

SAE ARP1967

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AEROSPACE RECOMMENDED PRACTICE

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ARP 1967

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CONTAINERS, SHIPPING AND STORAGE, AIRCRAFT ENGINES AND MODULES - METAL, REUSABLE

1. SCOPE: This ARP recommends design and test criteria for reusable metal shipping and storage containers for Aircraft engines and modules that are of gross (loaded) weight in excess of 150 lbs. The containers are to provide water-vaporproof and physical protection.
2. APPLICABLE DOCUMENTS:
 - 2.1 Specifications and Standards: The latest issue of the following specifications and standards form a part of this ARP to the extent specified herein.

SPECIFICATIONS -

Federal:

- TT-C-490 - Cleaning Method and Pretreatment of Ferrous Surfaces for Organic Coatings
- TT-E-515 - Enamel, Alkyd, Lusterless, Quick-drying
- TT-E-516 - Enamel, Lusterless, Quick-drying Styrenated Alkyd type
- TT-E-527 - Enamel, Alkyd, Lustreless
- TT-E-529 - Enamel, Alkyd, Semigloss
- TT-I-1795 - Ink, Marking, Stencil, Opaque (Porous and Non-Porous Surfaces)
- TT-P-636 - Primer, Coating, Alkyd, Wood and Ferrous Metal
- TT-P-664 - Primer, Coating, Synthetic, Rust-inhibiting, Lacquer-resisting
- TT-P-1757 - Primer Coating, Zinc Chromate, Low Moisture Sensitivity

Military:

- MIL-D-3464 - Desiccants, Activated, Bagged, Packaging Use and Static Dehumidification
- MIL-S-5002 - Surface Treatments and Inorganic Coatings For Metal Surfaces of Weapons Systems
- MIL-C-5541 - Chemical Conversion Coatings on Aluminum Alloys
- MIL-W-6858 - Welding, Resistance, Spot and Seam

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- MIL-I-6866 - Inspection, Penetrant Method of
- MIL-I-6868 - Inspection Process, Magnetic Particle
- MIL-A-8625 - Anodic Coatings, for Aluminum & Aluminum Alloys
- MIL-T-10727 - Tin Plating, Electrodeposited or Hot-Dipped, for Ferrous and Non-Ferrous Metals
- DOD-P-16232 - Phosphate Coatings, Heavy, Manganese or Zinc Base (for Ferrous Metals)
- MIL-W-22248 - Weldment, Aluminum and Aluminum Alloy
- MIL-P-23377 - Primer Coating, Epoxy - Polyamide, Chemical and Solvent Resistant
- MIL-I-26860 - Indicator, Humidity, Plug, Color Change
- MIL-V-27166 - Valve, Pressure Equalizing, Gaseous Products
- MIL-W-45205 - Welding, Gas Metal-Arc and Gas Tungsten-Arc, Aluminum Alloys, Readily Weldable for Structures, Excluding Armor
- MIL-C-46168 - Coating, Aliphatic Polyurethane, Chemical Agent Resistant
- MIL-P-52192 - Primer Coating, Epoxy
- MIL-S-81733 - Sealing and Coating Compound, Corrosion Inhibitive
- MIL-C-87115 - Coating, Immersion Zinc Flake/Chromate Dispersion

STANDARDS -

Military:

- MIL-STD-453 - Inspection, Radiographic
- MIL-STD-648 - Design Criteria for Specialized Shipping Containers
- MIL-STD-889 - Dissimilar Metals
- MIL-STD-1261 - Welding Procedures for Construction Steels
- MIL-STD-1568 - Materials and Processes For Corrosion Prevention and Control In Aerospace Weapons Systems

Federal:

"Federal Test Method Std No. 101, Test Procedures for Packaging Material"

3. REQUIREMENTS:

- 3.1 First Article Sample: Before starting production, a sample of the finished container should be submitted for approval. The approval of the first article sample does not relieve the supplier of responsibility for compliance with all applicable provisions of this document, during subsequent production.
- 3.2 Materials: Materials to be used in containers should be identified on specifications and drawings. Materials which are not covered by specifications or which are not specifically described should be of the lightest practical weight, and entirely suitable to meet all performance requirements.

- 3.2.1 Metals: Metal components should be corrosion resistant or suitably processed to resist corrosion. Dissimilar metals as defined in MIL-STD-889 should not be used in intimate contact unless suitably protected against electrolytic corrosion. When it is necessary that any combination of such dissimilar metals be assembled, an interposing material compatible with each should be used. Alternatives such as tin-plating in accordance with MIL-T-10727 or zinc-plating in accordance with MIL-C-87115 are recommended in lieu of cadmium plating. Cadmium plating may be used in accordance with the requirements of MIL-STD-1568 and MIL-S-5002 providing the cadmium plated parts are not in intimate contact with the contained item.
- 3.2.2 Welding: Welding should be in accordance with MIL-STD-1261, MIL-W-45205, MIL-W-6858, or MIL-W-22248. Welds should be reasonably smooth and free of craters and porosity. They should exhibit characteristics of fusion, penetration, and soundness of weld deposit representative of good welding practice. All welding fluxes, scale, weld spatter, acids, or basic solutions should be completely removed prior to application of any finish coats. External assemblies that are welded to the container body should be welded with continuous weld, if practical. If interrupted welding is used, caulking conforming to MIL-S-81733 or equivalent should be used to fill the gaps.
- 3.2.3 Primary Support Structure: All castings and machinings used in the primary support structure should be free of cracks or flaws.
- 3.3 Design and Construction:
- 3.3.1 Internal Component Parts:
- 3.3.1.1 Mounting Provisions: Each container should include all necessary interior supports, fixtures, and attachments to receive and secure the contained item(s). It should include individual mounting provisions or supports for designated accessories, and should include provisions for storing detachable hardware during shipment of an empty container. All fasteners used in the primary support structure should be of the self-locking type with non-metallic inserts. Safety wire should be used only if the configuration of the component precludes self-locking fasteners.
- 3.3.1.2 Accessibility: The container should be designed so as to provide ready accessibility to the interior supports and should permit the installation and removal of the item by means of overhead lifting devices through a sequence of simple operations.
- 3.3.1.3 Vibration and Shock Isolation: The container should be designed so as to prevent damage to the item resulting from shock and transient vibrations excited by the rough handling tests and also from steady-state vibrations encountered in shipment. If consistent with the shock requirements and other design considerations, the resonant frequency in the major translational modes of vibration should be above 7.0 Hz, and peak transmissibility across the isolators in the major translational modes of vibration should not exceed 5.0.

- 3.3.1.4 Isolation Mounts: Each isolation mount should be marked with its date of manufacture. This date should be visible when the mount is installed. Elastomeric materials used in isolation mounts should be capable of meeting the ozone and air-heat aging test specified in MIL-STD-648.
- 3.3.2 Free Drainage: Provisions should be incorporated to insure that any pockets on the exterior of the container are provided with a means of drainage in the normal storage position of the container. Where necessary, holes should be drilled of sufficient size (0.250 inch dia minimum) that they may be adequately painted without danger of subsequent stoppage. Where drainage holes are impractical, the affected area should be filled with a sealing compound conforming to MIL-S-81733, or equivalent, in such manner as to prevent the collecting of water.
- 3.3.3 Container Assembly:
- 3.3.3.1 Permanent Joints: All permanent fittings, seams, and joints, affecting the airtightness of the container, should be welded or brazed.
- 3.3.3.2 Container Closure:
- 3.3.3.2.1 Closure Fastenings: Closure fasteners should be either hand operated or require the use of only common hand tools, excluding torque wrenches, to open and close the container. The closure fasteners, if captivated to the cover section of the container, should not sustain damage when the cover is removed and placed on the floor, in its normal attitude. The type of fastener should be selected and specified by the procuring agency, with consideration of the anticipated service environment. Some options are:
- a. Hand Operated Self-Contained Latches
These latches include over center, cam action, and/or spring loaded configurations. They are convenient to use and produce consistent clamping force, and cannot be misplaced or lost, but might not be readily replaceable if damaged. Physical protection by recessing or shielding is recommended to prevent damage during normal handling.
 - b. Self-contained/Captive Threaded Fasteners
These cannot be misplaced or lost, but must be wrenched, and might not be readily replaceable if damaged.
 - c. Nuts and Bolts (Non-captive)
These are least expensive, and can be readily replaced if damaged, but must be wrenched, and might be misplaced or lost.

- 3.3.3.2.2 Container Sealing: All joining surfaces should be such as to ensure sealing under the performance requirements of this specification. All gasket joints should be processed so as to form a continuous gasket. The gasket should remain in place during normal installation and removal of the cover. When assembled, the sections of the container should apply no loads to the gasket(s) other than those required for sealing, and should compress the gasket material no more than 30 percent. Separately applied sealing compounds or materials should not be used. The main closure flange, between the cover and the base, should be configured such that rain water will not enter the container if the gasket is missing or fails, and such that the sealing surface will not be damaged when the cover is removed and placed on the floor, in its normal attitude.
- 3.3.3.2.3 Installation Time: The time required to open the container, to remove and reinstall the item, and to close the container for shipment should be the minimum practical.
- 3.3.3.2.4 Leakage. No leakage should occur under the tests prescribed herein.
- 3.3.4 Handling Provisions: Features provided for lifting, tiedown, and towing should be combined, wherever practical.
- 3.3.4.1 Lifting Rings, Eyes or Lugs: Lifting rings, eyes or lugs capable of withstanding the tests prescribed herein, without failure or visible permanent distortion, should be provided for lifting the container or major sections thereof with chains, hooks, or by a single overhead hook. If practical, the lifting features should also be suitable for hand lifting of the cover, if its weight is within hand lifting limits. These rings, eyes or lugs should be located so as to permit the container to be lifted without significant deviation from the normal storage attitude. Provisions for four-point suspension of the loaded container should be included for all containers that have a loaded gross weight of over 4,000 pounds. It is permissible to incorporate lifting eyes in the stacking brackets. Rings, eyes, or lugs, when not in use, should not project beyond the envelope of the container. Rings and eyes should have a minimum inside diameter of 3 inches and should permit full entry and closure of a safety hook.
- 3.3.4.2 Tiedown Provisions: Tiedown provisions should be compatible with the attachment points on aircraft cargo floors which in general have a capacity of 10,000 pounds and are spaced on 20-inch centers. There should be a minimum of two tiedown provisions on each of the longest sides and a minimum of one tiedown provision on each end of a container wider than 5 feet. They should be located on the base, if possible. Tiedown provisions should not create any unsafe, awkward, time-consuming or potentially dangerous handling conditions, nor should any permanent deformation of the tiedown provisions or supporting structure be observed when tested as prescribed herein.

- 3.3.4.3 Towing Hooks, Rings, or Eyes: Towing hook(s), ring(s), or eye(s) should be attached to the container base structure. They should have a minimum opening of 3 inches and the edges should be rounded. Hook(s), ring(s), or eye(s), when not in use, should not project beyond the envelope of the container.
- 3.3.4.4 Indexing and Stacking: Each container should be provided with indexing provisions on top and bottom in order to allow rapid and orderly stacking operations for containers of the same part number. These provisions should provide lateral and longitudinal structural restraint and should not interfere with forklift access. The container should be capable of supporting the superimposed weight of two like containers including the contents, or a number of like containers with contents stacked to a height of 16 feet, whichever is greater. Containers of flat-roofed configuration should also be capable of withstanding a distributed load of 175 pounds per square foot.
- 3.3.4.5 Forklifting: Enclosed forklifting pockets should be provided on both sides and both ends of the container, except if the loaded center of gravity is displaced from the end of the container by more than 40 inches. In that case, pockets should not be provided on that end, and provisions should be included to prevent forklift entry. The pockets need not be fully enclosed across the length and width of the container, but should provide lateral guidance for the fork tines, and should prevent the tines from contacting the container shell. Consideration should be given to protection of vulnerable areas near the pockets, which might be impacted by the tines. Width and spacing of the pockets should be in accordance with MIL-STD-648. Forklift handling of the container should exhibit no significant instability on the tines or tendency of the tines to permanently deform, fracture, or puncture the container.
- 3.3.5 Service and Maintenance Facilities: The following provisions should be incorporated in each container.
- 3.3.5.1 Desiccant Holder: The container should be equipped with interior receptacles for desiccant. The total capacity of the receptacles should be a minimum of 0.50 cubic feet per 100 cubic feet of empty container volume. Each receptacle should include a refillable enclosure to retain bagged desiccant conforming to MIL-D-3464, while permitting the passage of air. The enclosure should be accessible through openings in the surface of the container, which should be provided with airtight covers. The enclosure should also be accessible from the inside. The configuration of the desiccant holder should be such as to allow maximum desiccant exposure to the interior atmosphere of the container and no portion of the desiccant should be more than 3 inches from an exposed surface. The container shell should form no major surface area of the desiccant holder, and only one minor surface area.

- 3.3.5.2 Humidity Indicator: The container should incorporate a relative humidity indicator plug conforming to MIL-I-26860, Type II. The inside of the container should be configured to provide free access of the enclosed air to the indicator. Removal and replacement of the indicator should be possible without removing the container cover.
- 3.3.5.3 Visual Inspection Ports: Each container should be provided with two visual inspection ports which should consist of MIL-I-26860 humidity indicators with the cobaltous chloride indicating elements removed. Inspection ports should be located a minimum of four inches apart, at a convenient height for viewing, and in a manner such that one person can illuminate the contents through one port, while viewing through the other.
- 3.3.5.4 Relief Valves: Each container should be provided with an automatic pressure and vacuum relief valve conforming to MIL-V-27166, Type III. The minimum reseal settings should be 1.5 psi pressure and 1.0 psi vacuum with full flow achieved at 3 psi pressure and 2.5 psi vacuum. Full flow shall be a minimum of 12% of the empty container volume per minute, which equates to an aircraft descent rate of 3000 ft/min. More than one valve may be used, if necessary to achieve this flow. The automatic valve system should incorporate a manual relief feature. The valve should not be removable without the use of tools. The relief valve should be capable of removal and replacement without removing the container cover. Operating instructions should be provided adjacent to the valve.
- 3.3.5.5 Air Filling Valve: An air filling valve, Schrader 645E6, or equivalent, should be provided.
- 3.3.5.6 Record Receptacle: A receptacle should be provided of such size and shape as to permit easy insertion and removal of the necessary records. As a minimum, it should be designed to contain a 1-inch by 9-inch by 11-inch record book, without rolling or bending. The attitude of the installed receptacle should be such that water will not collect in it when the record receptacle cover is removed. There should be no access from the record receptacle into the interior compartment of the container. The receptacle should be closed from the outside with a watertight cover, and provisions should be made for tamperproof sealing of the record receptacle with lead seals and safety wire.
- 3.3.5.7 Receptacle Covers: All record and desiccant receptacle covers should be permanently retained to the container by means that will not interfere with accessibility to the receptacles. The covers should be capable of being removed and installed by hand, or by common hand tools.
- 3.3.5.8 Location of Service Facilities: If practical, the relief valve, record receptacle, humidity indicator and visual inspection ports should be grouped on one end or quadrant of the container, to coincide with the entrance to the end forklift openings, in order that they will be easily accessible for inspection under row storage. Whenever possible, relief valve(s) should be located such that breathing occurs through the

3.3.5.8 (Cont'd.)

desiccant holder. The visual inspection ports, air fill valve, relief valve, and humidity indicator should be provided with physical protection by recessing or shielding on the outside surface of the container in the immediate proximity of these facilities. All receptacles should be in the base, if space permits. Consistent with these requirements, the humidity indicator should be placed as far as practical from the desiccant receptacle.

- 3.3.5.9 Drain Plug: A 3/4 inch pipe plug should be installed in the lowest point of the container shell at the end or quadrant containing the other service receptacles. The plug should be installed in a bushing from the outside. The location should be protected against damage from forklifts.

3.4 Design Considerations:

- 3.4.1 Section Assembly: Alignment guides should be provided to facilitate assembly of major sections of the container. If major sections of the container must be assembled in only one relative position, they should be furnished with alignment guide(s) which will permit assembly in only that one relative position.
- 3.4.2 Interchangeability: All parts which can be removed during use, maintenance, or refurbishment should be directly and completely interchangeable.
- 3.5 Container Size: The size of the container should be the minimum consistent with the size of the contents and the performance requirements of this specification. The internal arrangement must provide clearance for the movement of the items, as permitted by the isolation system.
- 3.6 Weight: The container should be of the minimum practical weight consistent with the performance requirements of this specification.
- 3.7 Finish:
- 3.7.1 Cleaning and Surface Treatment: Aluminum alloy parts not otherwise treated should be surface treated in accordance with either MIL-A-8625, or MIL-C-5541. Ferrous metal threaded and other working surfaces should be surface treated in accordance with DOD-P-16232 or MIL-C-87115, or otherwise suitably processed to resist corrosion. Other ferrous metal surfaces should be treated in accordance with TT-C-490, except that shot peen should not be used.
- 3.7.2 Painting: All steel surfaces not otherwise corrosion resistant, should be painted with one coat of primer conforming to TT-P-636 or TT-P-664 and two coats of enamel conforming to TT-E-527 or TT-E-529. The color should be specified by the procuring agency.

- 3.7.3 Chemical Agent Resistant Coating: For containers requiring chemical agent resistant coating, all steel surfaces, except threaded and other working surfaces, should be painted with one coat of primer conforming to MIL-P-52192. All aluminum alloy surfaces should be painted with one coat of primer conforming to MIL-P-23377. All the primed exterior surfaces and skids should be painted with two coats of paint conforming to MIL-C-46168, Type I, color green 383. In addition to the marking requirements of 3.9, the letters "CARC" should be marked in one-inch letters in an area as near as practicable to the nameplate. Paint conforming to MIL-C-46168, Type I, color black, should be used for all marking.

3.8 Performance

- 3.8.1 Ability of the Container to Withstand Handling: When tested in accordance with the requirements of section 4, the container and all accessories should reveal no significant structural weaknesses. No deformation should have occurred that will not permit ready disassembly, reassembly and reuse of the container following complete disassembly. The interior mounts should reveal no significant structural weaknesses. All wrinkles or dislocations in the container shell or integral parts (except skids) in excess of 3/8 inch beyond their normal plane or location should be analyzed to determine if significant structural weaknesses exist.
- 3.8.2 Ability of Container to Protect Contents: When tested in accordance with the requirements of section 4, the contents of the container should show no damage that would affect their utility. There should be no evidence of a substantial amount of shifting of the contents within the container that would create conditions likely to cause such damage during shipment. Loads transmitted to the contents must be within the fragility limits established by the manufacturer of the contents.
- 3.9 Markings: Markings should be of waterproof ink, paint or decal. Ink should conform to TT-I-1795. Paint should conform to TT-E-527 or TT-E-529. Markings should be of a contrasting color. The following markings should be applied to all containers at the locations and in the sizes indicated unless impractical, in which case markings should be reduced or increased in proportion to the size of the container.

- a. Adjacent to the lifting rings, eyes or lugs in 1.75-2.0 inch letters:

LIFT HERE

Arrows 5 inches long should point to the rings, eyes, or lugs.

- b. On opposite sides of the upper section of the container, corresponding to lift-truck openings on the skids, in 1.75-2.0 inch letters:

DO NOT DROP

CAUTION: RELEASE PRESSURE BEFORE OPENING CONTAINER

3.9 (Cont'd.)

- c. Adjacent to the record receptacle in 1-inch letters:

RECORD RECEPTACLE

- d. Adjacent to the humidity indicator in 1-inch letters:

HUMIDITY INDICATOR

- e. Adjacent to the relief valve in 1-inch letters:

RELIEF VALVE
DO NOT DISTURB

CAUTION: RELEASE PRESSURE BEFORE OPENING CONTAINER

- f. At the loaded center of balance on both sides, a vertical line 6 inches long and 1 inch wide with the marking adjacent in 1-inch letters:

LOADED CENTER OF BALANCE

- g. When the container is designed for the shipment of more than one item, adjacent to the record receptacle in 1-inch letters:

CONTAINS ATTACHMENT FOR MOUNTING
(Nomenclature and Part Number)

- h. In four places on the shell adjacent to and above the closure flange in 1-inch letters:

CAUTION: RELEASE PRESSURE BEFORE OPENING CONTAINER

- i. On the interior of the container lower shell in a prominent place, in 1-inch letters:

LIFT LOADED CONTAINER BOTTOM BY
LIFTING RINGS, EYES, OR LUGS ONLY

- j. If major sections of the container must be assembled in only one relative position, at one of the alignment guides, two corresponding arrows (one on the top half and one on the bottom half) 5 inches long, pointing to the alignment guide. Directly above and below the arrows, in 1-inch letters:

ALIGN HERE

- k. At each pair of fork lift pockets, arrows pointing to the pockets, and in 1 inch high letters:

FORK LIFT

- 3.10 Identification: A nameplate should be permanently attached to each major section of the container, permanently and legibly marked with the following minimum information:

CONTAINER: SHIPPING & STORAGE REUSABLE (nomenclature of contained item)
 Manufacturer's Part No. (of container)
 Serial No.
 Manufacturer's Name or trade-mark

- 3.10.1 Data Plate: If required, a data plate for recording rework and technical compliance data should be permanently attached to one major section of the container and located adjacent to one of the nameplates, preferably on the base.

- 3.11 Installation Instructions: Each container should be accompanied by two sets of installation instructions. One set of instructions should be placed in the record receptacle, and the second set of instructions should be bonded to the inner wall of the bottom half of the container. The instruction should be positioned for easy viewing, and be provided with waterproof protection. Instructions should include a step-by-step procedure for installing and removing the contained item, including units of desiccant required.

4. QUALITY ASSURANCE PROVISIONS:

- 4.1 Classification of Inspection: The inspection requirements specified herein are classified as follows:
- a. First Article Inspection (see 4.2, 4.3)
 - b. Acceptance inspections (Quality Conformance Inspection). These are tests performed on individual lots for acceptance (see 4.4)
- 4.2 First Article Test (Qualification Test) One container of each new design should be subjected to all the tests specified in 4.5, except 4.5.2.2.
- 4.3 Test Conditions For The First Article Tests. The container should be loaded with either an actual item or an appropriate dummy load prior to testing. The dummy load should conform in weight, weight distribution and maximum envelope to the actual item for which the container is designed. The actual item or dummy load should be instrumented as a minimum, with a tri-axial accelerometer mounted at the center of gravity, or 3 individual accelerometers mounted so as to indicate acceleration in the 3 principal axes, at the center of gravity.
- 4.4 Acceptance Inspection:
- 4.4.1 Individual Tests: Each container submitted for acceptance should be subjected to the tests as described under 4.5.1 and 4.5.2.2.