ETSO-C69c
Date : 24.10.03

European Aviation Safety Agency

European Technical Standard Order

Subject: EMERGENCY EVACUATION SLIDES, RAMPS, RAMP/SLIDES, AND SLIDE/RAFTS

1 - Applicability

This ETSO gives the requirements that new models of emergency evacuation slides, ramps, ramp/slides, and slide/rafts that are manufactured on or after the date of this ETSO must meet in order to be identified with applicable ETSO marking.

Type I- Inflatable Slide
Type II- Inflatable Slide/Raft
Type III- Inflatable Exit Ramp
Type IV- Inflatable Exit Ramp/Slide

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO Subpart A.

2.2 - Specific

None.

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in Appendix 1, Federal Aviation Administration Standards for emergency evacuation slides, ramps, ramp/slides, and slide/rafts, as amended and supplemented by this ETSO.

Where applicable, instead of the referenced FAA documents/paragraph the corresponding IR, CS or ETSO document/paragraph shall be used, when available.

3.1.2 - Environmental Standard

See CS-ETSO Subpart A paragraph 2.1.

3.1.3 - Computer Software

None.

3.2 - Specific

None

4 - Marking

4.1 - General

Marking is detailed in CS-ETSO Subpart A paragraph 1.2.

4.2 - Specific

The component also must be marked with the applicable emergency evacuation device type: "Type I, Type II, Type III, or Type IV." Type II devices shall also be marked with the rated and overload capacities and the weight of the device including any accessories required by this ETSO.

5 - Availability of Referenced Document

See CS-ETSO Subpart A paragraph 3.

APPENDIX 1. FEDERAL AVIATION ADMINISTRATION MINIMUM PERFORMANCE STANDARD FOR EMERGENCY EVACUATION SLIDES, RAMPS, RAMP/SLIDES, AND SLIDE/RAFTS

Note : Any reference made to US standards, regulations and organisations are for information purpose only and may be replaced, if applicable, by the European equivalent when acceptable to the Agency.

1. Purpose. This standard provides the minimum performance standards for inflatable emergency evacuation slides, overwing exit ramps, ramp/slides, and slide/rafts. However, the deployment and erection characteristics for these devices, as installed on the aircraft, are specified in Title 14 of the Code of Federal Regulations (14 CFR) § 25.810 and must be complied with along with the requirements in this TSO.

2. Scope. This performance standard provides for the following types of emergency evacuation devices:

Type I- Inflatable slide suitable for assisting occupants in descending from a floor-level aircraft exit or from an aircraft wing.

Type II- Inflatable slide also designed to be used as a life raft, i.e. a slide/raft.

Type III- Inflatable exit ramp suitable for assisting occupants in descending to an aircraft wing from certain overwing exits.

Type IV- Combination inflatable exit ramp and wing-to-ground slide.

Further definitions of terms used in this TSO are given in appendix 2.

3. Materials. The materials used must be of a quality, which experience and/or tests have demonstrated to be suitable for use in emergency evacuation slides, ramps, ramp/slides and slide/rafts, i.e. emergency evacuation devices.

3.1 Nonmetallic Materials.

3.1.1 The finished device must be clean and free from any defects that might affect its function.

3.1.2 Coated fabrics and other items, such as webbing, which are subject to deterioration must have been manufactured not more than 18 months prior to the date of manufacture of the finished product. However, these materials may be re-qualified for an additional 18 months if they pass the requirements of paragraph 5.1 of this appendix.

3.1.3 The materials must not support fungus growth.

3.1.4 Materials used in the construction of flotation chambers and decks for Type II devices must be capable of withstanding the detrimental effects of exposure to fuels, oils, hydraulic fluids, and sea water.

3.1.5 Coated Fabric. Coated fabrics, including seams, which are subject to deterioration and used in the manufacture of the devices, must retain at least 90 percent of their original physical properties after these fabrics have been subjected to the accelerated aging test specified in paragraph 5.1 of this appendix.

3.1.5.1 Strength. Coated fabrics used for these applications must conform to the following minimum strengths after aging:

Tensile Strength (Grab Test)
Warp 190 pounds/inch
Fill 190 pounds/inch

Tear Strength (Trapezoid Test or Tongue Test)
Non walking/sliding surface: 13 x 13 pounds/inch (minimum)
Walking/Sliding surface: 50 x 50 pounds/inch (minimum)

Puncture Strength
Walking/Sliding surface: 67 pounds force

3.1.5.2 Adhesion. In addition to the strength requirements of paragraph 3.1.5.1 above, coated fabrics must meet the following minimum strengths after aging:

Ply Adhesion
5 pounds/inch width at 70 + 2 degrees F at a separation rate of 2.0 to 2.5 inches/minute

Coat Adhesion
5 pounds/inch width at 70 + 2 degrees F at a separation rate of 2.0 to 2.5 inches/minute

3.1.5.3 Permeability. For coated fabrics used in the manufacture of inflation chambers, the maximum permeability to helium may not exceed 10 liters per square meter in 24 hours at 77 degrees F, or its equivalent using hydrogen, using either of the permeability test methods specified in paragraph 5.1 of this appendix. The permeameter must be calibrated for the gas used. In lieu of either of these permeability tests, an alternate test may be used provided the alternate test has been approved as an equivalent to this permeability test by the manager of the FAA office having purview of the manufacturer's facilities, as required in paragraphs 3b, Deviations and 5a, Application Data, of this TSO.

3.1.5.4 Hydrolysis. Pressure holding coated fabrics, including seams, must be shown to be resistant to hydrolysis. It must be shown by tests specified in paragraph 5.1 of this appendix that the porosity of the basic pressure holding material is not increased as a result of the material being subjected to hydrolysis conditioning. Seam strength and coat adhesion must not be reduced more than 20 percent and still must not fall below the minimums prescribed in paragraphs 3.1.5.2 and 3.1.6 of this appendix as a result of hydrolysis conditioning.

3.1.6 Seam Strength and Adhesives. Seams used in the manufacture of the device must meet the following minimum strength requirements:

Shear Strength (Grab Test)
175 pounds/inch width at 75 degrees F
40 pounds/inch width at 140 degrees F

Peel Strength (Peel Test)
5 pounds/inch width at 70 degrees F

3.1.7 Seam Tape. If tape is used for seam reinforcement or abrasion protection of seams or both, the fabric used for the seam tape must have a minimum breaking strength (Grab Test) of 40 pounds/inch width in both the warp and fill directions. When applied to the seam area, the adhesion strength characteristics must meet the seam strength requirements in paragraph 3.1.6 above.

3.1.8 Canopy. Fabrics used for this purpose on Type II slide/rafts must be waterproof and resistant to sun penetration, must not affect the potability of collected water, and must meet the following minimum requirements in the applicable tests prescribed in paragraph 5.1 of this appendix, except that in lieu of meeting the tensile strength requirements, a fabricated canopy erected on the device may be demonstrated to withstand sustained wind velocities of 35 knots and 52-knot gusts:

Tensile Strength (Grab Test)
Warp 75 pounds/inch
Fill 75 pounds/inch

Tear Strength (Tongue or Trapezoid Test)
4 x 4 pounds/inch

Coat Adhesion of Coated Fabrics
3.5 pounds/inch width at 70±2 degrees F at a separation rate of 2.0 to 2.5 inches/minute

3.1.9 Flammability. The device (including carrying case or stowage container) must be constructed of materials which comply with the requirements of 14 CFR § 25.853(a), Appendix F, part I (a)(1)(ii) in effect on March 6, 1995.

3.1.10 Radiant Heat Resistance. The pressure holding materials in the device must meet the 90-second minimum time to failure requirement and the 180-second average time to failure requirement of the radiant heat resistance test specified in paragraph 5.3 of this appendix.

3.1.11 Molded Nonmetallic Fittings. Molded nonmetallic fittings must retain their physical characteristics when subjected to temperatures of -65 to +160 degrees F.

3.2 Metallic Parts. All metallic parts must be made of corrosion-resistant material or must be suitably protected against corrosion.

3.3 Protection. All inflation chambers and load carrying fabrics must be protected in such manner that non-fabric parts do not cause chafing or abrasion of the material in either the packed or the inflated condition.

4. Detail Requirements.

4.1 Operation. The operation of the device must be simple enough so that brief, easily understood, posted instructions can be followed by the user.

4.2 Function. The device, including its inflation system, must be demonstrated to be capable of fully functioning when subjected to temperatures from -40 to +160 degrees F. If the device is intended for installation outside the pressurized cabin, the device must be capable of functioning after being stowed at -65 degrees F. The function of the device must be demonstrated in accordance with the hot and cold soak test procedures described in paragraph 5.9 of this appendix.

4.3 Strength.

4.3.1 Beam Strength-Type I, II, & IV Devices. The structural integrity of the device during and after the dynamic challenge of multiple sand bag loading of the device (to simulate loading by three, tightly-bunched evacuees entering each lane of the device) must be shown by test to be adequate, as described in paragraph 5.5 of this appendix.

4.3.2 Attachment Means Strength. The means by which the device is attached to the aircraft, typically the girt, must not fail and must remain intact and suitably attached to both the aircraft and the device during and after the severe loading tests simulating normal evacuation. The device must withstand the static tensile load tests defined in this appendix in paragraphs 5.6, for girts, or 5.7, for non-girts, and 5.8, as appropriate, for evacuees inadvertently entering pontoon areas. Separate girt specimens may be used in the two tests required in paragraph 5.6 of this appendix.

4.4 Elimination of Static. The device and its fastening must be so constructed that static electricity will not be generated in sufficient quantity to cause a spark which would create a hazard if there is any fuel spillage nearby.

4.5 Damage Resistance and Usage.

4.5.1 The device must be capable of resisting puncture and tear of the sliding and walking surfaces and supporting structure from objects normally carried or worn by passengers that could result in collapse of the device, prevent the device from performing its intended function, or both.

4.5.2 Type I, II & IV devices must be so constructed as to permit their use with ground personnel assistance as a noninflatable device in the event of puncture or tear which may render the device incapable of holding air and sustaining inflation.

4.5.3 If the device is of a multiple-inflatable compartment construction, loss of any one of these compartments must not render the device totally unusable.

4.6 Length. Type I, II & IV devices must be of such length after full deployment that the lower end is self-supporting on the ground. The device must provide safe evacuation of occupants to the ground when the aircraft is on the ground with the landing gear extended and after collapse of one or more legs of the landing gear.

4.7 Elimination of Encumbrances. Encumbrances which might be grabbed by evacuees must be kept to a minimum consistent with good design for maximum operational efficiency.

4.8 Hardware and Attaching Means Strength. All hardware, webbing and straps used to attach the device to the aircraft and all straps, grips, and handholds not associated with attachment to the aircraft must have a strength not less than 1.5 times the highest design load imposed in showing compliance with the strength requirements of paragraph 4.3 of this appendix and for Type II devices, in establishing the rated capacity under paragraph 4.26.1 of this appendix.

4.9 Use as Re-entry Device. If the device is designed with provisions for use as a means of re-entering the aircraft, these additional provisions must not interfere with the use of the device for evacuation.

4.10 Evacuation Rate.

4.10.1 The device must be shown, by tests conducted under the conditions described in paragraph 5.4.1 of this appendix, to be capable of safely accommodating evacuees at a rate of at least 70 evacuees per minute per lane. The evacuees must exit the device without assistance.

4.10.2 Evacuation capability under the test conditions shown in paragraph 5.4.3 of this appendix must be demonstrated in order to confirm the acceptability of the device and it’s and/or the associated airplane's emergency lighting system for use by evacuees under dark-of-night conditions. An evacuation rate based upon the rating of the exit (see paragraph 5.4.3.10 of this appendix) to which the device will be attached must be achieved. A detailed test plan to meet these requirements should be submitted at least 60 days prior to the test to the FAA aircraft certification office having purview of the manufacturer's facilities. The test plan shall include, but not be limited to, the test protocol, a description of the test facilities, a description of the measurement and recording equipment and procedures, and the safety provisions for protecting test participants. The test plan must be approved by the manager of that FAA office prior to conduct of the test.

4.11 Inflation.

4.11.1 The device must be demonstrated to meet the applicable automatic inflation requirements of 14 CFR § 25.810 (a)(1)(ii), (b), and/or (d)(4). See paragraph 4.12 below.

4.11.2 The device shall be designed to prevent its inflation out of proper sequence.

4.11.3 A manual means of actuating inflation must be provided. The manual means of actuation of the inflation system may be mechanical or electrical. However, the manual inflation actuating means must be neither visible nor presented for use until the device has been deployed. If the means is not an integral part of the device, details of its connection must be included in the installation limitations required in paragraph **5a, Application Data**.

4.12 Inflation Time.

4.12.1 Type I floor-level exit slides and Type III devices must be fully erected in 6 seconds after actuation of the inflation controls has begun.

4.12.2 Type II devices must meet the requirements in paragraph 4.12.1 above and, if there are actions required to convert usage from slide mode to raft mode, the time required to complete those actions must not exceed 10 seconds after actuation of the conversion means.

4.12.3 Type IV devices and Type I wing-to-ground slides must be automatically erected in not more than 10 seconds after actuation of the inflation controls.

4.13 Device Length Extensions.

4.13.1 The device extension must be capable of being inflated at any time after inflation of the basic device has been initiated. The time required to complete extension of the device must not exceed 4 seconds beyond the time required to inflate the basic device.

4.13.2 Inflation of the extension must be initiated by separate controls from those for the basic device. The controls must be clearly identified and must be located separately from the manual inflation actuation controls to minimize the possibility of inadvertent actuation.

4.13.3 The junction of the basic device and the extension must not impede evacuation.

4.14 Manual Inflation Actuation Controls.

4.14.1 Inflation controls must be equipped with a rigid cross member as an actuation handle. The handle must be red in color, marked with the word "PULL" (or other appropriate instruction) in high visibility reflective letters at least 1/2-inch high and of a contrasting color. In addition, there must be a placard with the words "PULL TO INFLATE" (or other appropriate instruction) located as close to the handle as possible.

4.14.2 When the inflation actuation controls are exposed for use, they must be visible to an aircraft occupant, standing at the doorsill, under the minimum emergency lighting conditions specified in 14 CFR § 25.812 in effect at the time of application.

4.14.3 Unless a rational analysis is provided to locate them elsewhere, or if there is no girt attachment, inflation actuation controls must be on the right side of the girt as seen by an aircraft occupant looking out of the aircraft door.

4.14.4 Inflation actuation controls must be so designed that the maximum required pulling force will not pull the deployed device back into the doorway. The pulling force required must not exceed 30 pounds.

4.14.5 Inflation actuation controls must be constructed so they cannot trip or entangle evacuees.

4.14.6 When actuated, the manual inflation actuation controls must function in a manner which will not cause rotation or twist of the deployed assist means.

4.15 Inflation System.

4.15.1 The inflation system must be connected to the evacuation device and ready for instant use. The inflation system must minimize leakage due to backpressure after inflation.

4.15.2 If an air aspirator system is used, the system must be constructed to prevent the ingestion of small foreign objects or to prevent failure or malfunction of the system as a result of ingestion of the small foreign objects.

4.15.3 Components must meet Department of Transportation (DOT) Specifications 3AA (49 CFR 178.37) or 3HT (49 CFR 178.44) in effect May 30, 1976, FRP-1 (49 CFR 178.AA) in effect February 1987, CFFC (49 CFR 178) in effect November 1996, or an equivalent specification approved by the manager of the FAA office having purview of the manufacturer's facilities, as required in paragraphs 3b, Deviations and 5a, Application Data of this TSO.

4.15.4 Inflation systems for Type II devices, in addition to meeting the above requirements of paragraph 4.15 of this appendix, shall be arranged so that failure of one inflatable chamber or manifold will not result in loss of gas from the other chamber. The inflation equipment shall be located so as not to interfere with boarding operations.

4.16 Multiple Lane Devices.

4.16.1 A multiple lane device must provide space for evacuees sliding simultaneously in each lane. Each sliding surface, if separated by a raised divider not considered to be a part of the sliding surface, must be at least 20 inches wide. The combined width of two sliding surfaces not separated by a raised divider must be at least 42 inches. The width of a multiple lane device with no raised lane divider must be sufficient to enable evacuees to jump side-by-side into each slide lane simultaneously and reach the ground safely.

4.16.2 A multiple lane device must resist adverse twisting or deflecting when subjected to maximum asymmetrical loading represented by evacuees traversing each lane of the device individually at the evacuation rate prescribed in paragraph 4.10 of this appendix. Test conditions shall be as specified in paragraph 5.4 of this appendix except that only the normal sill height and nominal pressure shall be tested.

4.16.3 Where used, a raised divider or center median must be constructed so as to prevent injury to evacuees and not to throw from the device evacuees who jumped into it astraddle or partly astraddle the divider or median. Multiple lane devices, if canted, must provide for the avoidance of cross-flow effects due to the canting.

4.17 Side Guards. A single or multiple lane inflatable device must be equipped with side guards or other means to prevent evacuees from accidentally missing or falling from the device. The means must provide protection for an evacuee who crosses the aircraft emergency exit threshold at a horizontal velocity of approximately 6 feet per second and contacts the device installed at its steepest design angle.

4.18 Emergency Knife Location. If an emergency knife is provided, it must be so installed that it cannot injure persons using the evacuation device in a normal manner. For Type II devices, the knife must also meet the requirements of paragraph 4.39 of this appendix.

4.19 Device Illumination.

4.19.1 Integral device illumination must be designed so the illumination means is activated automatically during deployment or inflation and the level of illumination meets the appropriate requirements in 14 CFR § 25.812 in effect at the time of application.

4.19.2 The illumination means must not interfere with the safe evacuation of persons using the device in a normal manner.

4.20 Wind. The device must be shown, in 25-knot winds directed from the most critical angle, to deploy and, with the assistance of only one person who has evacuated down the device, to remain usable after full deployment to evacuate occupants safely to the ground. The device shall be tested while it is properly attached to the exit or location on the airplane on which installation is intended or on an equivalent mock-up.

4.20.1 To determine the most critical angle, the wind shall be directed at the device from at least the following directions: aft along the centerline of the aircraft (0 degrees position) and then every 45 degrees on the same side of the fuselage as the device is intended for installation.

4.20.2 If the straight section of the descent portion of the device forms an angle greater than 10 degrees to a line perpendicular to the aircraft centerline, the wind shall be applied to the device from directions perpendicular to both sides (i.e., the edges of the device parallel to the straight section of the descent portion) and from every 45 degrees between these two directions on the same side of the fuselage as the device is intended for installation. For directions which are not tested, a rational analysis shall be presented to show why those directions are less critical than those tested.

4.21 Device Surface.

4.21.1 The surfaces of the device, including its coating, must be suitable and safe for use in any weather condition, including a rainfall of 1 inch per hour. The evacuation rate achieved in demonstrating suitability and safety of the device sliding surface under rainfall conditions shall be no less than that shown in paragraph 5.4.3.10. Evacuees shall meet the requirements of paragraph 5.4.1.5 of this appendix.

4.21.2 Each device sliding lane, including its coating, must provide safe and rapid evacuation without detrimental erosion or deterioration for at least 200 adult persons without any rework of the surface.

4.22 Device Performance. At least five consecutive deployment and erection tests must be demonstrated without failure. At least three tests must be conducted using a single representative sample of the device.

4.23 Dynamic Pressure Retention Test. The device must maintain adequate pressure to satisfactorily accomplish its intended function throughout an emergency evacuation in which:

4.23.1 The device is installed at its critical angle (with respect to buckling);

4.23.2 The device is inflated by the inflation system designed for that purpose, the initial pressure of which is at the minimum of its design range;

4.23.3 The pressure relief valve(s), if installed, is unrestricted; and

4.23.4 At least 200 persons in no more than 10 separate demonstrations use each slide lane of the device at an average rate of not less than one person per second per lane.

4.24 Overpressure Tests. The device must be shown to withstand the overpressure test requirements of paragraph 5.2.2 of this appendix without damage.

4.25 Static Pressure Retention Test. The device must be shown to meet the pressure retention test requirements of paragraph 5.2.1 of this appendix.

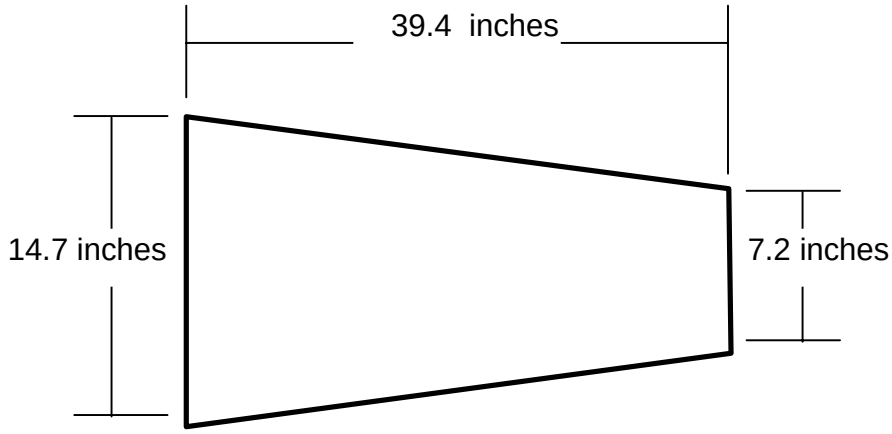
4.26 Raft Capacity-Type II Devices.

4.26.1 Rated Capacity. The rated capacity shall be the usable seating area on the deck/sliding surface of not less than 3.6 ft^2/person.

4.26.2 Overload Capacity. The overload capacity shall be the usable seating area on the deck/sliding surface of not less than 2.4 ft^2/person.

4.26.3 Capacity. Alternate Rating Methods. In lieu of the rated capacity prescribed in paragraph 4.26.1 above, one of the following methods may be used:

4.26.3.1 The rated capacity of a Type II device may be determined by the number of seating spaces which can be accommodated within the occupiable area exclusive of the perimeter structure (such as inflation/buoyancy tubes) without overlapping of the occupant seating spaces. The occupant seating spaces may not be less than the following size unless an equivalent size has been approved by the manager of the FAA office having purview of the manufacturer's facilities.



4.26.3.2 The rated capacity also may be determined on the basis of a controlled pool or fresh water demonstration which includes conditions prescribed under paragraph 5.2.3 of this appendix and the following:

4.26.3.2.1 The sitting area on the raft deck may not be less than 3.0 ft^2/person.

4.26.3.2.2 At least 30 percent but no more than 50 percent of the participants must be female.

4.26.3.2.3 Except as provided below, all participants must select their sitting space without outside placement assistance. A raft commander, acting in the capacity of a crewmember, may direct occupant seating to the extent necessary to achieve reasonable weight distribution within the device.

4.26.3.2.4 All participants must not have practiced, rehearsed, or have had the demonstration procedures described to them within the past 6 months.

4.27 Buoyancy.

4.27.1 Type I devices installed at main deck floor level exits shall be designed to have positive buoyancy when extended so that they can be used as emergency flotation devices.

4.27.2 Type II devices shall have two independent inflatable flotation tubes. If either tube is deflated, the other tube and the device floor shall be capable of supporting the rated and overload capacities in fresh water.

4.27.2.1 It shall be shown by tests in fresh water that the Type II device, loaded to rated capacity using an average weight of 170 lbs./person, has a freeboard of at least:

4.27.2.1.1 Twelve inches with both flotation tubes at minimum raft mode operating pressure; and

4.27.2.1.2 Six inches with the critical flotation tube deflated and the remaining flotation tube at minimum raft mode operating pressure. In lieu of meeting the 6-inch freeboard requirement of this paragraph, the buoyancy provided by the tubes only (disregarding buoyancy derived from the floor and inflatable floor support) shall be capable of supporting the rated capacity based on an average weight of at least 200 lbs./person.

4.27.2.2 It shall be shown by tests in fresh water that the Type II device loaded to its overload capacity and using an average weight of 170 lbs./person has a measurable freeboard with the critical flotation tube deflated.

Ballast in the form of sandbags or the equivalent may be used to achieve the 170-lb weight, provided the appropriate distribution within the device is maintained.

4.28 Disconnect Means.

4.28.1 Type I devices' disconnect means must be a readily apparent, flexible cloth/webbing loop capable of being operated by untrained persons and covered until ready for use. The method of disconnecting the device from the aircraft must be conspicuously and clearly indicated by brief instruction placards.

4.28.2 Type II device release from an aircraft, whether by automatic or manual means, shall not be restricted by the critical conditions of: (a) floor sill height above the water, (b) wind velocity and direction, or (c) occupant load. Devices having aircraft mounted inflation systems shall have means for quick detachment from the inflation system so that separation cannot cause loss of raft buoyancy. Release means shall be a readily apparent flexible cloth/webbing loop capable of being operated by untrained persons and covered until ready for use. The method of disconnecting the device from the aircraft must be conspicuously and clearly indicated by brief instruction placards.

4.29 Mooring Line.

4.29.1 Type I devices must be equipped with a nonrotting mooring line so that the deployed device automatically will remain secured to the aircraft when it is used as an emergency flotation platform. The mooring line shall not endanger the device, cause the device to spill occupants if the aircraft sinks, or interfere with the operation of the device. The mooring line shall have a minimum length of 20 feet and have a knotted breaking strength of not less than 500 lbs. The attachment to the evacuation device shall be stronger than the mooring line. The moored device shall be quickly and easily disconnected from the aircraft. The mooring release means shall be readily apparent and operable by untrained evacuees.

4.29.2 Type II devices, in addition to meeting the requirements of paragraph 4.29.1, shall have a mooring line capable of keeping the device, loaded to rated capacity, attached to a floating aircraft. The line may be equipped with a mechanical release linkage. The breaking strength of the line shall be 500 – 1000 pounds.

4.30 Lifeline. Type I and Type II devices shall be equipped with a nonrotting lifeline of a size greater than or equal to 3/8-inch diameter or ½-inch width, .060 minimum thickness and of a color that contrasts with the device. The lifeline shall be attached along at least 80 percent of the length of both sides of the device. The lifeline shall not adversely compromise the use of the device as a slide. The lifeline and its attachment must be capable of withstanding a minimum load of 500 lbs. and must not interfere with the device's inflation.

4.31 Capsize Resistance-Type II Devices. There shall be water pockets or other means to provide ballast to resist capsizing an empty or lightly loaded raft.

4.32 Righting-Type II Devices. Unless it is shown that there is no tendency for the device to become inverted during loading and release from the aircraft, the slide/raft must comply with the righting tests specified in paragraph 5.2.3.5 of this appendix.

4.33 Boarding Aids-Type II Devices. Boarding aids shall be provided at two opposing positions on the raft. Boarding aids shall permit unassisted entry from the water into the unoccupied raft and shall not at any time impair either the rigidity or the inflation characteristics of the raft. Puncturing of inflatable boarding aids shall not affect the buoyancy of the raft flotation chambers. Boarding handles and/or stirrups used in conjunction with the boarding aids shall withstand a pull of 500 pounds. Boarding aids must be shown to comply with the test requirements of paragraph 5.2.3.6 of this appendix.

4.34 Heaving-Trailing Line-Type II Devices. At least one, floating, heaving-trailing line, not less than 75 ft in length and at least 250 lbs. strength, shall be located on the main flotation tube near the sea anchor attachment. The attachment point of the line shall withstand a pull force of not less than 1.5 times the line rated strength without damage to the device.

4.35 Canopy-Type II Devices. A canopy shall be packed with or attached to the device. The erected canopy shall be capable of withstanding sustained wind velocities of 35 knots and 52-knot gusts in open water. The canopy shall provide adequate headroom, minimum 1 inch clearance, for the 95th percentile male (seated height) and shall provide openings 180 degrees apart. Means shall be provided to make the openings weather tight. If the canopy is not integral with the raft, it shall be capable of being erected by occupants following conspicuously posted, simple instructions. It shall be capable of being erected by one occupant of an otherwise empty raft and by occupants of a raft filled to rated capacity.

4.36 Color-Type II Devices. Except surfaces which have been treated for the purpose of reflecting radiant heat, the color of the device surfaces, including the canopy surface, visible from the air shall be an International Orange-Yellow or an equivalent high visibility color.

4.37 Sea Anchor-Type II Devices. A sea anchor, or anchors, or other equivalent means must be provided to maintain the raft, with rated capacity and canopy installed, on a substantially constant heading relative to the wind and must have the ability to reduce the drift to 2 knots when subjected to winds of 17 to 27 knots. Unless analysis and/or test data substantiating the adequacy of a lower breaking strength is approved by the manager of the FAA office having purview of the manufacturer's facilities as required in paragraphs **3b, Deviations**, and **5a**, **Application Data**, the line securing a sea anchor to the device shall have a breaking strength of 500 pounds or 40 pounds times the rated capacity of the raft, whichever is greater. The attachment of the line to the raft shall be capable of withstanding a load of 1.5 times the line-rated strength without damaging the device. The line shall be at least 25 feet in length and shall be protected to prevent it from being inadvertently cut by raft occupants.

4.38 Emergency Inflation Equipment-Type II Devices. A means readily accessible to occupants of the device shall be provided to manually inflate the device and maintain the raft mode minimum operating pressure. The emergency inflation means must have a displacement of at least 32 cubic inches per full stroke. Manual inflation valves, with a non-return opening adequate for the size and capacity of the inflation means, shall be located to permit inflation of all chambers. The inflation means and valves shall have provisions to prevent inadvertent removal and loss when either stowed or in use.

4.39 Knife-Type II Devices. A hook-type knife secured by a retaining line shall be sheathed and attached to the device adjacent to the point of mooring line attachment. This knife must also meet the requirements of paragraph 4.18 of this appendix.

4.40 Placards- Type II Devices. Suitable placards shall be provided in contrasting colors in waterproof paint which is not detrimental to the fabric, that denote use and location of the inflation systems, raft equipment, boarding aids, and righting aids. The letters used for such placarding shall be at least 2 inches high, except the details and miscellaneous instructions may be of smaller lettering. Applicable placarding shall take into account persons boarding or righting the raft from the water.

4.41 Emergency Lights-Type II Devices. At least one TSO-C85a, or the latest revision, approved survivor locator light shall be provided. The light shall be automatically activated upon device inflation in the water and shall be visible from any direction by persons in the water. The light shall be located at or near a boarding station.

4.42 Actuation Means-Type II Devices. If the device as a slide requires an additional operation to make it usable as a raft, the means for initiating the additional operation shall be designed to preclude inadvertent actuation but be readily available for use. If a pull motion is used, the force required must not be more than 30 pounds.

4.43 Sea Performance-Type II Devices. The device shall meet the seaworthiness requirements in paragraph 5.2.4 of this appendix and shall be capable with its equipment of withstanding a saltwater marine environment for a period of at least 15 days.

5. Tests.

5.1 Material Tests. Testing the material properties specified in paragraph 3, Materials, of this appendix must be conducted in accordance with the following test methods or other approved equivalent methods:

Test Method

Tests Required	Federal Test Method Standard	Other Test Method
Accelerated Age	(1.) - Method 5850	Per Note (2.)
Tensile Strength (Grab Test)	(1.) - Method 5100	Per Note (8.)
Tear Strength (Trapezoid Test)	(6.) - Method 5136	
Tear Strength (Tongue Test)	(1.) - Method 5134 (Alternate to Trapezoid Test paragraph 3.1.5.1)	
Ply Adhesion	(1.) - Method 5960	Per Note (4.)
Coat Adhesion	(1.) - Method 5970	Per Note (9.)
Permeability	(6.) - Method 5460	Per Note (7.)
Seam Shear Strength	(1.)	Per Notes (3.) (8.)
Seam Peel Strength	(1.) - Method 5960	Per Note (4.)
Puncture Strength		Per Note(10.)
Hydrolysis Conditioning		Per Note (11.)
Porosity Test (Hydrolysis)		Per Note (12.)
Flammability (Vertical Burn Rate)		Per Note (5.)

NOTES:

(1) Federal Test Method Standard (FTMS) No. l91A dated July 20, 1978.

(2) Samples for the accelerated aging tests must be exposed to a temperature of 158 ± 5 degrees F for not less than 168 hours. After exposure, the samples must be allowed to cool to 70 ± 2 degrees F for neither less than 16 hours nor more than 96 hours before determining their physical properties in accordance with paragraph 3.1 of this appendix.

(3) Each sample shall consist of two strips 2 inches maximum width by 5 inches maximum length bonded together with an overlap of 3/4 inches maximum. The free ends must be placed in the testing machine described in FTMS l91A, Method 5100 and separated at a rate of 12 ± 0.5 inches/minute. The average value of a minimum of three samples must be reported. Samples may be multilayered to ensure against premature material failure. Samples may be gripped across the full two inches of width.

(4) Separation rate must be 2.0 to 2.5 inches/minute. Sample width shall be one inch.

(5) The material must meet the flammability requirements of 14 CFR § 25.853(a), Appendix F, part I (a)(1)(ii) in effect March 6, 1995.

(6) FTMS No. 191 in effect December 31, 1968.

(7) ASTM Method D1434-82, Procedure V, approved July 30, 1982, is an acceptable alternate method.

(8) Use of pneumatic grips for holding test samples is an acceptable alternate to the mechanical grips described in Method 5100.

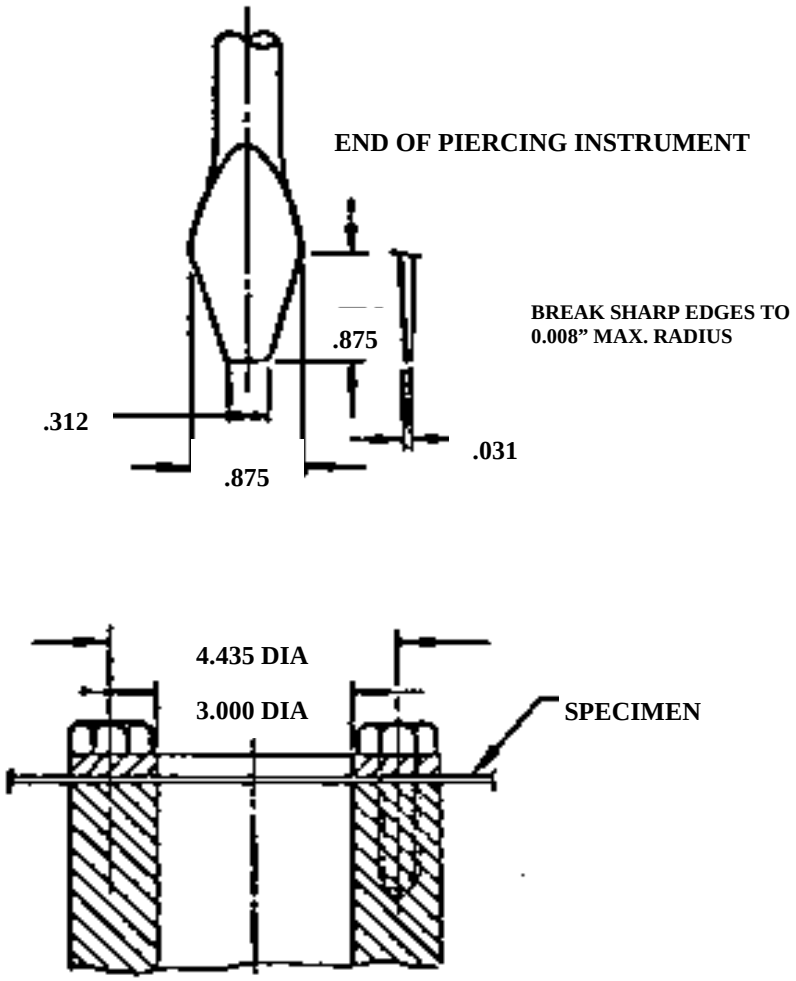
(9) The sample shall be prepared using the adhesive and construction methods used to manufacture the evacuation device. Separation rate must be 2.0 to 2.5 inches/minute.

(10) The fabric shall be tested in a specimen holder constructed in accordance with figure 1. The fabric shall be clamped tightly in the specimen holder to present a wrinkle-free surface and prevent slippage during the test. A piercing instrument with its end conforming to figure 1 shall be forced against the fabric at approximately the

center of the area enclosed by the specimen holder. The force required to puncture the specimen shall not be less than the specified 67 pounds. The test shall be run using a crosshead speed of 12 inches/minute.

(11) Each sample shall be exposed to a temperature of 136 ± 4 degrees F and a relative humidity of 95 ± 4 percent for a period of 50 days.

(12) Porosity testing conducted for hydrolysis resistance shall be conducted with the test apparatus specified in paragraph 5.3 or an equivalent test method approved by the manager of the FAA having purview of the manufacturer's facilities, as required in paragraphs **3b, Deviations** and **5a, Application Data,** of this TSO. Note specimen size and mounting information of paragraphs 5.3.3.1 and 5.3.4.5 of this appendix. Tests should be conducted at the devices nominal operating pressure for a duration of 30 minutes. Porosity is indicated by a loss in chamber pressure during testing. Pressure loss for material specimens after hydrolysis conditioning shall not be greater than the pressure loss for the material before conditioning.



SPECIMEN HOLDER

DIMENSION IN INCHES

FIGURE 1. PIERCING INSTRUMENT AND SPECIMEN HOLDER

5.2 Functional Tests.

5.2.1 Pressure Retention. Under static conditions and when inflated and stabilized at the nominal operating pressure, the pressure in each inflatable chamber of a Type II device must not fall below the minimum raft mode operating pressure in less than 24 hours. For Type I, III & IV devices, the pressure in each inflatable chamber must not fall below 50 percent of the nominal operating pressure in less than 12 hours.

5.2.2 Overpressure Tests.

5.2.2.1 The device must withstand a pressure at least 1.5 times the maximum operating pressure for at least 5 minutes without sustaining damage.

5.2.2.2 At least one specimen of the inflatable device model must be shown by test to withstand a pressure at least 2 times the maximum operating pressure without failure for at least 1 minute. Devices so tested must be clearly identified.

5.2.3 Water Tests-Type II Devices. In either a controlled pool or fresh water the capacity and buoyancy of the device must be demonstrated as follows:

5.2.3.1 Both rated and overload capacities established in accordance with the requirements of paragraph 4.26 of this appendix must be demonstrated with inflation tubes at minimum raft mode operating pressure and with the critical buoyancy chamber deflated. The resultant freeboard in each case must meet the requirements of paragraph 4.27.2 of this appendix.

5.2.3.2 Persons used in the demonstration must have an average weight of not less that 170 pounds. Ballast in the form of sand bags or equivalent may be used to achieve proper loading provided the appropriate weight distribution within the device is maintained.

5.2.3.3 Persons used in the demonstration must wear FAA approved life preservers with at least one chamber inflated.

5.2.3.4 The raft equipment required by this TSO, plus one emergency locator transmitter or a weight simulating a transmitter, must be aboard the device.

5.2.3.5 Unless it can be shown that there is no tendency for the device to become inverted during loading and release from the airplane, it must be demonstrated that the device is self-righting or that it can be righted by one person in the water, or that while inverted it can be boarded and provide flotation for the normal rated capacity.

5.2.3.6 It must be demonstrated that the boarding aids are adequate for the purpose intended and that it is possible for male and female adults wearing inflated life preservers to board the raft unassisted.

5.2.4 Sea Trials – Type II Devices. The device must be demonstrated by tests or analysis, or a combination of both, to be seaworthy in an open sea condition with maximum sustained winds of 17 to 27 knots and waves of 6 to 10 feet. In tests, ballast in the form of sand bags or equivalent may be used to achieve proper loading provided the appropriate weight distribution within the raft is maintained. If analysis is used, the analysis must be approved by the manager of the FAA office having purview of the manufacturer's facilities as required in paragraph **5a, Application Data** of this TSO. For this seaworthiness demonstration, the following apply -

5.2.4.1 The raft must be boarded by the rated number of occupants to demonstrate the method of loading from a simulated aircraft sill installation.

5.2.4.2 The proper functioning of the means to separate the raft from the simulated aircraft installation must be demonstrated.

5.2.4.3 All equipment required by this TSO must be aboard and the proper functioning of each item of equipment must be demonstrated.

5.2.4.4 The canopy must be erected for a sufficient time to assess its resistance to tearing and the protection it affords. The method of erection must be shown to be accomplished by one occupant of an otherwise empty raft and by occupants of a raft filled to rated capacity.

5.2.4.5 The stability of the raft must be demonstrated when occupied at normal rated capacity and at 50 percent rated capacity.

5.3 Radiant Heat Test. The pressure holding materials in the emergency evacuation inflatable device shall be tested for resistance to radiant heat in accordance with this standard. If any of the outer surface of the pressure holding material is altered by marking, by lettering, by affixed overlay or underlying material, or in any other manner which affects radiant heat resistance, the altered material shall also be tested.

5.3.1 Criteria for Acceptance. For each material which requires testing, at least three specimens shall be tested at 1.5 Btu/ft^2-sec (1.7 W/cm^2), and the resulting times to failure averaged. The average time to failure may not be less than 180 seconds with no value less than 90 seconds. Time to failure is the time between first application of heat to the specimen and first drop in pressure below the maximum pressure attained in the test cylinder during the test.

5.3.2 Test Apparatus. The tests shall be conducted using the FAA Slide Material Radiant Heat Apparatus, or another equivalent test apparatus and test method approved by the manager of the FAA office having purview of the manufacturer's facilities as required in paragraphs **3b, Deviations**, and **5a, Application Data** of this TSO. The apparatus consists of a horizontally mounted cylinder closed at one end and fitted with a source of air pressure and pressure measurement. A specimen holder clamped over the open end seals the cylinder air tight with the material specimen acting as a pressure holding diaphragm. The cylinder and specimen holder are mounted on a pivot and slide bar, and can be positioned at varying distances from a 3-inch (76mm) diameter electric radiant heat furnace and a calorimeter. The test apparatus is described in figures 2 through 5 and paragraphs 5.3.2.1 through 5.3.2.6 of this appendix.

5.3.2.1 The pressure cylinder and specimen holder, as shown in figures 2, 3, and 4 of this appendix, consist of a 7-inch (178 mm) outside diameter (O.D.) by 6 1/2-inch (165 mm) inside diameter (I.D.) by 12 3/8-inch (314 mm) long aluminum tube. On one end of the tube is welded a 1/2-inch (13 mm) thick aluminum plate, drilled and tapped for a 1/4-inch American national pipe taper thread to facilitate air pressure and pressure recording hookups. On the other end of the tube is welded a 7-inch (178 mm) O.D. by 5 1/2-inch (140 mm) I.D. ring of 1/2-inch (13 mm) thick aluminum. This ring is drilled and tapped for 10-32 by 7/8-inch (22 mm) long studs. Another 6 3/4-inch (171 mm) O.D. by 5 1/2-inch (140 mm) I.D. by 1/2-inch (13 mm) thick aluminum ring and two neoprene rubber gaskets with matching clearance holes to fit over the studs provide a means for clamping and sealing the test specimen in place. Hinges and adjustable stops are welded to the sides of the cylinder, shown in figures 2, 3, and 4.

5.3.2.2 The electric furnace meeting the requirements of the FAA Fire Test Handbook is shown in figure 5 of this appendix. It has a 3-inch (76 mm) diameter opening to provide a constant irradiance on the specimen surface. An acceptable furnace, part number 680860025700, is available from Newport Scientific, Inc., 8246-E Sandy Court, Jessup, Maryland 20794-9632. Another acceptable furnace, part number 680860380000, is also available from Newport Scientific, Inc.

5.3.2.3 A 0-5 Btu/ft^2-sec (5 W/cm^2) calorimeter meeting the requirements of the FAA Fire Test Handbook is required. (Vatell thermogage calorimeter no. 1000-1B, available from Vatell, P.O. Box 66, Christiansbury, Virginia 24073, is acceptable.) The calorimeter is mounted in a 4 1/2-inch diameter by 3/4-inch insulating block and is hinged to one of the sliding bars of the framework. The surface of the calorimeter is flush with the surface of the insulating block and centered with the furnace. See figure 4 of this appendix. The calorimeter must be calibrated to a primary standard by NIST or calibrated per the requirements of appendix 4.

5.3.2.4 The pressure cylinder, calorimeter, and furnace are mounted on a framework as detailed in figure 4 of this appendix. Adjustable sliding stops are located on each of the bars for setting the cylinder and calorimeter at the desired distance from the opening of the furnace.

5.3.2.5 Compressed air is connected to the cylinder through a needle valve attached to the end of the framework. A tee on the outlet side of the valve provides for a 0-5 psig pressure gauge, transducer, and flexible tube to supply air to the rear plate of the pressure cylinder, as shown in figure 2 of this appendix.

5.3.2.6 The outputs of the calorimeter and pressure transducer are measured and recorded using a recording potentiometer or other suitable instrument capable of measurement over the range required.

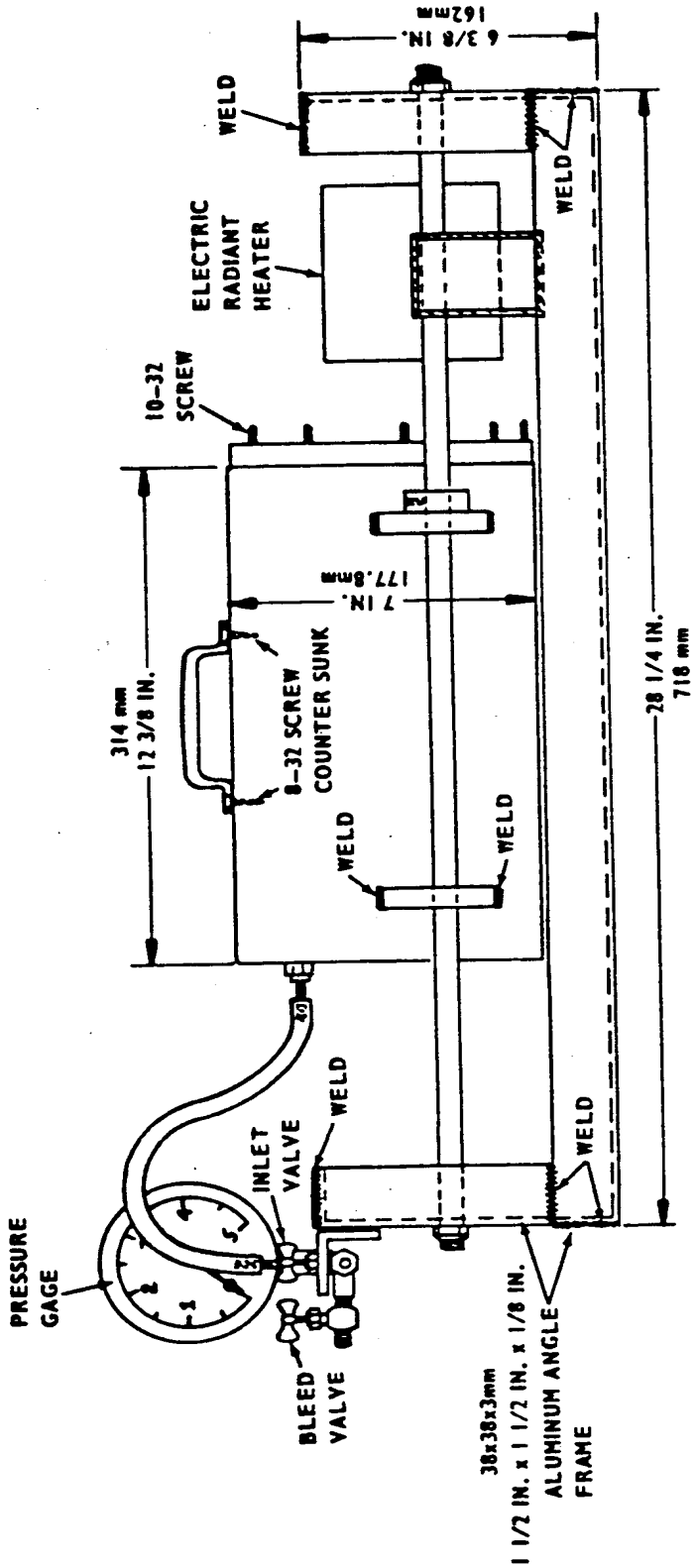


FIGURE 2. LABORATORY TEST (FRONT)

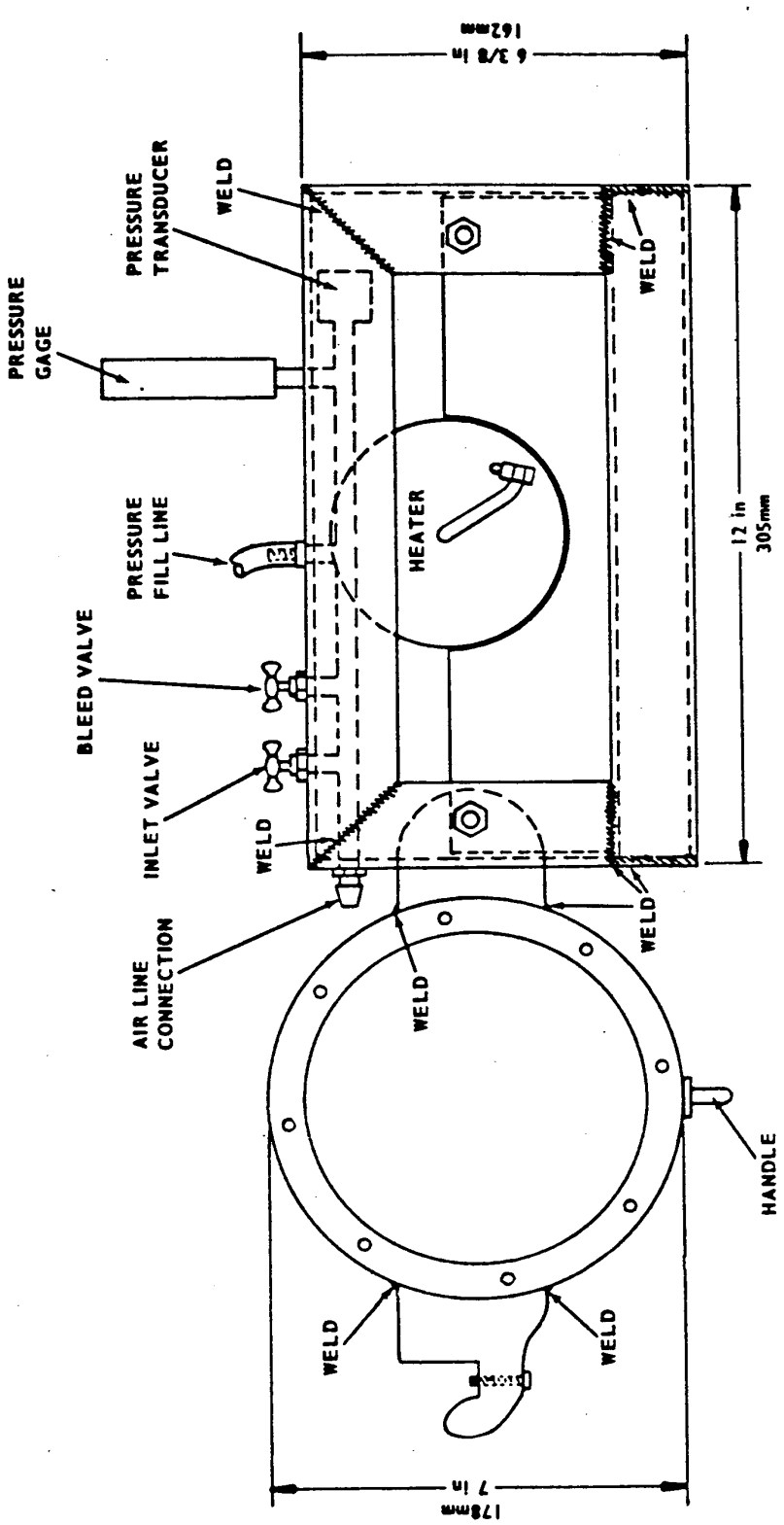


FIGURE 3. LABORATORY TEST

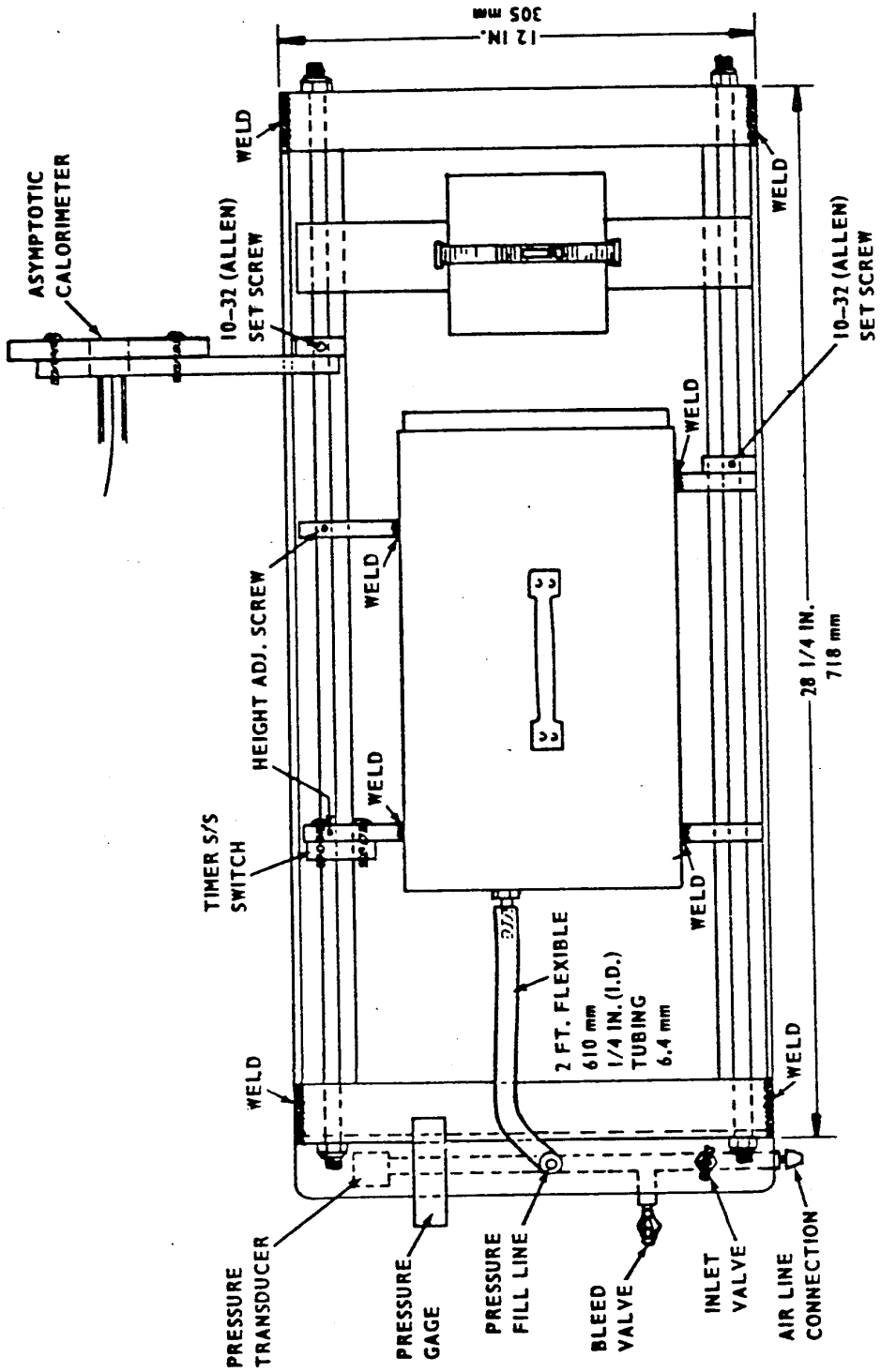


FIGURE 4. LABORATORY TEST (TOP VIEW)

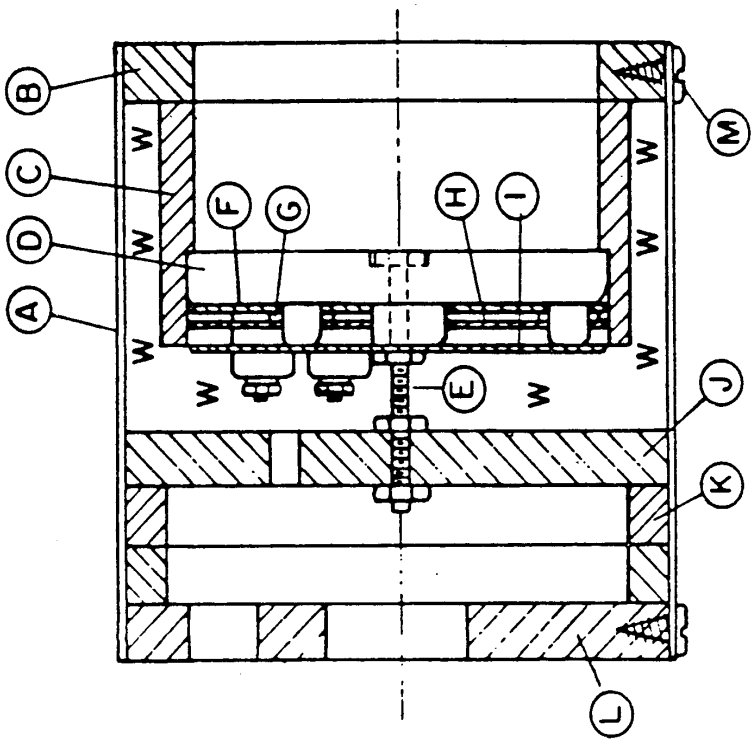


FIGURE 5. FURNACE SECTION

5.3.3 Test Specimens.

5.3.3.1 Test specimens 7 inches (178mm) in diameter with 1/4-inch (6mm) holes punched in the material to match the studs in the pressure cylinder must be cut from the material to be tested.

5.3.3.2 Test specimens must be conditioned at 70 ± 3 degrees F (21±3 degrees C) and 50 ±5 percent relative humidity for at least 24 hours prior to testing.

5.3.4 Test Procedures.

5.3.4.1 All tests must be conducted in a draft free room or enclosed space.

5.3.4.2 After turning on the radiant heat furnace and other required instrumentation, allow 1/2 to 3/4 hour to stabilize heat output and for instrumentation warm-up.

5.3.4.3 Adjust transformer to produce a radiant heat flux of 2 Btu/ft^2-sec (2.3 W/cm^2) when the calorimeter is positioned 1 1/2 inches (38mm) in front of the radiant heat furnace.

5.3.4.4 Find the location in front of the furnace for the test heat flux of 1.5 Btu/ft^2-sec (1.7 W/cm^2) by sliding the calorimeter on the horizontal bar and fixing the position with the sliding stop. Swing the calorimeter out of position.

5.3.4.5 Mount the specimen on the open end of the cylinder with a neoprene gasket on each side of the specimen with the reflective surface of the material facing the furnace. Place the aluminum ring on the studs and tighten the nuts so that an airtight seal made.

5.3.4.6 Pressurize the cylinder to the device nominal operating pressure. Check for leakage.

5.3.4.7 Check the distance from the radiant heat furnace to the surface of the test specimen. This distance is the same as the distance to the surface of the calorimeter.

5.3.4.8 Place the calorimeter in front of the radiant heat furnace and record the heat flux. An acceptable heat flux is 1.5 Btu/ft^2-sec (1.7 W/cm^2). Remove calorimeter.

5.3.4.9 Place the pressure cylinder and test specimen in front of the radiant heat furnace. Start timer or note starting time on the recorder.

5.3.4.10 Pressure is monitored from the time the specimen is placed in front of the furnace until initial pressure loss is observed.

5.4 Evacuation Rate Tests.

5.4.1 Basic Test Conditions. The following test conditions shall be applicable to tests run for showing compliance with paragraph 4.10.1 of this appendix:

5.4.1.1 The device shall be tested at normal sill height.

5.4.1.2 The device shall be tested at three different inflation pressures: minimum operating, maximum operating, and the nominal operating pressure.

5.4.1.3 The surface of the device shall be dry.

5.4.1.4 The test area may be illuminated to any level suitable for safe conduct of the test.

5.4.1.5 The evacuees may be of any age, gender, weight, or experience level suitable for safe conduct of the test, but each evacuee group must average a minimum of 170 pounds per person. Evacuees may participate in more than one test run.

5.4.1.6 Each device lane shall be traversed by a minimum of 20 evacuees per lane for each test run.

5.4.1.7 All test runs shall be on the same test article.

5.4.1.8 Each test run must have a rate of 60 evacuees/minute per lane or higher.

5.4.1.9 The combined average rate of all test runs must be 70 evacuees/minute per lane or higher. If different numbers of evacuees are used among the different test runs, the rates for each test run shall be mathematically weighted to ensure proper averaging.

5.4.2 Maximum and Minimum Sill Height Conditions. In addition to the tests in paragraph 5.4.1 above, the device shall be tested at the maximum and minimum sill heights. Three test runs shall be conducted on the same test article for both sill heights, one each at minimum operating, maximum operating, and the nominal operating pressure of the normal conditions pressure range. At maximum sill height, a minimum of five evacuees per lane per run shall use the device and be conveyed safely to the ground. At minimum sill height, a minimum of 20 evacuees per lane per run shall use the device. The evacuees shall meet the same requirements as in paragraph 5.4.1.5 of this appendix. No specific evacuation rate is required for the maximum sill height tests. However, at minimum sill height the rate shall be no less than that shown in paragraph 5.4.3.10.

5.4.3 Emergency Lighting Test Conditions. The following test conditions shall be applicable to tests run for showing compliance with paragraph 4.10.2 of this appendix:

5.4.3.1 The test shall be run on the airplane on which installation is intended or an approved, representative mock-up of the relevant section of the airplane.

5.4.3.2 The sill height used shall represent normal conditions for the airplane with all landing gear extended.

5.4.3.3 When using a mock-up, the exit cutout and the door (if necessary) shall be representative of the airplane. The passageway to the exit should be no greater than the minimum specified for that exit in 14 CFR § 25.813, e.g., 36 inches wide for a Type A or B exit, or 20 inches wide for a Type I, II or C exit. The assist space shall be per current FAA guidance contained in AC 25-17. Cabin features such as doors, cabinets, monuments, door hinges, or other impediments intruding into the exit path which may influence the evacuation rate shall be realistically simulated along the length of the passageway.

5.4.3.4 The device shall be installed, inflated to its nominal operating pressure and ready for use. Note: Emergency lights mounted on the device shall not be illuminated until test initiation, and shall be powered by batteries conditioned per 14 CFR § 25.812(i), or an equivalent power supply.

5.4.3.5 The surface of the device shall be dry.

5.4.3.6 The device shall be hidden from view of the evacuees prior to test initiation.

5.4.3.7 For a period of 5 minutes prior to the initiation of the test, the area holding the evacuees, i.e., the "cabin interior", shall be illuminated to a minimum level of 5 foot-candles, or the level which is representative of typical cabin lighting as measured on the centerline of the passageway floor, one foot inboard of the exit sill. The ambient illumination in the test area outside of the airplane or mock-up shall not exceed 0.005 foot-candles; measurements should be made at the ground end of the assisting means and at the exit, just outside of the fuselage. Provisions shall be made, where necessary, to prevent light reflecting off of surfaces in the outside test area, e.g., hangar walls, from providing visual references to the test participants. All illumination measurements shall be made with a light meter in current calibration, with an accuracy/resolution of at least 2 percent and 0.001 foot-candles.

5.4.3.8 Upon test initiation, the illumination of the "cabin interior" shall be reduced to the nominal light level provided by the airplane emergency lighting system (with batteries conditioned per 14 CFR § 25.812(i)) as measured as incident light on the centerline of the passageway floor, one foot inboard of the exit sill. The assist means lighting system(s) will be activated.

5.4.3.9 The evacuees shall not have participated in any test or demonstration involving airplane evacuation devices within the past year.

5.4.3.10 The evacuee group size shall be per the following table:

Exit type	Rating	Evacuees	Pass/fail criterion (in seconds)***
A	110	44 (22 per lane)	30 +T_t****
B	75	45 (22/23 per lane)	45 +T_t
C	55	22	30 +T_t
I	45	27	45 +T_t
II	40	24	45 +T_t
III	35	21	45 +T_t
III (dual*)	70	42 (21 per III)	45 +T_t
III (dual**)	70	39 (19/20 per III)	45 +T_t

*Dual separated by >= 3 seat rows.
**Dual separated by < 3 seat rows.
***The total time allowed from the start of the test, when the light level changes, as described in 5.4.3.8, until the last evacuee reaches the ground.
****T_t = Transit time (T_t), determined by averaging the times required by five or more evacuees tested one at a time to traverse the descent route in factory ambient lighting conditions. Evacuees must meet the conditions in 5.4.3.9 and 5.4.3.11.

5.4.3.11 The age/gender mix of the evacuee group shall be as defined in the current version of Appendix J of 14 CFR part 25.

5.4.3.12 For floor level exits, a person trained to give verbal commands shall direct the evacuation from an assist space provided for the aircraft and may stop the test if conditions warrant. He/she should use procedures or techniques approved by the manager of the ACO having purview of the device manufacturer's facilities. These procedures and techniques shall not include physically assisting hesitant evacuees through the doorway.

5.4.3.13 The following information may be given to participants and the following procedures may occur during the briefings identified below:

5.4.3.13.1 Recruiting briefing:

+ Describe purpose of the test.
+ Identify possible hazards of the test.
+ Identify benefits for test participants.
+ Identify benefits to airline passengers.
+ Describe types of clothing/footwear required.

5.4.3.13.2 Orientation briefing:

+ Get subject characteristics.
+ Check for appropriate clothing and footwear.
+ Prepare paperwork (medical forms, etc.).
+ Give building safety information (fire evacuation plan, etc.).
+ Describe test and procedures.

+ Show pictures of the device from ground level in daylight.
+ Describe how to enter the device using pictures from ground level, if desired.
+ Get informed consent.

5.4.3.13.3 Final briefing:

+ Escort to test area.
+ Escort into test mock-up (also known as test module) to prepare for test.
+ Describe test procedures again.
+ Line up (position) evacuees at the exit(s) in single or dual lanes, as appropriate, for the test.
+ Begin test protocol.

5.5 Beam Strength Tests-Except Type III Devices.

5.5.1 Basic Test Conditions. The following test conditions shall be applicable to tests run to show compliance with paragraph 4.3.1 of this appendix.

5.5.1.1 Sand Bags.

5.5.1.1.1 Three sand bags, each weighing a minimum of 170 pounds, connected in series, are required for each and every lane of the device.

5.5.1.1.2 All sand bags shall be equal to each other in weight within 5.0 lbs.

5.5.1.1.3 A single 170-pound sand bag may be assembled from two or more smaller bags for ease of handling. The smaller bags need not be of equal weight.

5.5.1.1.4 The outer covering of the sand bag shall be a material having a coefficient of friction of at least 0.4 when tested per ASTM Standard D 1894-95. (This value is typical of some cotton and polyester/cotton material blends. Test data for the material used shall be included with the final test report.)

5.5.1.1.5 Filler materials other than sand may be used, however, liquids are not acceptable unless they are sufficiently constrained to prevent shifting within the bag.

5.5.1.1.6 The basic shape of a sand bag should be a rectangular solid with rounded corners and a minimum contact surface width of 15 inches. The bag should be longer than it is wide and the height should be less than the width.

5.5.1.1.7 Provisions to securely connect the three sand bags to each other shall be included on each bag. The interconnection provisions shall be designed to minimize any tendency for the bags to roll or tumble.

5.5.1.1.8 When connected, the three sand bags shall occupy an area not to exceed 7.5 feet by 2 feet.

5.5.1.2 Delivery System.

5.5.1.2.1 A delivery system shall be used to convey the sand bags to the beginning of the down-slide portion of the device and to release them so that they may slide down the device. The vertical offset of the end of the delivery system and the device at the point of delivery should be minimized to minimize tumbling of the sandbags.

5.5.1.2.2 The delivery system shall consist of a flat, rigid plane a maximum of 8 feet in length covered with material similar to that used on the sliding surface of the device.

5.5.1.2.3 The delivery system shall incorporate provisions for slowly elevating the rear portion of the plane until the sand bags will begin to move downward onto the sliding surface solely by the effect of gravity or until the plane is at the same angle as the sliding surface and acts as a seamless extension to it. Angles between these two points are acceptable, but in no case shall the angle of the plane exceed the angle of the sliding surface. The sand bags should be restrained until test initiation.

5.5.1.2.4 Where a straight delivery system design cannot be used because the device has a ramp or porch or is more than 20 degrees from being perpendicular to the fuselage, an alternate delivery system design may be used if approved in advance by the manager of the ACO having purview of the manufacturer's facilities.

5.5.1.3 Device Configuration and Installation.

5.5.1.3.1 The device shall be in its production-deliverable configuration with all required equipment installed.

5.5.1.3.2 The sliding surface of the device shall be dry and new (i.e. never having been subjected to persons or sand bags sliding on its surface prior to the tests).

5.5.1.3.3 The pressure in each and every chamber of the device shall be its nominal operating pressure.

5.5.1.3.4 The device shall be installed at its normal sill height and with its normal attachment means. If the device is intended for use at more than one exit pair, it shall be tested at the normal sill height for each exit pair.

5.5.1.3.5 The width of the exit through which the sand bags are delivered shall be representative of the airplane exit to which the device will normally be attached and where the evacuees would normally enter the device. For devices not mounted at the exit sill, only the airplane structure which would control evacuee flow onto the device needs to be simulated.

5.5.2 Testing.

5.5.2.1 For a multi-lane device, the sand bags for all lanes shall be launched simultaneously or as nearly so as possible. A single mechanism which will provide simultaneous release of all bags is recommended. In no case shall the sand bags be launched with an offset of more than one sand bag length difference among all the lanes. A case not conforming t
this requirement shall be considered a non-test.

5.5.2.2 Sand bags shall not overlap or lie atop one another at test initiation.

5.5.2.3 Sand bags shall not roll or tumble more than 180 degrees either by force of launch or through action of movement down the device. Some tumbling of the sand bags at the bottom of the device due to the effects of the deceleration means is acceptable.

5.5.2.4 Sand bags shall not depart the device except at the bottom end where evacuee contact with the ground is intended.

5.5.2.5 Cross-over of the sand bags from one lane to another on a multiple lane device is acceptable.

5.5.3 Success Criteria.

5.5.3.1 For the test article to be deemed acceptable, the test shall be completed successfully three consecutive times. (Tests which are aborted or considered non-tests, e.g., there is more than one sand bag offset between lanes during the start of a multiple lane device test, do not count against the goal of three consecutive successful tests.)

5.5.3.2 All sand bags in all lanes shall completely depart the end of the device, or shall be deemed to be likely to exit the device if not obstructed by bags which are partially on the ground and partially on the device.

5.5.3.3 The bottom of the sliding surface shall not contact the ground at any time.

5.5.3.4 The device, without repair, shall meet the requirements of paragraph 4.10.1 of this appendix after being subjected to this test.

5.5.4 Alternative Test Method. As an alternative to the test method (using sand bags) described in paragraph 5.5.1, a test using human subjects may be conducted as follows:

5.5.4.1 Test Subjects. Prior to testing, all test subjects shall be briefed on safety and test issues per paragraph 5.4.3.13 of this TSO. The briefing shall include instructions for required behavior while participating in the test. While test subjects may be experienced, they shall not behave in a prohibited manner. Prohibited behavior includes shifting of body weight and/or use of hands and/or feet to "propel oneself' along the slide surface in order to depart the end of the device.

5.5.4.2 Device Configuration and Installation.

5.5.4.2.1 The device shall be in its production-deliverable configuration with all required equipment installed.

5.5.4.2.2 The sliding surface of the device shall be dry and new (i.e. never having been subjected to persons or sand bags sliding on its surface prior to the tests).

5.5.4.2.3 The pressure in each and every chamber of the device shall be its nominal operating pressure.

5.5.4.2.4 The device shall be installed at its normal sill height and with its normal attachment means. If the device is intended for use at more than one exit pair, it shall be tested at the normal sill height for each exit pair.

5.5.4.2.5 The width of the exit through which the test subjects would pass before entering the device shall be representative of the airplane exit where the device will normally be attached and where the evacuees would normally enter the device. For devices not mounted at the exit sill, only the airplane structure which would control evacuee flow onto the device needs to be simulated.

5.5.4.3 Test Protocol. The following test protocol, which is applicable for single or multiple lane devices, shall be used:

5.5.4.3.1 The test subjects' clothing which contacts the device surface shall be made of material with a coefficient of friction of at least 0.4 per ASTM Standard D1894-90 (typical of cotton or polyester/cotton blend).

5.5.4.3.2 Each test subject shall weigh at least 170 pounds.

5.5.4.3.3 For each lane of the device, three test subjects shall be seated "toboggan" style. The legs of the second and third person in each group shall straddle the person ahead. The first and second persons in the group shall grasp the legs of the person behind them.

5.5.4.3.4 The first person in the group should be located entirely on the downward portion of the device, i.e., he/she would slide if not holding onto the legs of the person behind. The second person in the group should be located either entirely on the downward portion of the device or at the transition point between the door sill or device ramp and the downward portion of the device. The third person should be on the door sill or device ramp, i.e., would not slide if not holding onto anything or being held by the legs by the second person in the group.

5.5.4.3.5 For each group, the distance from the front of the first test subject's torso to the back of the third test subject's torso shall not exceed 7.5 feet at the initiation of sliding by the third (last) person in the group.

5.5.4.3.6 At the test conductor's word "go", the test subjects in each lane will proceed down the slide together. For multiple lane devices, simultaneous push-off is required for all lanes, i.e., no more than a one-person offset is permissible among all lanes. Minor pushing off, particularly by the second and third persons in each group, is allowed to start the group sliding. Additional persons are allowed to gently push the last person in each group to start the sliding process.

5.5.4.3.7 After the third person in each group has started to slide, that person may signal the two others in the group to let go of the legs by yelling "OK" or "Let go."

5.5.4.3.8 Upon hearing that signal, the first two persons in the group should let go of the others' legs in order to provide freedom of movement for exiting the device and moving out of the way. After releasing the legs, the test subjects shall not engage in pushing, scooting or shifting of weight in order to exit the device. As soon as foot contact with the ground is made, the test subjects may stand immediately and move away quickly.

5.5.4.3.9 The first and second persons in the group are to stand and move away quickly when exiting the device to prevent blocking the person behind them.

5.5.4.3.10 As an alternative to paragraph 5.5.4.3.4, a delivery system can be used to convey the test subjects to the beginning of the down-slide portion of the device. See paragraph 5.5.1.2.2 through 5.5.1.2.4 for description of the delivery system.

5.5.4.4 Success Criteria.

5.5.4.4.1 For the device to be deemed acceptable, the test must be completed successfully three consecutive times. (Tests which are aborted or considered non-tests, e.g., there is more than a one person offset between lanes during the start of a multiple lane device, do not count against the goal of three consecutive successful tests.)

5.5.4.4.2 The first two test subjects in each and every lane shall exit the end of the device with continuous motion. The third person should also exit the device with continuous motion, but may stay on the device if his/her motion was stopped by the person in front of him/her. Crossover of persons from one lane to another on a multiple lane device is acceptable; however, no more than one person may remain on the device in any lane.

5.5.4.4.3 The underside of the sliding surface shall not contact the ground at any time.

5.5.4.4.4 None of the test subjects shall perform prohibited movements (as described above).

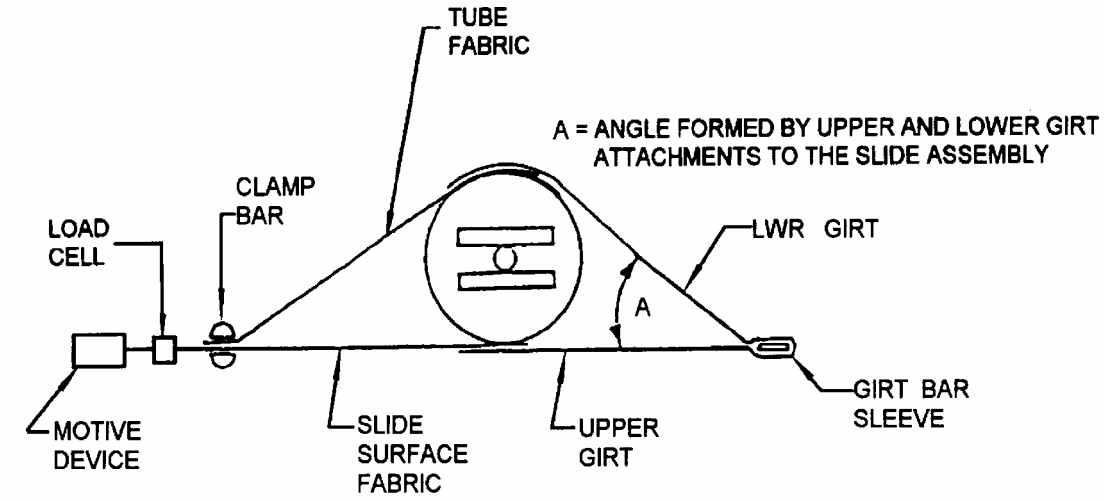
5.5.4.4.5 The device, without repair, shall meet the requirements of paragraph 4.10.1 of this appendix after being subjected to this test.

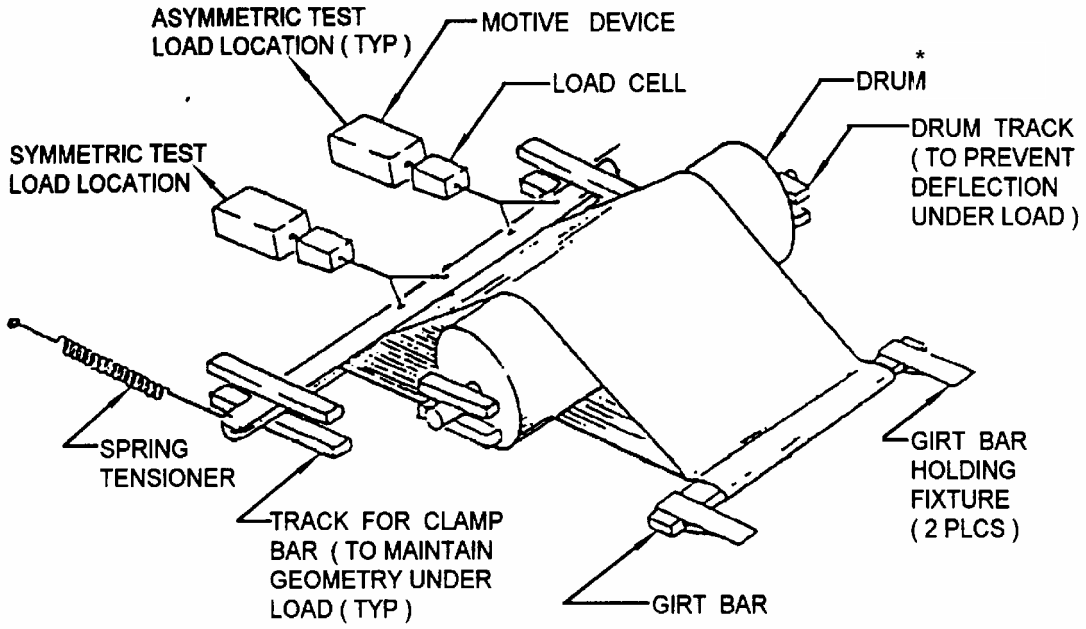
5.6 Attachment Means Tests - Girt (See figure 6 of this appendix.).

5.6.1 Symmetric Girt Tensile Load Test. A representative production configuration girt including attachments to the device and the aircraft shall be installed to produce a symmetric load in a tensile test machine. The girt shall be attached on one end using the girt bar, or equivalent, and on the other end to the normal girt attachment means to the inflatable device. The slide fabric to which the girt attachment is bonded shall be fastened to a steel plate or around a cylinder designed to represent the inflatable to which the girt is attached (See figure 6 of this appendix). The girt shall be able to withstand a test load which is equal to the maximum expected in-use load

multiplied by a factor of 1.5 (as required by paragraph 4.8 of this appendix). The in-use load is a combination of all the loads acting on the girt attachments during any individual test run. The loads shall be established by instrumenting the girt attachment(s) to a test module simulating the aircraft fuselage and measuring the forces transmitted to the attachment(s) during deployment and use of the device. (The means for measuring the peak loads must be shown to be reliable, accurate, in calibration, and appropriate for the type of testing. If the means is a data acquisition system utilizing an analog-to-digital converter, see appendix 3 of this TSO for guidance.) The use conditions shall include, but not be limited to, those encountered in demonstrating compliance with the requirements of paragraphs 4.3.1, 4.10, 4.11, 4.12, 4.13, 4.20, 4.21, 4.22, 4.23, 4.28, 5.2.4 and 5.8 of this appendix. The test load shall be applied to the girt for 60 seconds. During the test, tearing of the girt is not acceptable. Deformation of the girt is acceptable if it would not prevent continued safe use of the device in an actual evacuation.

5.6.2 Asymmetric Girt Tensile Load Test. A representative production configuration girt shall be installed to produce an asymmetric load in a tensile test machine and an asymmetric load shall be applied. The girt shall be attached on one end using the girt bar, or equivalent, and on the other end to the normal girt attachment means to the inflatable device. The slide fabric to which the girt attachment is bonded shall be fastened to a steel plate designed to represent the inflatable to which the girt is attached (See figure 6 of this appendix). The girt shall be able to withstand a test load applied asymmetrically by pulling the steel plate away from the secured girt bar at a point even with the edge of the girt. The test shall be repeated for each side of the device girt. The test load(s) is equal to the maximum expected in-use load multiplied by a factor of 1.5 (as required by paragraph 4.8 of this appendix). The in-use load shall be established by instrumenting each girt attachment to the aircraft and measuring the forces transmitted to the attachment during deployment and use of the device. (The means for measuring the peak loads must be shown to be reliable, accurate, in calibration, and appropriate for the type of testing. If the means utilizes an analog to digital converter, see appendix 3 of this TSO for guidance.) The use conditions shall include, but not be limited to, those encountered in demonstrating compliance with the requirements of paragraphs 4.20, 4.21, 4.28, 5.2.4 and 5.8 of this appendix. The test load shall be applied to the edge of the girt for 60 seconds. During the test, tearing of the girt is not acceptable. Deformation of the girt is acceptable if it would not prevent continued safe use of the device in an actual evacuation.





*** DRUM SHALL RETAIN ITS SHAPE THROUGHOUT TEST LOADING AND SHALL BE OF SUFFICIENT DIAMETER TO ALLOW SIMULATION OF THE GIRT ATTACHMENT ANGLE, A.**

Figure 6. Typical Girt Loading Test Set-Up

5.7 Attachment Means Tests - Other Than a Girt. When the attachment means is other than a girt, e.g., a number of narrow straps attached at different locations on the aircraft, only the straight tensile test is necessary for each of the straps. A representative production configuration of each of the straps, including its attachment to the device and to the airplane, shall be individually installed to produce a symmetric load in a tensile test machine. Each strap shall be able to withstand a test load which is equal to the maximum expected in-use load multiplied by a factor of 1.5 (as required by paragraph 4.8 of this appendix). The in-use load shall be established by instrumenting each strap attachment to a test module simulating the aircraft fuselage and measuring the forces transmitted to that attachment during deployment and use of the device. The use conditions shall include, but not be limited to, those encountered in demonstrating compliance with the requirements of paragraphs 4.3.1, 4.10, 4.11, 4.12, 4.13, 4.20, 4.21, 4.22, 4.23, 4.28, 5.2.4 and 5.8 of this appendix. The test load shall be applied to the strap for 60 seconds. During the test, tearing of the strap is not acceptable. Deformation of the strap is acceptable, if it would not prevent continued safe use of the device in an actual evacuation.

5.8 Attachment Means - Pontoon Loading Tests. If the device is equipped with outrigger pontoons (also known as sponsons) which can be inadvertently entered by evacuees during an emergency evacuation, the following test shall be conducted on each side:

5.8.1 The device shall be installed at normal sill height and inflated to the minimum value of the normal conditions pressure range.

5.8.2 Weights that represent 170 pound individuals shall be placed in the pontoon(s) at the bottom outside area on one side of the device . The number of individuals to be simulated shall be based on the length, in feet, of the occupiable portion of the pontoon divided by 4.5. Any remainder from the division may be discarded.

5.8.3 An evacuee group of twenty persons shall jump into the device at an average rate of 70 per minute (after the first jumper, the last 19 have 16 seconds to jump into the device). The evacuee group shall average at least 170 pounds per person. In the case of multi-lane devices, the evacuees will jump only into the lane adjacent to the loaded pontoon. The evacuees may be of any age, gender, and experience level.

5.8.4 To pass this test, the means of attachment to the aircraft shall not tear or rip, and no evacuee shall enter the pontoon area or fall off the device.

5.9 Hot & Cold Soak Test Protocol.

5.9.1 Stabilize the normally charged stored gas bottle to a temperature of 70 ± 5 degrees F, then, for the cold test only, reduce the stored gas bottle pressure to the minimum dispatch pressure. As an alternate, the bottle may be charged directly to the minimum dispatch pressure for the cold test. However, for mixed-gas systems, the ratio of the gas mix must be maintained.

5.9.2 Thermally condition the device for at least 16 hours according to the following table:

Condition	Temperature (degrees F)
Hot Soak	=160 (for all devices)
Cold Soak	=-40 (for devices installed in the pressurized cabin)
Cold Soak	=-65 (for devices installed outside the pressurized cabin)

5.9.3 Deploy the device into ambient temperature conditions (typically defined as between 65 and 85 degrees F) from the appropriate airplane door or a suitable airplane door mock-up or module, within 10 minutes after removal from the conditioning chamber.

5.9.4 To be considered acceptable, the unit should deploy and inflate into a useable attitude and achieve minimum operating pressure in all inflation chambers but should not exceed the specified maximum operating pressure. The pressure reading should be taken as soon as possible but no later than one minute after deployment.

APPENDIX 2. GLOSSARY OF TERMS

critical angle (with respect to buckling) – the angle which the device makes with the ground at which the maximum vertical load will be applied to the device by evacuees using it. The angle chosen should be sufficient to permit attaining an evacuation rate of one person per second per lane, but may not exceed 30 degrees from horizontal.

dark of night conditions - exterior lighting conditions in which the illumination measured normal to the direction of the incident light does not exceed 0.005 foot-candles.

girt - the typical means by which a device is attached to an airplane. It consists of a strong fabric wrapped around a girt bar which is usually installed at the sill of the exit. The girt may be attached to more than one of the device inflatable chambers.

high visibility color – international orange-yellow or a bright orange-yellow color similar to color numbers 28915 or 38903 of table X in Federal Standard 595, Colors.

maximum operating pressure - maximum pressure (in each/every chamber) that may be reached after the device has reached a usable attitude. Typically, this pressure is determined during the device developmental process when evaluating all test conditions.

maximum sill height - the maximum height above the ground of the exit sill with the collapse of one or more of the aircraft landing gear legs. Typically this is calculated using rational analysis.

minimum dispatch pressure - minimum actual pressure required in the inflation system for dispatch of the airplane. This inflation system pressure will inflate the device to at least minimum operating pressure under the cold soak conditions described in paragraph 5.9.2 of appendix 1 of this TSO.

minimum operating pressure - minimum pressure (in each/every chamber) at which the evacuation rate requirement of paragraph 4.10.1 of appendix 1 of this TSO can be met.

minimum raft mode operating pressure - minimum pressure required to meet the minimum design buoyancy requirements of paragraph 4.27.2 of appendix 1 of this TSO.

minimum sill height - lowest height above the ground of the exit sill with the collapse of one or more of the aircraft landing gear legs. Typically this is calculated using rational analysis.

most critical angle (wind) - the angle at which winds have the greatest adverse effect upon the device's ability to convey evacuees safely to the ground, e.g., where there is the greatest lateral and/or torsional displacement or buckling.

nominal operating pressure - the mid-point of the normal conditions pressure range.

normal conditions pressure range - the range of pressures attained during typical deployments conducted in accordance with paragraph **5b(1)** of this TSO. The lower limit must not be lower than the minimum operating pressure. The upper limit must not be more than the maximum operating pressure.

normal sill height - the height of the exit sill above the ground with all aircraft landing gear extended.

APPENDIX 3. MEASUREMENT OF LOADS ON THE ATTACHMENT(S) TO THE AIRPLANE

Data acquisition systems which utilize an analog-to-digital (A/D) converter to process the electronic signals from load cells must be configured to accurately record loads during a test. The following parameters are recommended for recording with an A/D converter system:

1. Sample Rate	20 Hz minimum
2. Resolution	12 bits minimum
3. Anti-aliasing pre-filter	5 Hz low pass (0 to -4 dB at 5 HZ), -20 dB/decade rolloff at frequencies above 10 Hz

The signal amplifier should provide sufficient gain so that the expected full-scale, or highest anticipated value to be recorded, is at least 70 percent of the maximum input range of the analog-to-digital converter (A/D). No post acquisition digital filter, smoothing, or averaging algorithm may be applied to the data.

APPENDIX 4. CALORIMETER SPECIFICATION AND CALIBRATION PROCEDURE

1. Scope. This procedure shall be used to calibrate all circular foil heat flux transducers (Gardon gauges). Calibration establishes the value of this product to the user.

2. Terminology. For definitions of general terms, refer to ASTM Standard C168. Definitions specific to this procedure are:

a. Sensor Scale Factor – the ratio between the incident heat flux and the transducer output signal produced at the heat flux, expressed in W/cm²/mV or BTU/ft²-sec/mV.

b. Sensor Sensitivity – the ratio between the transducer output signal and the incident heat flux, expressed in mV/W/cm² or mV/BTU/ft²-sec.

c. Calibrated Heat Flux Level – the maximum heat flux reached during the calibration cycle.

d. Calibration Standard Scale Factor – the sensor scale factor for the reference standard transducer used in calibration, expressed in W/cm²/mV or BTU/ft²-sec/mV.

e. Emissivity – the ratio between total radiant energy absorbed by a plane surface and total radiant energy incident on that surface, expressed as a value between 0.0 and 1.0.

3. Calorimeter Specifications.

a. One inch diameter, cylindrical, water-cooled, Gardon gauge.
b. Calibration range approximately 0 - 5 watts.
c. Foil diameter shall be 0.25 in. +/- 0.005.
d. Foil thickness shall be 0.0005 in. +/- 0.0001.
e. Foil material shall be thermocouple grade constantan.
f. Temperature measurement shall be a copper-constantan thermocouple.
g. Copper center wire diameter of 0.0005 in. +/- 0.0001.
h. The entire face of the calorimeter shall be lightly coated with high temperature paint having an emissivity of 0.94 or higher.

4. Equipment and Supplies. Calibrations shall be performed using a 50 kW flat plate heater furnace. The furnace shall be equipped with transducer mountings, water cooling lines and an exhaust system of sufficient capacity to remove the heat of calibrations at 50 kW input power to the plate. The heater shall be a graphite plate 0.125”±0.0625 thick, and 1.50” minimum width by 1.50” minimum length. Electric current shall be conducted through the longest dimension of the plate. An X-Y recorder with adjustable gains that has been calibrated against NIST standards shall be mounted on a shelf on the front of the furnace. A reference transducer of approximately the same full scale range as the test transducer shall be prepared and calibrated against a NIST calibrated transducer. The coating on the surface of the reference transducer shall be high temperature paint, applied and cured according to the standard coating procedure for an emissivity of 0.94 or higher.

5. Preparations for Calibration. The flat plate heater shall be prepared for calibrations as follows:

a. pyrolytic graphite transitions shall be attached to both ends of the flat plate heater with rubber cement and the heater shall be centered and clamped evenly in the furnace;

b. the exhaust fan shall be turned on;

c. the heater shall be gradually heated electrically until all rubber cement burns away and a good bond is achieved at both ends;

d. the heater shall be energized with sufficient electric current to produce a dull red heat; and

e. uniformity of the flat plate temperature from side to side and top to bottom shall be observed on both sides.

If the flat plate temperature is non-uniform, clamping forces shall be adjusted and, if necessary the transitions reattached to achieve uniformity. The reference transducer shall be mounted on one side of the flat plate heater, centered over the face of the heater and 1/8" to 3/8" from the heater surface. The distance shall be set with a thickness gauge. Water cooling lines shall be connected. The test transducer shall be coated with high temperature paint cured for an emissivity of 0.94 or higher. It shall be mounted on the other side of the flat plate heater, centered over the face of the heater and an equal distance from the heater surface. The distance shall be verified with the same thickness gauge. Water cooling lines shall be connected. The water supply system shall be leak tested and reconnected if necessary. The output signal of the reference transducer shall be connected to the Y-axis input of the X-Y recorder. The output signal of the test transducer shall be connected to the X-axis input. Recorder gains shall both be set to 1.00.

6. Calibration Procedure.

a. A fresh sheet of graph paper shall be mounted in the X-Y recorder. X and Y zeros shall be adjusted. The cooling water pump shall be turned on, but not the exhaust fan.

b. If the full scale range of the test transducer is 50 BTU/ft²-sec or less, the potentiometer control of the furnace shall be adjusted to approximately 150 percent of the full scale heat flux value for the test transducer. After a few seconds to stabilize temperatures, the pen shall be dropped on the recorder, and the heat flux gradually reduced to zero. A straight line trace from the upper right quadrant of the graph to the zero for both X and Y should be recorded.

c. If the full scale range of the test transducer is greater than 50 BTU/ft^2-sec the recorder pen shall be dropped and then the control of the furnace shall be slowly adjusted to approximately 150 percent of the full scale value for the test transducer. After this the pen shall be lifted and the furnace control quickly reduced to zero. A straight line trace from the zero for both X and Y to the upper right quadrant should be recorded.

7. Analysis.

a. The analysis will relate the sensitivity and scale factor of the test transducer to those of the reference transducer, based on the slope of the graph recorded in step 6.

b. A straight line shall be drawn from X=0, Y=0 on the graph to fit the recorded trace. If this line intercepts the right-hand edge of the graph, the test transducer scale factor shall be calculated by multiplying the intercept by the reference transducer scale factor. If the line intercepts the top edge of the graph, the test transducer scale factor shall be calculated by multiplying the reference transducer scale factor by 7 (the graph is 7 units high) and dividing that result by the intercept.

c. The test transducer sensitivity shall be obtained by inverting the test transducer scale factor.

d. The maximum heat flux level used in calibration shall be calculated from the X-axis excursion on the graph. The scale factor of the reference transducer shall also be recorded. The reference transducer measures incident heat flux, so the calibration will always be in terms of incident heat flux.