout the batch.

b) Conditioning shall be 70°F to 80°F and 40% – 60% relative humidity for 12 hours minimum.

c) Test conditions shall be 70°F to 80°F and 30% – 70% relative humidity.

d) Length, width, and thickness measurements shall be made with a 6-inch digital or dial caliper.

e) Measurements shall be made and reported to the nearest 0.001 inches.

f) Density shall be reported in pounds per cubic foot (pcf) and no correction is made for the (negligible) buoyant effect of air.

g) The standard deviation of the three density determinations need not be calculated or reported.

8.1.5.1.2 Mechanical Properties

Exhibited foam compressive strength for 10% strain parallel to foam rise shall be determined in accordance with ASTM D-1621, with the exceptions noted below, and shall fall within the range of values presented in Table 8-2.

Table 8-2 Packaging Rigid Polyurethane Foam Property Compressive Strength Range

Part	Density (pcf)	Compressive Strength	
		Min	Max
Endcap Impact Limiters	20.0 +/- 2.0	888 psi	1332 psi
Outerpack Package Body	10.0 +/- 1.0	262 psi	393 psi
Inner Pillow Impact Limiters	6.0 +/- 1.0	132 psi	198 psi

a) Specimen shall be right rectangular prisms 1.0+/-0.1 inches thick x 2.0+/-0.1 inches x 2.0+/-0.1 inches with the 1.0+/-0.1 inch dimension parallel to the direction of foam rise.

b) A specimen from each batch shall be tested.

c) Conditioning shall be 70°F to 80°F and 40% – 60% relative humidity for 12 hours minimum.

d) Test conditions shall be 70°F to 80°F and 30% – 70% relative humidity.

e) Length, width, and thickness measurements shall be made with a 6-inch digital or dial caliper.

f) Measurements shall be made and reported to the nearest 0.001 inches.

g) Strain rate shall be 0.1 +/- 0.05 in/in – min.

h) Only actual values (not averages or standard deviations) need be reported.

8.1.5.1.3 Flame Retardant Characteristics

Flame retardant characteristics shall be qualified by demonstrating compliance with the following requirements. The requirements shall be demonstrated by flame testing described in FAA Powerplant Engineering Report No. 3A. Additional certification testing to validate the flame-retardant characteristics shall also be performed in accordance with ASTM F-501-93. The test described in b) below is not applicable to the 6 pcf foam.

a) Foam shall not be capable of sustaining a flame for a period greater than five (5) minutes, following the removal of the heat source and after being exposed to temperatures up to 1,500°F. A heat source with a flame temperature of at least 1,500°F is applied until the foam is ignited. The heat source is removed after ignition of the foam and the time until self-extinguishment of the flame (absence of flame) will be monitored and compared against the 5-minute acceptance criteria.

b) Prepare a representative sample of the foam material and test in accordance with the following:

   1) Cut two pieces of sheet metal (16 gauge maximum/25 gauge minimum) to a size sufficient to cover a 10 inch diameter test sample.

   2) Attach a thermocouple at the approximate center of one side of each piece of sheet metal.

   3) Prepare a representative sample of the foam material inside a 10-inch inner diameter by 6-inch long steel cylinder. Foam to fill the entire length of the cylinder and the full 10-inch diameter.

   4) Sandwich the sample between the two pieces of sheet metal, with the thermocouples in contact with the foam.

   5) Expose one end of the foam sample (sheet metal) to a heat source. Apply enough heat to

cause the indicated thermocouple temperature to increase from ambient temperature to 1,475°F minimum on the exposed side.

6) Hold the sample at a minimum of 1,475°F for a minimum period of thirty (30) minutes.

Acceptance criteria shall be as follows:

During the period that heat is applied, the thermocouple on the non-exposed end of the sample shall not exceed 180°F. The thermocouple on the back side (away from the flame) shall be isolated from the sheet metal to prevent heat from radiating from the metal instead of traversing the foam core. The thermocouple can be isolated using a piece of Nomex cloth or approved equivalent.

8.1.5.1.4 Thermal Properties

The foam shall exhibit the following nominal thermal characteristics for the 6 pcf, 10 pcf, and 20 pcf nominal density pours, minimum of three specimens per qualification:

a) Thermal Conductivity

Table 8-3 Packaging Rigid Polyurethane Foam Thermal Conductivity Properties

Part	**Thermal Conductivity** (Test Method – ASTM C-177 at 75°F mean temperature)	**Density (pcf)**	**k-factor** (BTU/Hr-ft^2-F/inch)
Endcap Impact Limiters	LAST-A-FOAM® FR-3706	6.0 +/- 1.0	0.240
Outerpack Package Body	LAST-A-FOAM® FR-3710	10.0 +/- 1.0	0.279
Endcap Impact Limiters	LAST-A-FOAM® FR-3720	20.0 +/- 2.0	0.376

b) Specific Heat

0.353 BTU/lb-°F (Test Method – ASTM E-1269)

8.1.5.1.5 Water Absorption Properties

The average water absorption by the foam observed through testing using ASTM D-2842, with the following testing exceptions, shall not be more than 5% by volume. The construction of the Traveller will further ensure that, in actual operation, significantly lower water absorption rate would be observed.

a) Length, width and thickness measurements shall be made with a digital or dial caliper.

b) Measurements shall be made and reported to the nearest 0.001 inches.

c) A single specimen of the qualifying material shall be molded to the density range as stated in the density chart above.

d) The specimen shall consist of a single 3.0 inches x 6.0 inches x 6.0 inches (tolerance on dimension is 0.5 inches) block of foam.

e) No correction shall be made for cut or open cells in the specimen's volume calculations.

8.1.5.1.6 Chemical Composition

The chemical composition of the foam shall be as follows:

C: 50% – 70%
O: 14% – 34%
N: 4% – 12%
H: 4% – 10%
P: 0% – 2%
Si: < 1%
Cl: < 1800 PPM
Leachable Chlorides: < 1 PPM
Other: < 1%

The foam will be a rigid polyether polyurethane formed as reaction product of the primary chemicals: polyphenylene, polymethylene, polyisocyanate (polymeric isocyanate) and polyoxypropylene glycols (polyether polyols). These materials react to produce a rigid, polyether, polyurethane foam. The foam will not contain halogen containing flame retardant or trichloromonoflouromethane (Freon 11).

Leachable chloride testing is required when using stainless steel as the container structure because free chloride ions in contact with the container sides have been faulted as a contributor to stress corrosion cracking. Leachable chlorides will not be greater than 1 ppm when tested in accordance with GP-TM9510: Method for Sample Preparation and Determination of Leachable Chlorides in Rigid Polyurethane Foam or EPA 300.0: Determination of Inorganic Anions by Ion Chromatography.

8.1.5.2 Neutron Absorber Plates

Neutron absorber plates are installed along the four faces of the Clamshell or six faces of the VVER Clamshell to meet the requirements specified in Section 6 of this document. The neutron absorber material, BORAL, is a hot-rolled composite aluminum sheet consisting of a core of uniformly distributed boron carbide and aluminum particles, which is enclosed within layers of pure aluminum forming a solid barrier against the environment. The plates are used to ensure subcriticality during transportation as a neutron absorber and are not relied upon for the conductivity or mechanical properties. The service conditions are not so severe as to promote significant alterations of these plates. Therefore, durability of these neutron absorbing materials is regarded to meet or exceed the service requirements of this application.

To ensure the BORAL meets the drawing requirements, the plates will be inspected on a periodic basis not to exceed five years per Section 8.2.5. This will ensure that the BORAL maintains its durability throughout its service lifetime. The visual inspection will verify that the plates are present and in good condition. This includes inspection of the BORAL core for chipping or flaking resulting from brittleness. There are no significant loads applied to the BORAL plates, therefore no durability problems should arise during normal conditions of transport.

No processing changes are anticipated for the production of BORAL since the established process will be used to produce the packages.

8.1.5.2.1 Boron-10 Areal Density

The BORAL neutron absorber plate minimum ^{10}B areal density for the final thickness of 0.125±0.006" is 0.024 gm/cm^2. Acceptance testing to ensure that the manufacturing process is operating in a satisfactory manner may be conducted using neutronics transmission or chemical analysis to ensure an effective minimum ^{10}B areal density of 0.024 gm/cm^2.

Neutron Transmittance is a neutron counting testing technique performed to determine the concentration of an isotope in a material. Testing involves placement of test coupons in a calibrated neutron source beam and measuring the number of neutrons allowed to pass through the test material. Based on the number of neutron count, the areal density of the coupon can be calculated and compared to certified standards. Chemical analysis is assay testing performed on a sample taken from test coupons to determine the boron content.

8.1.5.2.2 Neutron Absorption Testing Requirements

Neutron Transmittance testing shall be performed at thermal neutron energies per approved test method to verify the minimum required ^{10}B concentration. Test coupons are considered acceptable when the transmittance data indicates a ^{10}B areal density equal to or greater than 0.024 gm/cm^2. Statistical data on transmissivity may be coupled with luminescence test data to demonstrate uniformity of the boron material.

Neutron Radiograph testing shall be performed for each selected sample with a luminance test or approved equivalent to verify the uniformity of the ^{10}B distribution in the sheet at thermal neutron energies. Neutron Radiograph (luminance) testing is a non-destructive imaging technique for the internal evaluation of materials. It involves attenuation of a neutron beam by an object to be radiographed, and registration of the attenuation process (as an image) on film or video. Inspection results shall be recorded using the appropriate data recording method by the testing facility.

8.1.5.2.3 Chemical Testing Requirements

Chemical testing may be employed as an acceptable substitute to the neutronics testing to verify the minimum areal density of ^{10}B is present in the neutron absorber plate. Prior to ^{10}B verification by chemical testing, the process shall be demonstrated to be equivalent to the neutronics testing described with respect to ^{10}B uniformity and isotopic composition. Test coupons are considered acceptable when the calculated ^{10}B areal density is equal to or greater than is 0.024 gm/cm^2.

8.1.5.2.4 Sampling Rates and Test Methods

The inspection levels shall be as stipulated in the supplier submitted process specification(s). Test methods, when not referenced herein, shall be reviewed by Westinghouse Engineering. Sample coupons shall be randomly selected and be representative of the configuration, material, and lot being evaluated.

Table 8-4 Packaging Material Test Methods

Requirement	Number of Tests Per Lot	Test Method
Aluminum Alloy Compositions	1 per Heat	ASTM B209/B221 and Approved Procedure
Neutron Radiograph	100%(1)	NFD Approved Procedure
Neutron Transmittance for ^{10}B Areal Density	100%(1)	NFD Approved Procedure
Chemical Testing	100%(2)	NFD Approved Procedure

Notes:

(1) For every lot, initial sampling of coupons for neutron transmission measurements and radiograph/ radioscopy shall be 100%, which shall be considered normal sampling. Rejection of a given coupon shall result in rejection of any contiguous plate(s). Reduced sampling (50%) may be introduced based upon acceptance of all coupons in the first 25% of the lot. The approved process specification shall reflect the use of reduced sampling, as applicable. A rejection during reduced inspection will require a return to 100% inspection of the lot.

(2) For every lot, initial sampling of coupons for chemical testing shall be 100%, which shall be considered normal sampling. Rejection of a given coupon shall result in rejection of any contiguous plate(s). Reduced sampling of the lot to 95/95 confidence sampling is acceptable based upon acceptance of all coupons in the first 25% of the lot. The approved process specification shall reflect the use of reduced sampling, as applicable. A rejection during reduced inspection will require a return to 100% inspection of the lot.

8.1.5.2.5 Mechanical Tests

The neutron absorber plates perform a neutronic function of the Traveller package. Thus, no mechanical testing is required.

8.1.5.2.6 Visual Inspection

For all plates, the finished plate shall be free of visual surface cracks, blisters, pores, or foreign inclusions.

Evidence of foreign material shall be cause for rejection (embedded pieces of B_4C matrix are not considered foreign material). Creases or other surface discontinuities are acceptable on the cladding of the BORAL provided the core is not exposed. If necessary, the plate shall be examined with a 5X glass to determine if a surface indication is a crease or a crack. Surface roughness shall not exceed 125 RMS roughness maximum.

8.1.5.2.7 Test Terminology

Acceptance test criteria are as follows:

a) Lot Definition – A lot shall consist of all plate of the same nominal size, condition and finish that is produced from the same heat, processed in the same manner, and presented for inspection at the same time.

b) Heat Definition – A heat shall consist of the total molten metal output from a single heating in a

batch melting process or the total metal output from essentially a single heating in a continuous melting operation and targeted at a fixed metal chemistry at the furnace spout.

c) Coupon (BORAL) – A selected sample of the thinnest section of a lot of the neutron absorber used for acceptance testing of the candidate material.

8.1.5.3 Polyethylene Moderator Blocks

This section establishes the requirements and acceptance criteria for inspection and testing of Ultra High Molecular Weight (UHMW) Polyethylene moderator blocks utilized within the Traveller packaging.

The supplier shall certify that the polyethylene is Ultra High Molecular Weight (UHMW).

8.1.6 Shielding Tests

The Traveller package does not contain any shielding components.

8.1.7 Thermal Tests

The material properties utilized in Chapter 3, Thermal Evaluation, are consistently conservative for the Normal Conditions of Transport (NCT) thermal analysis performed. The Hypothetical Accident Condition (HAC) fire certification testing of the Traveller package (see Section 3.6.5, Certification Tests) served to verify material performance in the HAC thermal environment. As such, with the exception of the tests required for specific packaging components as discussed in Section 8.1.5, Component and Material Tests, specific acceptance tests for material thermal properties are not required or performed.

8.2 MAINTENANCE PROGRAM

This section describes the maintenance program used to ensure continued performance of the Traveller package.

Visual inspection for damage of all exposed surfaces will be performed before each use. Individual components will also be inspected as described in the sections below. If any defects are found during inspection, the package will be segregated and dispositioned by standard site procedure before its next use.

8.2.1 Structural Tests

The Traveller packaging does not contain any structural or lifting/tie-down devices that require testing. There is also no pressure testing requirement.

8.2.2 Pressure Leak Tests

The Traveller packaging does not have any requirements for leak testing.

8.2.3 Component and Material Tests

8.2.3.1 Fasteners

Threaded components shall be inspected prior to each use for deformed or stripped threads. Damaged components shall be repaired or replaced prior to further use.

8.2.3.2 Weather Seal

Prior to each use, visual inspection of the silicone rubber or fiberglass weather seal shall be performed for tears, damage, or deterioration. Unacceptable seals shall be replaced.

8.2.3.3 Shock Mounts

Prior to first use and at an interval not to exceed five years or 50 cycles, whichever is more limiting, each Lord Sandwich Shock Mount (Part Number J-5425-275 [STD and XL], J-3424-21 [VVER], or engineering approved equivalent) shall be visually inspected. The inspection shall verify the condition of the shock mount for tears, missing material or deterioration from aging. A load shall be placed on the Clamshell to tension the shock mounts to visual inspect. A light source with a videoscope is used to inspect the full circumference of each shock mount. Damaged or suspect shock mounts shall be replaced with Lord Sandwich Shock Mount Part Number J-5425-275 [STD and XL], J-3424-21 [VVER], or engineering approved equivalent.

8.2.4 Thermal

No thermal tests are necessary to ensure continued performance of the Traveller packaging.

8.2.5 Neutron Absorber Plates

On a periodic basis (not to exceed five years or 50 cycles, whichever is more limiting), packages will be inspected to verify the neutron absorber plate configuration complies with the drawing requirements. Quality Control Instructions and Mechanical Operating Procedures will define the specific inspection requirements. In accordance with established site procedures, a visual inspection will be conducted of the visible side of the neutron absorber plates. Personnel will visually verify that the plates are present and in good condition. Any neutron absorber plate with deep scratches or gouges, which expose the inner boron carbide center, shall be replaced. Neutron absorber plates covered with cork rubber shall be visually inspected at each screw location and the cork rubber inspected for signs of tampering. Documentation relating to these inspections, repairs, part replacements, etc. will be produced and maintained.

8.3 APPENDICES

8.3.1 References

[1] U.S. Nuclear Regulatory Commission Code of Federal Regulations, Title 10 Part 71, "Packaging and Transport of Radioactive Material," 2016.