INCH-POUND
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PERFORMANCE SPECIFICATION

TESTER, PRESSURIZED CABIN LEAKAGE, AIRCRAFT, (AF/M24T-3 and AF/M32T-1)

This specification is approved for use by the Air Force Life Cycle Management Center and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This purchase specification covers two types of aircraft pressurized cabin leakage testers, designated AF/M24T-3 and AF/M32T-1, as specified.

1.2 Classification. The pressurized leakage testers are of the following types:

TYPE I	AF/M24T-3 (Electric Motor Driven, EMD
TYPE II	AF/M32T-1 (Diesel Engine Driven, DED

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

Comments, suggestions, or questions on this document should be addressed to: WR-ALC AFLCMC/WNZEC, Robins AFB GA 31098-1813 or emailed to SPEC99@us.af.mil . Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil .

AMSC N/A FSC 4920

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

INTERNATIONAL STANDARDIZATION AGREEMENTS

STANAG-3315	Air Craft Pressurizing Test Connections

FEDERAL STANDARDS

FED-STD-595/31136	Lusterless Red
FED-STD-595/37038	Lusterless Black
FED-STD-595/26173	Grey

COMMERCIAL ITEM DESCRIPTIONS

A-A-393	Extinguisher, Fire, Dry Chemical (Hand Portable)
A-A-52464	Coupler, Drawbar, Ring; Light Duty, 60,000 Lb GVW; Offset (Taper Shank), 60,000 Lb GVW; and Heavy Duty 120,000 Lb GVW
A-A-52557	Fuel Oil, Diesel; for Posts, Camps and Stations
A-A-52624	Antifreeze, Multi-Engine Type

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-2104	Lubricating Oil, Internal Combustion Engine, Combat/ Tactical Service
MIL-DTL-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-B-18013	Battery, Storage, Support Equipment
MIL-PRF-23377	Primer Coatings: Epoxy, High-Solids
MIL-DTL-25959	Tie Down, Tensioners, Cargo, Aircraft
MIL-PRF-26915	Primer Coating, for Steel Surfaces
MIL-PRF-27260	Tie Down, Cargo, Aircraft, CGU-1/B
MIL-PRF-46167	Lubricating Oil, Internal Combustion Engine, Arctic
MIL-DTL-83133	Turbine Fuels, Aviation, Kerosene Type, JP-8 (NATO F-34), NATO F-35, and JP-8+100 (NATO F-37)
MIL-DTL-81928	Manuals, Technical: Aircraft Maintenance Instructions, Technical Content Requirements.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-461	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
MIL-STD-810	Environmental Engineering Considerations and Laboratory Tests

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-470	Designing and Developing Maintainable Products and Systems
MIL-HDBK-781	Handbook for Reliability Test Methods, Plans, and Environments for Engineering, Development, Qualification, and Production

(Copies of these documents are available online at http://quicksearch.dla.mil.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AIR FORCE DRAWINGS

50B6228	Adapter Assembly-Inlet Pressurization Test, 3-inch Hose, 2 3/8 --12 Fitting.
50B6230	Adapter Assembly -- Inlet Pressurization Test, 3-inch Hose, 1 1/4 --12 Fitting.
50B6335	Gasket-Inlet Adapter Pressurization Test.
AN929	Cap Assembly, Tube, Pressure Seal
AN6270	Hose Assembly -- Detachable Swivel Fitting, Low Pressure.

(Copies of AF drawings required by manufacturers in connection with specific acquisition functions should be obtained as directed by the contracting officer).

AIR FORCE INSTRUCTION (AFI)

AFI 32-7086	Hazardous Materials Management

(Copies of this document are available online at http://www.e-publishing.af.mil/.)

TEST OPERATIONS PROCEDURE (TOP)

TOP 2-2-800	Center of Gravity

(Copies of this document are available online at https://vdls.atc.army.mil/.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

B40.1	Gauges - Pressure Indicating Dial Type - Elastic Element

(Application for copies of ANSI should be addressed to the American National Standard Institute, 11 W. 42ND Street, 13TH Floor, New York NY 10036 or online at http://webstore.ansi.org)

AMERICAN WELDING SOCIETY (AWS)

D1.1/D1.1M	Structural Welding Code–Steel–22nd Edition
D1.2/D1.2M	Structural Welding Code–Aluminum–Fifth Edition
D1.3/D1.3M	Structural Welding Code–Sheet Steel–Fifth Edition
D1.6/D1.6M	Structural Welding Code–Stainless Steel

(Application for copies should be addressed to American Welding Society, 550 N.W. LeJeune Road, Miami FL 33126 or online at http://www.amweld.org/.)

ASTM INTERNATIONAL (ASTM)

ASTM D975	Standard Specification for Diesel Fuel Oil
ASTM D1655-05	Standard Specification for Aviation Turbine Fuels

(Application for copies should be addressed to ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken PA 19428-2959 or online at http://www.astm.org.)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

MG 1	Motors and Generators
WD 6	Wiring Devices-Dimensional Specifications

(Copies of this document can be obtained online at http://www.nema.org or at National Electrical Manufactures Association, 1300 North 17th Street, Suite 1752, Rosslyn, VA. 22209 or online at http://www.nema.org/stds/.)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

Pamphlet 70	National Fire Protection Association Standard

(Copies of this document can be obtained online at http://www.nfpa.org or by mail at National Fire Protection Association, 1 Batterymarch Park, Quincy, MA. 02269)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

ARP1247	General Requirements for Aerospace Ground Support Equipment, Motorized and Nonmotorized
AS8090	Mobility, Towed Aerospace Ground Equipment, General Specification For
J541	Voltage Drop for Starting Motor Circuits

(Application for copies should be addressed to SAE, Inc., 400 Commonwealth Drive, Warrendale PA 15096 or online at http://www.sae.org/.)

TIRE AND RIM ASSOCIATION

Year Book

(Application for copies should be addressed to The Tire and Rim Association, Inc., 175 Montrose West Ave., Suite 150, Copley OH 44321 or online at htpp://www.us-tra.org/.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2b), one sample of each type shall be subjected to first article inspection in accordance with 4.2.

3.2 Item description. The tester is a self-contained, portable, trailer mounted, electric motor driven or diesel engine driven unit designed to furnish air supply under various combinations of pressures and flows to check pressurized aircraft cabins and canopy seals for leakage.

3.2.1 Components. The tester shall consist of the following as a minimum:

a. Electrical System Hardware (see 3.13)

b. Diesel Engine Driven or Electric Motor Driven (see 3.14)

c. Canopy Seal System (see 3.15)

d. Pressurization System (see 3.16)

e. Instrument Control Panel (see 3.17)

f. Housing (see 3.18)

g. Trailer (see 3.19)

h. Accessory Equipment (see 3.20)

3.3 Design and construction. The design shall promote cost effective, life-cycle sustainability by addressing considerations such as incorporating open standards, reducing pollutant emissions and wastes, and increasing fuel economy, while satisfying system performance requirements. It shall be designed and constructed so that no parts will work loose in service, and to withstand the strains, jars, vibrations, and other conditions incident to shipping, storage, installation, and service. It shall be weatherproof and designed to prevent the intrusion of water, sand, and dust into critical operating components.

3.3.1 Materials, protective coatings, and finish.

3.3.1.1 Recycled, recovered, environmentally preferable, or biobased materials. Recycled, recovered, environmentally preferable, or biobased materials shall be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.3.1.2 Protective coatings. Materials that deteriorate when exposed to sunlight, weather, or operational conditions normally encountered during the service life of the tester shall not be used or shall have means of protection against such deterioration that does not prevent compliance with the performance requirements specified herein. Protective coatings that chip, crack, or scale with age or extremes of climatic conditions or when exposed to heat shall not be used. Exposed surfaces of fasteners, handles, and fittings shall also be primed and painted. Commercial items (see 6.6.1) used as components of the tester (but not the tester itself) may be prepared and coated in accordance with the manufacturer's standard practice, provided it is compatible with the exterior finish color. See 3.3.4.2 for prohibited hazardous materials.

3.3.1.2.1 Surface preparation and pretreatment. Surface preparation and pretreatment shall be in accordance with the respective primer and topcoat specifications. Structures shall be cleaned, degreased, and scuffed or blasted prior to priming; primer shall be applied before any oxidation or rusting occurs. Aluminum surfaces shall have MIL-DTL-81706, Type II, Class 1A, chemical conversion coating applied in accordance with the manufacturer's directions prior to priming.

3.3.1.2.2 Primer. Raw metal edges, to include fastener and drain holes, shall be coated with primer before applying topcoat.

3.3.1.2.2.1 Ferrous surfaces. Ferrous structures and surfaces shall be primed with a non-water reducible zinc rich primer in accordance with MIL-PRF-26915, Type I, Class B. The zinc rich primer may be followed, within four hours, by a coat of MIL-DTL-53030 intermediate primer in a wet-to-wet primer application. The primer system shall yield a dry-film thickness of 2.0-2.5 mils for the zinc rich primer and 0.9 to 1.1 mils for the intermediate primer, if utilized. The primer system shall be allowed to dry and fully cure in accordance with the primer manufacturer's directions prior to top coating.

3.3.1.2.2.2 Aluminum and mixed aluminum and ferrous surfaces. Aluminum and mixed aluminum and ferrous structures and surfaces shall be primed with an epoxy primer, Type II, Class N of MIL-PRF-23377. This single part primer system shall yield a dry-film thickness of 0.6 to 0.8 mils.

3.3.1.2.3 Topcoat. Topcoat shall be polyurethane in accordance with Type I, Class H of MIL-PRF-85285. Neither Chemical Agent Resistant Coating (CARC) nor powder coating shall be used. Topcoat shall be applied to a dry film thickness of 1.6 to 2.4 mils in all instances, regardless of the primer system utilized. The coating shall be free from runs, sags, orange peel, or other defects.

3.3.1.3 Dissimilar metals. Dissimilar metals, as defined in MIL-STD-889, shall not be in contact with each other. Metal plating or metal spraying of dissimilar base metals to provide electromotively compatible abutting surfaces is acceptable. The use of dissimilar metals when separated by suitable insulating material is permitted, except in systems where bridging of insulation materials by an electrically conductive fluid can occur. Sealants or gel type gasket materials shall be used between faying surfaces and butt joints.

3.3.1.4 Finish. The exterior finish color of the tester and the inner surfaces of compartments shall be Gray, Color Number 26173 of FED-STD-595.

3.3.1.5 Exclusion of water. The design of the tester shall be such as to prevent water leaking into, or being driven into, any part of the tester interior when either in an operating or travelling configuration. All doors, panels, covers, etc., shall be provided with sealing arrangements such that the entry of water is minimized when these testers are correctly closed. Particular care shall be taken to prevent wetting of equipment and heat and sound proofing materials. Sharp corners and recesses shall be avoided so that moisture and solid matter cannot accumulate to initiate localized attack. Sealed floors with suitable drainage shall be provided for storage compartments, engine compartments, and other areas in the tester that could collect and retain water.

3.3.1.5.1 Fluid traps and faying surfaces. There shall be no fluid traps on the tester. Faying surfaces of all structural joints, except welded joints, shall be sealed to preclude fluid intrusion.

3.3.1.5.2 Ventilation. Ventilation shall be sufficient to prevent moisture retention and buildup.

3.3.1.5.3 Drainage. Drain holes shall be provided to prevent collection or entrapment of water or other unwanted fluid in areas where exclusion is impractical. All designs shall include considerations for the prevention of water or fluid entrapment and ensure that drain holes are located to effect maximum drainage of accumulated fluids. The number and location of drain holes shall be sufficient to permit drainage of all fluids when the tester is on a 20 degree longitudinal slope facing both up and down and on a 8 degree side slope facing both directions. The minimum size of the drain holes shall be 0.25 inch.

3.3.2 Markings. All external devices which require an operational or maintenance interface shall be marked in accordance with MIL-STD-130. Markings shall be applied with decals and shall be 1-inch high block letters unless prohibited by the available space. In such cases, the markings shall be the largest size possible. Markings, Information/Caution shall be Lusterless Black, Color Number 37038 of FED-STD-595, and Markings, Warning/Danger shall be Lusterless Red, Color Number 31136 of FED-STD-595. The center of gravity of the tester shall be stenciled on the unit within 1.0 inch of the calculated center of gravity.

3.3.3 Identification and information plates.

3.3.3.1 Identification plate. An identification plate in accordance with MIL-STD-130 shall be securely attached to the tester in a readily accessible location. The identification plate shall contain the following information: Nomenclature, part number, serial number, date of manufacture, manufacturer's name, Commercial and Government Entity (CAGE) code, date of warranty expiration, and National Stock Number (NSN). The tester and any of its components for which the Government's unit cost is more than $5,000, is serially managed, or the procuring agency determines is mission essential, shall have Unique Identification (UID) (also known as Item Unique Identification (IUID)) information permanently affixed on or near the respective identification plate(s), marked in accordance with MIL-STD-130. UID information shall be included as both a bar code and human readable markings.

3.3.3.2 Transportation data plate. A transportation data plate shall be securely attached to the tester in a readily accessible location. The plate shall contain at least the following information:

a. Side and rear silhouette views of the tester.

b. Horizontal and vertical location of the center of gravity of the tester, marked on the silhouette views.

c. Shipping weight.

d. Loading cubage.

e. Overall height, width, and length.

f. Front and rear axle loads.

g. Tie down information.

3.3.4 Environment, Safety, and Occupational Health (ESOH).

3.3.4.1 System safety. The design of the tester shall not contain any system safety mishap risk categories greater than medium as defined in Table VI of MIL-STD-882.

3.3.4.2 Hazardous material. The design shall minimize and control hazards associated with the inclusion or use of hazardous or toxic materials and the generation of toxic or noxious gases. The tester shall not generate or use Class I or Class II Ozone Depleting Substances (ODS) during operation, maintenance, or disposal. The tester shall not contain or use hexavalent chromium. For the purposes of this requirement, the Class I ODS and controlled substances identified in Chapter 4 of AFI 32-7086 shall not be used in any system, component, or process.

3.3.4.3 Component protection. All space in which work is performed during operation, service, and maintenance shall be free of hazardous protrusions, sharp edges, or other features which may cause injury to personnel. All rotating and reciprocating parts and all parts subject to high operational temperatures or subject to being electrically energized, that are of such nature or so located as to be hazardous to personnel, shall be guarded or insulated to eliminate the hazard. All wires, cables, tubes, and hoses shall be supported and protected to minimize chafing and abrasion and shall be located to provide adequate clearance from moving parts and high operational temperatures. Grommets shall be provided wherever wires, cables, tubes, or hoses pass through bulkheads, partitions, or structural members.

3.3.4.4 Foreign object damage (FOD). All loose metal parts, such as pins or connector covers, shall be securely attached to the tester with wire ropes or chains. "Dog tag" style beaded chains shall not be provided. Removable panels, if provided, shall be attached with captive fasteners. Tire valve stem caps shall be made of plastic.

3.3.4.5 Noise. The design shall ensure that noise created by the tester is compatible with the environment and minimize exposure of personnel to noise hazards during operations and maintenance activities. Acoustical noise limits shall be those that are acceptable and current for industrial application and shall be no more than 95 dBA (decibels “A” level). These limits shall not be exceeded at ten feet from the periphery of the tester. At the operators position the limits may be five decibels higher in each frequency band than those allowed at ten feet. A placard shall be added at a visible location indicating to operator that hearing protection is required.

3.3.5 Electromagnetic interference (EMI). The tester shall be in accordance with the following conducted and radiated emission and susceptibility requirements of MIL-STD-461: CE102, CE106, CS101, CS103, CS104, CS105, CS114, CS115, CS116, RE102, and RS103.

3.3.6 Human systems integration. The tester shall be designed in accordance with MIL-STD-1472 for ease of operation, inspection, and maintenance, including the use of arctic mittens and Mission-Oriented Protective Posture (MOPP) Level 4 Chemical Warfare Gear. Chemical Warfare Gear is not required for preventive maintenance.

3.3.7 Fastening devices. All screws, bolts, nuts, pins, and other fastening devices shall be properly designed, manufactured, and installed with adequate means of preventing loss of torque or adjustment. Cotter pins, lock washers, or nylon patches shall not be used for this purpose, except for the attachment of trim items or as provided in commercial components. Tapped threads shall have a minimum thread engagement in accordance with Table I.

TABLE I. Minimum thread engagement.

Material	**Minimum Thread Engagement**
Steel	1.0 times the nominal fastener diameter
Cast iron, brass, or bronze	1.5 times the nominal fastener diameter
Aluminum, zinc, or plastic	2.0 times the nominal fastener diameter

3.3.8 Welders and welding. All welders shall be certified to weld in accordance with AWS D1.1 for structural steel, AWS D1.2 for aluminum, AWS D1.3 for sheet steel, and AWS D1.6 for stainless steel, as applicable. The contractor shall make available to the Government certifications for all welders being utilized on the tester. Welding procedures and all welding on the tester shall be in accordance with AWS D1.1, AWS D1.2, AWS D1.3, and AWS D1.6, as applicable. The surface parts to be welded shall be free from rust, scale, paint, grease, and other foreign matter.

Welds shall be of sufficient size and shape to develop the full strength of the welded parts. Welds shall transmit stress without cracking or permanent distortion when the parts connected by the welds are subjected to test, proof, and service loadings. Cast components, structural steel components with an ultimate tensile strength greater than 100,000 psi, and threaded fasteners (except for weld studs and weld nuts) shall not be welded. Heat treated components shall be in the annealed, normalized condition when welded.

3.4 Environmental conditions.

3.4.1 Operating temperature range. The tester shall be capable of operating in ambient temperatures ranging from -40° Fahrenheit (F) to 125° F.

3.4.2 Storage temperature range. The tester shall be capable of being stored in ambient temperatures ranging from -65° F to 165° F.

3.4.3 Precipitation.

3.4.3.1 Rain. The tester shall be capable of storage and operation during rainfall of 5-inches per hour for three consecutive hours and 10-inches per hour for 10 consecutive minutes, with winds of up to 35 knots; and with 6-inches of rain per hour impinging on the tester at angles from vertical to 45° for 30 consecutive minutes.

3.4.3.2 Snow. The tester shall be capable of storage and operation during accretion of wet snow up to 2-inches per hour for at least 12 hours on exposed horizontal surfaces.

3.4.3.3 Ice. The tester shall be capable of storage and operation with ice accretion up to 1.5-inches on exposed horizontal surfaces. An operator may use an ice scraper for five minutes during the start-up process.

3.4.4 Solar radiation. The tester shall not be adversely affected by full time exposure to solar radiation, such as those conditions encountered in desert environments and high altitudes.

3.4.5 Fungus. All materials used in the tester shall be fungus resistant or shall be suitably treated to resist fungus. Materials treated for fungus resistance shall retain their original electronic and physical properties, shall not present toxic hazards, and treatment shall last for the entire service life of the part. The tester shall be suitable for operation and storage in conditions encountered in a tropical environment.

3.4.6 Salt fog. The tester shall be capable of storage and operation in high temperature, high humidity, salt laden, sea coast environments without damage or deterioration of performance.

3.4.7 Sand and dust. The tester shall be capable of storage and operation during exposure to wind-blown sand or dust without damage or deterioration of performance.

3.5 Weight and dimensions. Overall weight and dimensions shall not exceed Table II:

Table II. Overall weight and dimensions.

DIMENSION	PROPORTION
Weight	3500 pounds
Length	86 inches
Width	48 inches
Height	60 inches

3.6 Transportability.

3.6.1 Surface transportability. The tester shall be transportable via all modes of surface shipment (highway, rail, and water) in accordance with MIL-STD-1366, and shall be capable of withstanding the mechanical shock and vibration characteristics of highway, rail, and water transport, except that design for rail impact testing (see 5.2.5 of MIL-STD-1366) is not required.

3.6.2 Tie downs. The tester shall be symmetrically restrained during ground transport. Tie down points shall be rated at a minimum of 25,000 pounds, marked for capacity, with a clear opening compatible with MIL-DTL-25959 and MIL-PRF-27260 tie down devices. Each end of each tie down device shall terminate at a tie down point and not pass through any other tie down point. There shall be no interference between tie down devices and the tester. The tie down provisions shall be in accordance with 4.1 through 4.12 of MIL-STD-209.

3.6.3 Lifting provisions. The tester shall be equipped with sufficient attachment points so located that it can be lifted by crane; each attachment point shall be marked "Lift Point". The lifting provisions shall be in accordance with 5.1 through 5.1.4 of MIL-STD-209.

3.7 Reliability. The tester shall have a mean time between failure (MTBF) of at least 500 hours measured at 80 percent one-sided confidence limits. Definitions of reliability terms shall be in accordance with A.3. Reliability shall be applied for the EMD configuration and DMD configuration separately.

3.8 Maintainability. The tester shall be designed for maintainability in accordance with 5.9 through 5.9.18 of MIL-STD-1472; forces shall not exceed those specified for both males and females.

3.8.1 Preventive maintenance. The recommended routine preventive maintenance interval (PMI) shall be at least 250 operating hours.

3.8.2 Inspection and servicing provisions.

a. Pre-use inspections and servicing tasks shall not require tools.

b. Routine service and preventive maintenance shall not require special tools (see 6.6.3).

c. Drain plugs and filters shall be directly accessible from the ground and oriented to have unimpeded drainage to a catch pan.

d. The tester shall be designed with maximum usage of sealed lifetime lubrication bearings.

e. The tester shall be designed so the correct oil and coolant levels can be visually checked while the tester is running.

3.8.3 Relative accessibility. Critical items that require rapid maintenance shall be most accessible. When relative criticality is not a factor, items that require the most frequent access shall be most accessible. High failure rate items shall be accessible for replacement without moving non-failed items.

3.8.4 Error-proof design. The design of the tester shall incorporate error-proofing in equipment mounting, installing, interchanging, connecting, and operating.

a. Equipment shall include physical features (for example, supports, guides, size, or shape differences, fastener locations, and alignment pins) that prevent improper mounting. In the absence of physical features, equipment shall be labeled or coded to identify proper mounting and alignment.

b. Equipment that has the same form and function shall be interchangeable throughout a system and related systems. If equipment is not interchangeable functionally, it shall not be interchangeable physically.

c. Connectors serving the same or similar functions shall be designed to preclude mismating or misalignment.

d. Design, location, procedural guidance, and suitable warning labels shall be provided to prevent damage to equipment while it is being handled, installed, operated, or maintained.

3.8.5 Special tools. The design of the tester shall minimize the requirement for special tools (see 6.6.3). All special tools shall be provided with, and stored on, the tester.

3.9 Mobility. The tester shall be in accordance with SAE AS8090 for Type II, Group C mobility except as otherwise specified herein.

3.9.1 Terrain.

3.9.1.1 Paved surfaces. The tester shall be towable at speeds up to 20.0 miles per hour (mph) over paved surfaces.

3.9.1.2 Graded gravel. The tester shall be towable at speeds up to 10.0 mph over graded gravel.

3.9.1.3 Belgian block. The tester shall be towable at speeds up to 8.0 mph over Belgian block.

3.9.2 Towing force. The towing force shall be in accordance with 3.3.4 of SAE AS8090.

3.9.3 Clearances. Ground clearance, ramp breakover angle, and angles of approach and departure shall be in accordance with 3.3.9 of SAE AS8090.

3.9.4 Suspension. The tester shall have a suspension system in accordance with 3.4.1.2 of SAE AS8090.

3.9.5 Steering. The tester shall have a steering system in accordance with 3.5.1.1 of SAE AS8090.

3.9.6 Brakes.

3.9.6.1 Parking brakes. The tester shall have parking brakes in accordance with 3.6.1 of SAE AS8090.

3.9.6.2 Service brakes. The tester shall have service brakes in accordance with 3.6.2 of SAE AS8090.

3.9.7 Bumper. The tester shall have a rear bumper in accordance with 3.7 of SAE AS8090.

3.9.8 Fenders. The tester shall have fenders in accordance with 3.9 of SAE AS8090.

3.9.9 Mudflaps. The tester shall have mudflaps in accordance with 3.12 of SAE AS8090.

3.9.10 Pintle hook. The rear pintle hook, specified in 3.13 of SAE AS8090, shall not be provided; the tester shall be towed singly, not in trains, as specified in 3.3.8 of SAE AS8090.

3.9.11 Towbar. The tester shall be equipped with a towbar in accordance with 3.17.1 of SAE AS8090. It shall have a lunette eye in accordance with A-A-52464 and accommodate any pintle hook height from 22 through 30 inches. When in operation or storage (that is, not being towed), the towbar shall be stowed upright, secured, and not hinder visibility, operation, or maintenance.

3.9.12 Tires and wheels. The tester shall be equipped with single or dual tubeless steel belted radial tires with on/off-road type tread mounted on steel disc wheel assemblies. Tire and wheel assemblies shall be identical at all wheel positions. Tires and wheels shall be in accordance with the *Tire and Rim Association Year Book* requirements for this application.

3.10 Engine and related equipment. When specified (see 6.2d), the tester shall be equipped with a diesel engine. Consistent with the requirement to operate on fuels containing over 15 parts per million (ppm) sulfur, the engine shall be certified to comply with the Environmental Protection Agency (EPA) non-road diesel engine emission requirements at the time of engine manufacture.

3.10.1 Engine starting system.

3.10.1.1 Starter. The engine shall be equipped with a 12 volt DC electric starter.

3.10.1.2 Engine starting aids. The engine shall start within 15 seconds cranking in any ambient temperature within the required operating range of the tester. Internal engine starting aids, fluid starting aids, and heat from the winterization system (see 3.11) may be used prior to and during the start period to facilitate engine starting under the following conditions in Table III:

TABLE III. Engine starting aids.

Temperature Range	Starting Aids Permitted
40° F through 125° F	None
0° F through 39° F	Internal engine starting aids and fluid starting aids
-40° F through -1° F	Internal engine starting aids, fluid starting aids, and heat from the winterization system

3.10.2 Engine air intake system. The engine air intake system shall be in accordance with 3.13.1.4.3 of SAE ARP1247. The inlet shall not draw air from directly beneath the tester and shall not be located near the cooling system air outlet nor the engine exhaust outlet. Joints shall be minimized between the air filter outlet and the actual engine air inlet and shall be designed to ensure no leakage of unfiltered air into the engine. A differential pressure air filter service indicator shall be provided.

3.10.3 Engine cooling system. The engine cooling system shall be in accordance with 3.13.1.4.2 of SAE ARP1247. Silicone radiator and heater hoses, constant-torque clamps, a coolant filter, and a coolant recovery system shall be provided. Engine coolant shall be in accordance with A-A-52624, Type I, and of adequate strength to provide protection to -65° F. The engine out (top of radiator) coolant temperature shall not exceed 210° F or the engine manufacturer's recommendations at 125°F during operation. The coolant filter shall be rated for one year or 2,000 hours between replacements, with supplementary coolant additives (SCA) either included in the filter or added separately.

3.10.4 Engine lubrication system. The engine lubrication system shall be designed so that the tester can be operated on a 20 degree longitudinal slope facing both up and down and on a 8 degree side slope facing both directions.

3.10.4.1 Engine oil. The engine shall be compatible with Grade 15W40 of MIL-PRF-2104 from 0° F to 125° F. Oil pre-heat for operation below 0° F is allowed. The engine shall be compatible with arctic engine oil in accordance with MIL-PRF-46167 from -40° F to 60° F.

3.10.4.1.1 Engine oil operating temperature. The engine oil sump temperature shall not exceed 250° F or the engine manufacturer's recommendations at 125° F during operation.

3.10.4.1.2 Engine oil consumption. The engine oil consumption shall not exceed 0.0035 pounds per brake horsepower-hour (lbs/bhp-hr) under any operating condition.

3.10.4.2 Engine oil filter. The engine oil filter shall be in accordance with 3.13.1.4.4 of SAE ARP1247.

3.10.5 Exhaust system. The exhaust system shall be constructed of stainless steel. The muffler(s) shall be constructed of aluminized steel or stainless steel. Exhaust system outlet(s) shall be directed away from personnel accessing any control panel or equipment compartment and the engine air intake, and shall not be directed toward the ground.

3.10.6 Engine fuels and fuel system.

3.10.6.1 Engine operating fuels. The following shall be standard operating fuels:

a. 1-D S15, 1-D S500, 1-D S5000 in accordance with A-A-52557 and ASTM D975, below 60° F ambient air temperature.

b. 2-D S15, 2-D S500, 2-D S5000 in accordance with A-A-52557 and ASTM D975, above 32° F ambient air temperature.

c. JP-5, in accordance with MIL-DTL-5624, -40° F to 125° F ambient air temperature.

d. JP-8, in accordance with MIL-DTL-83133, -40° F to 125° F ambient air temperature.

e. TS-1 in accordance with GOST 10227-86 with JP-8 additives, -40° F to 125° F ambient air temperature.

3.10.6.2 Engine emergency fuels. The following shall be emergency fuels:

Jet A, Jet A1 in accordance with ASTM D1655-05, all ambient temperatures.

Note: Jet A and Jet A1 may contain corrosion inhibitor/lubricity improver and icing inhibitors which shall result in properties equal to JP-8.

3.10.6.3 Engine fuel consumption. When operating on JP-8, the engine at full rated load shall not exceed 450 lbs/bhp/hr brake specific fuel consumption.

3.10.6.4 Fuel system. The fuel system shall be in accordance with 3.13.1.5.1 through 3.13.1.5.11 of SAE ARP1247 except as otherwise specified herein. The fuel system shall be constructed of materials which are compatible with the fuels listed in 3.10.6.1 and 3.10.6.2. Copper shall not be used in the fuel system. The fuel system shall be equipped with a fuel shut-off valve(s) to prevent continuous spillage when fuel lines are disconnected for service.

3.10.6.4.1 Fuel priming pump. The tester shall be equipped with an electric fuel pump in addition to the mechanical fuel pump. The electric pump shall be used as a priming pump capable of re-priming the engine fuel system following fuel exhaustion.

3.10.6.4.2 Fuel filters. Primary and secondary fuel filters and a heated fuel/water separator shall be provided. The fuel/water separator shall include a water coalescer and a drain valve that is readily accessible by an operator or a mechanic. A combination fuel filter and fuel/water separator may be provided. Fuel filter elements shall be easily replaceable by a mechanic using nothing more than common hand tools (see 6.6.2) without loss of engine prime.

3.10.6.4.3 Fuel tank. The fuel tank shall be in accordance with 3.13.1.5.5 through 3.13.1.5.9 of SAE ARP1247. The tank shall be designed so that the tester can be operated on a 20 degree longitudinal slope facing up and down and on a 8 degree side slope facing both directions. The tank shall be provided with corrosion protection and baffles. A 0.25 to 0.375-inch nominal drain valve shall be provided for emptying fuel and sediment into a container underneath the tester without removal of the tank or any other major component. The fuel tank shall have a fuel fill opening of not less than three inches inside diameter and shall be designed to drain fuel spillage overboard for collection outside the tester. The fuel cap shall be equipped with a retention device to prevent loss and FOD. The fuel fill opening, fuel cap, and fuel cap retention device shall be fabricated from non-sparking material.

3.10.7 Engine diagnostic and emergency shutdown systems.

3.10.7.1 Engine diagnostic system. If the engine is equipped with an electronic control module, a diagnostic system shall be provided with a means to indicate engine faults; it shall be equipped with a CAN buss connector. If the tester is equipped with a diagnostic or built-in-test system, the engine diagnostic system shall be integrated with it; if not, it shall be a standalone system.

3.10.7.2 Engine emergency shutdown system. The engine shall be equipped with an engine emergency shutdown system consisting of a fuel cutoff solenoid activated by the following conditions:

a. Low oil pressure, less than 10 psi or in accordance with the engine manufacturer's recommendations.

b. Coolant over heat or cylinder head temperature over heat condition in accordance with the engine manufacturer's recommendations.

c. Engine over speed should the engine exceed 110% rated speed. This is required for engines over 100 bhp and optional for engines less than 100 bhp rated horsepower.

3.10.8 Engine operator instruments. The following instruments shall be provided to the engine operator for the diesel engine:

a. Tachometer.

b. Coolant temperature gauge.

c. Low coolant level indicator.

d. Oil pressure gauge.

e. Oil temperature gauge.

f. Fuel level gauge.

g. Hour meter.

3.10.9 Electrical system. The tester shall have a 12-volt, negative ground electrical system in accordance with 3.13.1.2 of SAE ARP1247 except as otherwise specified herein.

3.10.9.1 Alternator. A single or dual alternator charging system in accordance with 3.13.1.4.9 of SAE ARP1247 shall be provided. The alternator shall be capable of restoring the energy expended during an engine start in less than 15 minutes of engine idle at -40° F.

3.10.9.2 Batteries and battery compartment.

3.10.9.2.1 Batteries. Batteries shall be of the commercial maintenance-free sealed lead acid, starved electrolyte, gas recombination, spiral wrapped, absorbent gas mat (AGM), top post type in accordance with MIL-B-18013/1.

3.10.9.2.2 Battery compartment. The batteries shall be enclosed in a corrosion-resistant, weatherproof box or compartment and shall be readily accessible.

3.10.9.2.3 Battery cables. The battery cables shall be sized to handle the system voltage and current levels, be clearly identified with "+" and "-" or red and black markings, and shall not be spliced.

3.10.9.2.4 Battery charging system. A commercial battery charging system with sufficient capacity shall be supplied.

3.11 Winterization system. A winterization system may be provided for starting in temperatures to -40° F. The winterization system may include heaters for engine coolant, engine oil, and the fuel tank, as well as battery warmers, refer to Table III. The winterization system shall be designed to operate from an external electrical source (see 3.13). The winterization system shall incorporate high-temperature shutoff switches to prevent overheating of any fluid or component.

3.12 Performance requirements. The tester shall provide a range of 10 through 400 cubic feet per minute (CFM); standard airflow -- 0.765 through 30.6 pounds per minute (PPM) and a pressure range of 2 through 12.5 pounds per square inch gage (PSIG). The canopy seal pressure system shall provide 1 CFM standard air at 65 PSI.

3.12.1 Safety devices. Shields and caution notes shall be furnished where necessary and maximum use shall be made of applicable safety devices.

3.12.1.1 Danger zone. A red danger zone shall be marked on the air temperature gauge face beginning at 120 ° F.

3.12.1.2 Relief device. A relief device shall be incorporated to prevent over pressurization of aircraft under test.

3.13 Electrical system hardware. All electrical equipment and wiring shall conform to NFPA Pamphlet 70. All electrical equipment less than 18 inches from the ground surface shall be explosion proof for Class I, Division 2 location per Section 511-2 of NFPA Pamphlet 70. For EMD class, the electrical system shall be designed for operation on an external 380/440V, 3 phase, 50/60 cycle power supply and shall be designed for conversion to 220V, 3 phase, 50/60 cycle; voltage tolerance shall be ± 10 percent and the frequency tolerance shall be ± 5 percent.

3.13.1 Blower motor (EMD class only). The blower motor shall be in accordance with NEMA MG1 and shall drive the blower continuously under any conditions specified herein at maximum capacity without exceeding the temperature limits for the class of insulation used. The manufacturer's recommended full-load current shall not be exceeded during operation. The motor shall be designed to minimize the starting current surge when connected for 220V operation.

3.13.2 Blower control. A remote-operated control to turn the blower on/off shall be provided. For EMD class, the remote-operated control shall utilize 110V power and a circuit breaker, part-wind starter circuit for 220V operation, transformer fuse protection, overload heaters, and reverse phase relays shall be provided. For DED class, the remote-operated control shall utilize the 12V diesel engine electrical power.

3.13.3 Compressor control. A remote-operated control to turn the compressor on/off shall be provided. For EMD class, a 220/380/440V, single phase, 50/60 cycle remote-operated control for the compressor shall be provided. For DED class, a 12V remote-operated control for the compressor shall be provided.

3.13.4 Starter and starter case. A starter case to enclose all remote controls shall be furnished. For the EMD class, a 220/380/440V to 110V control transformer shall be furnished in the starter case. Complete instructions shall be furnished on a permanent nameplate fastened inside the starter case giving directions for converting the tester from 220V to 380/440V operation and vice versa.

3.13.5 Start-stop button. A momentary-contact, low-voltage protection start-stop push button shall be provided and mounted on the instrument panel for the blower control and compressor control. No key ignition shall be used.

3.13.6 Circuit breaker. A circuit breaker shall be furnished for each branch circuit.

3.13.7 Reverse rotation prevention device. A device shall be provided that will prevent operation of the electric motor(s) in reverse rotation in the event of incorrect phasing.

3.13.8 Electric cable and plug. The alternating current input cable shall be an extra flexible, 4 conductor cable, in accordance with current industry practices, 50 feet in length. The 48V contacts C1 and C2 shall be bridged at the plug. The cable shall be securely attached to the tester to take all strain from the terminals.

3.14 Diesel Engine Driven or Electric Motor Driven. When diesel engine driven is specified (see 6.2d), a diesel engine and all necessary accessories shall be selected and provided by the contractor in accordance with this specification; the blower shall be diesel engine driven and the air compressor shall be electric motor driven powered by the diesel engine 12V electrical system. When electric motor driven is specified (see 6.2d), an external electrical source (3.13) shall power all electrical motors in accordance with this specification.

3.15 Canopy seal system. The canopy seal system shall be capable of continuously providing 1 CFM standard oil-free air at 65 PSIG when supplied with air at 77° F and 29.92 Hg for pressurizing aircraft canopy seals. The output of the compressor shall be controlled by an automatic pressure regulator with manual adjustment to maintain any pressure setting throughout a range of 5 psi to 60 psi. A safety device shall be provided to limit maximum pressure to 65 psi. A pressure gage, 0 to 100 PSI scale (± 2% of full scale), shall be provided to indicate canopy seal pressure. The canopy seal pressure outlet on the tester shall have an SAE AS5406-6D fitting, and SAE AS5178-6D nut with an AN929-6D dust cap.

3.15.1 Air compressor. The air compressor for the canopy seal system shall be the type that is currently acceptable for industrial use. A maximum pressure relief valve set at 70 PSIG shall be provided in the system.

3.16 Pressurization system. The pressurization system shall consist of the following:

3.16.1 Blower. A positive displacement blower with intercooling shall be provided to supply 400 CFM standard air (30.6 PPM) at 12.5 PSI measured at the discharge end of the outlet hose. The bearings used in the blower shall be easily replaceable.

3.16.1.1 Drive shaft clearance. Means shall be provided for sealing the external and internal drive shaft clearance holes in the end plates to prevent leakage.

3.16.1.2. Installation and removal. Alignment of blower to engine (for DED class only) shall not require special tools for installation or removal.

3.16.2 Intake silencer. The blower intake shall be equipped with an air-intake/cleaner/silencer device that does not protrude more than 3 inches from the tester exterior surface.

3.16.3 Blower outlet silencer. A silencer shall be provided to reduce noise and dampen the pulsation of the blower discharge air.

3.16.4 Aftercooler. An air-to-air aftercooler capable of providing the required cooling and volume of air shall be provided. The aftercooler shall have sufficient capacity to cool blower discharged air to within 25° F of existing ambient temperature while delivering maximum flow and pressure.

3.16.4.1 Aftercooler fan. An aftercooler fan shall be provided to supply the necessary cooling air to the aftercooler.

3.16.4.2 Aftercooler fan inlet. The aftercooler fan inlet shall be equipped with adjustable louvers which lock in any degree of opening.

3.16.4.3 Aftercooler fan exhaust. The aftercooler fan exhaust shall extend to the outside of the tester housing and be protected from foreign objects.

3.16.5 Pressure regulating device. A pressure regulating device shall be provided to automatically regulate the pressure in the aircraft cabin being pressurized, and shall be installed between the aftercooler and flowmeter. For all pressure conditions, and where flow is varied between 50 and 400 CFM, the valve shall limit the rate of pressure change to ± 500 foot pounds per minute (FPM) as registered on the pressure equalization indictor. For all pressure conditions, and where flow is varied between 10 and 50 CFM, the pressure regulating valve shall limit the rate of pressure change between ± 750 FPM. The valve shall also limit pressure changes to between ± 1,500 FPM during adjustments of the pressure regulator to a new pressure setting.

3.16.5.1 Pressure regulating valve. The pressure regulating valve shall be free from chatter and of such capacity as to bypass the total output of the main blower at any pressure above 2 PSI without creating more than 0.50 PSI pressure rise above the valve setting.

3.16.5.2 Valve control system. The valve control system shall be manually adjustable and will remain fixed at any pressure set within the range of 2 through 12.5 PSI for all flow and temperature conditions specified herein. The manual adjustment for the valve control system shall be located on the instrument panel and calibrated in 0.25 PSI increments from 0 through 12.5 PSI (cabin pressure). The valve control system shall incorporate a sensitive means to adjust flow and to correct for changes, and shall include a pilot control valve, air resistor, and maximum pressure relief valve.

3.16.5.3 System dumping. A means shall be provided to dump the system at a minimum rate of 80 CFM with the unit running.

3.16.6 Air outlet connection. A 3 inch hose connection in accordance with SAE-AS5131 shall be provided at the flowmeter discharge and shall extend 6 inches beyond the tester housing for hose connection. The outlet shall be rigidly supported to prevent damage to the flow meter in the event the protruding section of the outlet is severely damaged, twisted, or sheared off. A protective cap, attached in some manner, shall be provided to protect all air outlets.

3.16.7 Air ducts. The air ducts and passages between the components specified herein shall provide a minimum of elbows, restrictions which would create an excessive pressure drop through the system. Hose of proper temperature and pressure rating is allowed between blower discharge and heat exchanger inlet.

3.17 Instrument control panel. The tester shall have a control panel on which all necessary instruments, gages, switches, valves, and controls shall be mounted. The panel and its accessories shall be readily accessible to operating personnel, and all testers shall be so mounted that they may be easily removed for replacement or servicing. Instruments subject to errors from vibration shall be shock mounted. All testers mounted on the panel shall be permanently and legibly identified by nameplates. A 4 by 6 inch, engraved, permanent-type diagram plate, showing the pneumatic circuit shall be securely fastened on or near the control panel. Voltages greater than 110V shall not be used on the control panel. The panel shall be located at sufficient height above the ground to accommodate a standing operator and inclined at an angle, 10° minimum.

3.17.1 Flowmeter. The flowmeter shall be accurate to within at least 2 percent of scale and shall measure the airflow to the aircraft being pressurized. The flowmeter shall provide a range of from 10 through 400 CFM standard air at pressures from 2.0 through 14.0 PSI . The pressure lines on the flowmeter shall be graduated in 2 PSI increments throughout the pressure range. Protective covering shall be provided over the flowmeter to protect the operator from injury in case the flowmeter should break or explode.

3.17.2 Temperature correction on curve. A legible waterproof pressure temperature correction curve shall be provided and mounted on the panel adjacent to the flowmeter for correcting observed airflow readings to ambient conditions. Pressure lines shall be shown and marked to correspond with pressure lines on the flowmeter.

3.17.3 Conversion chart. A legible, waterproof chart shall be provided and located on the panel for converting the airflow from cubic feet per minute to pounds per minute.

3.17.4 Pressure equalization indicator A rate of climb indicator shall be furnished to indicate pressure equalization of the tester output and the enclosure being pressurized. The dial face shall indicate decreasing and increasing pressurization instead of up and down. The indicator shall be red-lined beyond the 5,000-foot mark, both increasing and decreasing. Some means shall be provided to prevent damage to the instrument should the rate of increasing or decreasing pressure exceed the 5,000-foot mark. A permanent-type, etched or engraved nameplate containing the following information shall be securely attached to the panel immediately below the indicator.

CAUTION -- DO NOT INCREASE OR DECREASE CABIN PRESSURIZATION AT THE RED-LINED RATES

3.17.5 Cabin pressure gage. The corrosion-resistant gage shall be accurate to within 1 percent or less of full scale and shall conform to ANSI B40.1 except as specified herein. The gage shall provide a range of from 0 to 15 PSI and shall incorporate a means to restore the accuracy of the gage under all service conditions. The gage shall be suitable for operation from -40° F to 140° F. The gage shall be of the recess type provided with a mounting flange at the front of the gage. The mounting flange and dial shall not extend more than 5/8-inch beyond the external surface of the panel. All gages shall incorporate a safety blowout device to automatically relieve pressure in the gage case should the pressure reach .50 PSI due to gage failure. The pointer shall be adjustable without removing the gage from the panel.

3.17.6 Discharge air temperature indicator. A remote-reading, dial-type temperature indicator having a scale range of from -40° F to approximately 200° F and accurate within ±2° F throughout the range shall be furnished. The temperature indicator shall measure the temperature of the pressurized air on the discharge side of the flowmeter and shall be marked by a red sector above 120° F. A caution plate containing the following marking shall be securely attached:

CAUTION -- AIR TO CABIN SHOULD NOT EXCEED 120° F.

3.17.7 Pressure gages. The corrosion-resistant gages specified herein shall be included on the panel. Each pressure gage shall incorporate a safety blowout device that shall relieve the gage case pressure should it reach 0.50 PSI due to gage failure. The dial and pointer shall be separated from the gage movement to prevent rupture through the front of the gage in the event of gage failure. The pointer shall be adjustable without removing the gage from the panel. All gages shall be mounted using screws and tapped panel holes to permit removal by one person from front of the panel.

3.17.7.1 Connection. Pressure gages shall be connected with flexible AN or MS-type hose, or commercial equivalent, of sufficient length to permit removal and installation from the front of the panel.

3.17.7.2 Gage test fitting. The following three fittings in Table IV shall be mounted on the control panel adjacent to the appropriate gages, and the panel marked to indicate that the fittings are gage test connections.

Table IV. Gage test fittings.

Fittings
3.17.1.2.1 AS5406-4D nipple
3.17.1.2.2 AS5178-4D nut
3.17.1.2.3 AN929-4

3.17.7.3 Tubing. The interconnecting air lines shall be 1/2 inch OD tubing and connected to the hoses and takeoff points by means of AN fittings. The static pressure line outlet from the tester for connection to the static hose shall be an AS5406-8D fitting and an AS5178- 8D nut with an AN929-8 dust cap. 1/4 inch OD tubing may be used for internal connection lines for static systems only.

3.17.8 Blower pressure gage. A pressure gage having a minimum dial size of 3 inches, a range of 0 to 20 PSI, and minimum accuracy of 1 percent of full scale shall be furnished to indicate the blower pressure at the inlet side of the flowmeter.

3.17.9 Canopy seal pressure gage. A pressure gage with a scale range of 0 to 100 PSI, accurate to within 2 percent of full scale, shall be provided in the canopy seal system.

3.17.10 Hourmeter. A hourmeter having a range of from 0 to 9,999 hours shall be provided to record the hours of operation of the blower motor.

3.18 Housing. The tester components shall be completely enclosed in a weather-resistant housing. The housing shall utilize doors and adjustable louvers as required. The housing shall be capable of supporting a 200-pound weight distributed evenly over an area 4.50 by 5 inches at any location on top of the housing. The housing shall be adequately braced to prevent distortion or excessive vibration during handling and operation of the tester or handling of the housing while being removed from the tester.

3.18.1 Doors. The housing shall be provided with sufficient access and ventilating doors and adjustable louvers to permit access for operating and servicing, and to ventilate the tester. The doors and louvers in the housing shall be free from binding and easily operated with one hand. Provisions shall be incorporated to secure the doors rigidly in the fully open or fully closed position. An access port in the housing shall be provided to allow removal of temperature sensor from the discharge flowmeter.

3.18.2 Handles. The housing shall be easily removable by actuating not more than 12 quick-acting disconnecting fasteners and lifting or sliding the entire housing off the remainder of the tester. Handles or lifting eyes shall be provided for this purpose.

3.19 Trailer. The components of the tester shall be mounted and assembled on a trailer having mobility requirements as specified.

3.20 Accessory equipment. The following accessories shall be furnished:

a. One AN6270-8-300 hose. (Dust plugs, securely attached to the hose with metal chain, shall be provided for each end of hose.)

b. One AN6270-6-300. (Dust plugs, securely attached to the hose with metal chain**,** shall be provided for each end of hose.)

c. One AS5172-0608D bushing to adapt the 1/2-inch hose to the 3/8-inch static fitting on the aircraft.

d. One AS5172-0406D bushing to adapt the 3/8-inch hose to the 1/4-inch canopy seal fitting on the aircraft.

e. A complete set of adapters and a gasket for each in accordance with Drawings 50B6228, 50B6230, and 50B6335.

f. One 25-foot length of 3-inch (inside diameter) flexible, pressurized air hose, in accordance with MIL-DTL-26521, and the necessary clamps to secure the hose to the outlet specified in 3.17.6 and to the adapters specified in tester.

g. One stethoscope for detecting cabin leakage through the skin of the aircraft. The stethoscope shall be suitable for use at -40° F and shall be of rugged construction to withstand hard service usage.

3.21 Accessory box. An accessory box having three separate compartments shall be provided within the housing. One compartment shall contain the hose assemblies and fittings (installed on the hose) specified in 3.20 a, b, c, and d; the second compartment shall contain the adapters with gaskets specified in 3.20 e; the third compartment shall contain the stethoscope specified in 3.20 g. The box shall have a hinged cover with a hasp for possible padlocking and for holding the cover closed.

3.22 Pressurization hose storage device. A rack, tray, or compartment shall be provided within the tester housing to store the pressurization hose specified in 3.20 f. In addition, metal brackets shall be provided on the exterior of the housing to permit temporary storage of all hoses without disconnecting them from the outlets. The brackets shall be designed to retract against the housing when not in use.

3.23 Handbook compartment. A handbook compartment shall be provided and permanently mounted within the tester housing. The compartment interior shall be a minimum size of 10 by 12 by 4 inches.

3.24 Interchangeability. All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable. The drawing number and part numbers shall be structured in a manner to identify the tester.

3.25 Weight and dimensions. Overall weight and dimensions shall not exceed Table V:

Table V. Overall weight and dimensions.

DIMENSION	PROPORTION
Weight	3500 pounds
Length	120 inches
Width	60 inches
Height	70 inches

3.26 Workmanship. The tester, including all parts and accessories, shall be constructed and finished in a thoroughly workmanlike manner. Workmanship objectives shall include freedom from blemishes, defects, burrs and sharp corners and edges; accuracy of dimensions, surface finish, and radii of fillets; thoroughness of welding, painting, and riveting; marking of parts and assemblies; and proper alignment of parts and tightness of assembly fasteners.

3.26.1 Bolted connections. Bolt holes shall be accurately punched or drilled and shall be deburred. Threaded fasteners shall be tight and shall not work loose during testing or service usage.

3.26.2 Riveted connections. Rivet holes shall be accurately punched or drilled and shall be deburred. Rivets shall be driven with pressure tools and shall completely fill the holes. Rivet heads shall be full, neatly made, concentric with the rivet holes, and in full contact with the surface of the component.

3.26.3 Gear and lever assemblies. Gear and lever assemblies shall be properly aligned and meshed and shall be operable without interference, tight spots, loose spots, or other irregularities. Where required for accurate adjustment, gear assemblies shall be free of excessive backlash.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. First Article inspection (see 4.2).

b. Conformance inspection (see 4.3).

Requirements shall be verified in accordance with Table VI.

TABLE VI. Requirement verification matrix.

Section 3 Requirement	Verification Method	Section 4 Verification
3.1 First Article	Not Applicable (N/A)	
3.2 Item Description.	N/A	
3.3 Design and construction.	Examination	4.6.1 Examination of product.
3.3.1 Materials, protective coatings, and finish.	N/A	
3.3.1.1 Recycled, recovered, environmentally preferable, or biobased materials.	Examination	4.6.1 Examination of product.
3.3.1.2 Protective coatings.	Examination	4.6.1 Examination of product.
3.3.1.2.1 Surface preparation and pretreatment.	Examination	4.6.1 Examination of product.
3.3.1.2.2 Primer.	Examination	4.6.1 Examination of product.
3.3.1.2.2.1 Ferrous surfaces.	Examination	4.6.1 Examination of product.
3.3.1.2.2.2 Aluminum and mixed aluminum and ferrous surfaces.	Examination	4.6.1 Examination of product.
3.3.1.2.3 Topcoat.	Examination	4.6.1 Examination of product.
3.3.1.3 Dissimilar metals.	Examination	4.6.1 Examination of product.
3.3.1.4 Finish.	Examination	4.6.1 Examination of product.
3.3.1.5 Exclusion of water.	Examination	4.6.1 Examination of product.
3.3.1.5.1 Fluid traps and faying surfaces.	Examination	4.6.1 Examination of product.
3.3.1.5.2 Ventilation.	Examination	4.6.1 Examination of product.
3.3.1.5.3 Drainage.	Examination	4.6.1 Examination of product.
3.3.2 Markings.	Examination	4.6.1 Examination of product.
3.3.3 Identification and information plates.	N/A	
3.3.3.1 Identification plate.	Examination	4.6.1 Examination of product.
3.3.3.2 Transportation data plate.	Examination	4.6.1 Examination of product.
3.3.4. Environment, Safety, and Occupational Health (ESOH).	N/A	
3.3.4.1 System safety.	Analysis	4.6.14 System safety hazard analysis.
3.3.4.2 Hazardous material.	Examination	4.6.1 Examination of product.
3.3.4.3 Component protection.	Examination	4.6.1 Examination of product.
3.3.4.4 Foreign object damage (FOD).	Examination	4.6.1 Examination of product.

TABLE VI. Requirement verification matrix – Continued.

Section 3 Requirement	Verification Method	Section 4 Verification
3.3.4.5 Noise.	Test	4.6.7 Noise level.
3.3.5 Electromagnetic interference (EMI).	Test	4.6.6 Electromagnetic interference test.
3.3.6 Human systems integration.	Demonstration	4.6.1 Examination of product. 4.6.18 Maintainability Demonstration
3.3.7 Fastening devices.	Examination	4.6.1 Examination of product.
3.3.8 Welders and welding.	Examination	4.6.1 Examination of product.
3.4 Environmental conditions.	N/A	
3.4.1 Operating temperature range.	Test	4.6.3.2 High temperature. 4.6.3.1 Low temperature.
3.4.2 Storage temperature range.	Test	4.6.3.2 High temperature 4.6.3.1 Low temperature
3.4.3 Precipitation.	N/A	
3.4.3.1 Rain.	Test	4.6.3.3 Rain test.
3.4.3.2 Snow.	Analysis	4.6.3.4 Snow load analysis.
3.4.3.3 Ice.	Test	4.6.3.5 Ice accretion test.
3.4.4 Solar radiation.	Examination	4.6.1 Examination of product.
3.4.5 Fungus.	Examination	4.6.1 Examination of product.
3.4.6 Salt fog.	Test	4.6.3.6 Salt fog test.
3.4.7 Sand and dust.	Test	4.6.3.7 Sand and dust test.
3.5 Weight and dimensions.	Test	4.6.15 Weight and dimension tests. 4.6.15.1 Weight and center of gravity test. 4.6.15.2 Dimension measurement.
3.6 Transportability.	N/A	
3.6.1 Surface transportability.	Analysis	4.6.16 Surface transportability analysis.
3.6.2 Tie downs.	Analysis	4.6.15.1 Tie down analysis.
	Test	4.6.13 Reliability Analysis and Tests.
3.6.3 Lifting Provisions	Analysis	4.6.15.2 Lifting provisions analysis
3.7 Reliability	Test	4.6.13 Reliability Analysis and Tests.
3.8 Maintainability.	Demonstration	4.6.18 Maintainability Demonstration

TABLE VI. Requirement verification matrix – Continued.

Section 3 Requirement	Verification Method	Section 4 Verification
3.8.1 Preventive maintenance.	Demonstration	4.6.18 Maintainability Demonstration
3.8.2 Inspection and servicing provisions.	Demonstration	4.6.18 Maintainability Demonstration
3.8.3 Relative accessibility.	Examination	4.6.1 Examination of product.
3.8.4 Error-proof design.	Examination	4.6.1 Examination of product.
3.8.5 Special tools.	Examination	4.6.1 Examination of product.
3.9 Mobility.	N/A	4.6.11 Mobility tests.
3.9.1 Terrain.	N/A	4.6.11 Mobility tests.
3.9.1.1 Paved surfaces.	Test	4.6.11 Mobility tests.
3.9.1.2 Graded gravel.	Test	4.6.11 Mobility tests.
3.9.1.3 Belgian block.	Test	4.6.11 Mobility tests.
3.9.2 Towing force.	Test	4.6.11 Mobility tests.
3.9.3 Clearances.	Test	4.6.15.2 Dimension measurement.
3.9.4 Suspension.	Examination	4.6.1 Examination of product.
	Test	4.6.11 Mobility tests.
3.9.5 Steering.	Examination	4.6.1 Examination of product.
	Test	4.6.11 Mobility tests.
3.9.6 Brakes.	N/A	4.6.17 Brake tests.
3.9.6.1 Parking brakes.	Test	4.6.17.1 Parking brake test.
	Test	4.6.8 Operation in tilted position
3.9.6.2 Service brakes.	Test	4.6.17.2 Service brake test.
3.9.7 Bumper.	Examination	4.6.1 Examination of product.
3.9.8 Fenders.	Examination	4.6.1 Examination of product.
3.9.9 Mudflaps.	Examination	4.6.1 Examination of product.
3.9.10 Pintle hook.	Examination	4.6.1 Examination of product.
3.9.11 Towbar.	Examination	4.6.1 Examination of product.
3.9.12 Tires and wheels.	Examination	4.6.1 Examination of product.
3.10 Engine and related equipment.	Examination	4.6.1 Examination of product.
3.10.1 Engine starting system.	N/A	
3.10.1.1 Starter.	Examination	4.6.1 Examination of product.
3.10.1.2 Engine starting aids.	Examination	4.6.1 Examination of product.
	Test	4.6.3.1 Low temperature.
3.10.2 Engine air intake system.	Examination	4.6.1 Examination of product.
	Demonstration	4.6.20 Maintainability Demonstration
3.10.3 Engine cooling system.	Examination	4.6.1 Examination of product.
	Test	4.6.3.2 High temperature.
3.10.4 Engine lubrication system.	Test	4.5.3 Test rejection criteria

TABLE VI. Requirement verification matrix – Continued.

Section 3 Requirement	Verification Method	Section 4 Verification
3.10.4.1 Engine oil.	Examination	4.6.1 Examination of product.
3.10.4.1.1 Engine oil operating temperature.	Test	4.6.3.2 High temperature
3.10.4.1.2 Engine oil consumption.	Examination	4.6.1 Examination of product.
3.10.4.2 Engine oil filter.	Examination	4.6.1 Examination of product.
3.10.5 Exhaust system.	Examination	4.6.1 Examination of product.
3.10.6 Engine fuels and fuel system.	N/A	
3.10.6.1 Engine operating fuels.	Examination	4.6.1 Examination of product.
	Test	4.6.3.2 High temperature 4.6.3.1 Low temperature
3.10.6.2 Engine emergency fuels.	Examination	4.6.1 Examination of product.
3.10.6.3 Engine fuel consumption.	Examination	4.6.1 Examination of product.
3.10.6.4 Fuel system.	Examination	4.6.1 Examination of product.
3.10.6.4.1 Fuel priming pump.	Examination	4.6.1 Examination of product.
	Test	4.5.3 Test rejection criteria
3.10.6.4.2 Fuel filters.	Examination	4.6.1 Examination of product.
	Demonstration	4.6.18 Maintainability Demonstration
3.10.6.4.3 Fuel tank.	Examination	4.6.1 Examination of product.
3.10.7 Engine diagnostic and emergency shutdown systems.	N/A	
3.10.7.1 Engine diagnostic system.	Examination	4.6.1 Examination of product.
3.10.7.2 Engine emergency shutdown system.	Examination	4.6.1 Examination of product.
	Test	4.5.3 Test rejection criteria
3.10.8 Engine operator instruments.	Examination	4.6.1 Examination of product.
3.10.9 Electrical System	Test	4.6.8 Electrical system test
3.26 Workmanship.	Examination	4.6.1 Examination of product.
3.26.1 Bolted connections.	Examination	4.6.1 Examination of product.
3.26.2 Riveted connections.	Examination	4.6.1 Examination of product.
3.26.3 Gear and lever assemblies.	Examination	4.6.1 Examination of product.

4.2 First article inspection. The first article tester shall be subjected to the analyses, demonstrations, examinations, and tests described in 4.6.1 through 4.6.20. Throughout the remainder of this specification, the "first article tester" shall be referred to as just "tester". The contractor shall provide or arrange for all test equipment and facilities. Unless otherwise approved by the procuring activity, the tester shall be in the same configuration at all times and configuration changes shall not be made during the first article inspection.

4.3 Conformance inspection. Each production tester shall be subjected to the examination described in 4.6.1.

4.4 Test conditions.

4.4.1 Standard atmospheric conditions. When the pressure and temperature existing at the time of the test are not specified definitely, it is understood that the test is to be made at atmospheric pressure, approximately 29.92 inches Hg, and at room temperature, approximately 73° F. All airflow readings shall be reduced to standard air readings of 0.07651 PCF at 60° F.

4.4.2 Apparatus and instruments. Apparatus and instruments used in conjunction with testing specified herein shall be of laboratory precision type and shall be carefully checked to ascertain that they have been installed in a satisfactory manner for durability and accurate operation and shall be calibrated at intervals properly spaced to assure laboratory efficiency.

4.4.3 Airflow. The airflow shall be measured by means of the most accurate, scientifically recognized techniques, instruments and methods and shall be acceptable when certified.

4.4.4 Test periods. Unless otherwise specified, any test run shorter than 1 hour shall not be counted as test time.

4.4.5 Preliminary run-in and calibration. Any preliminary run-in of the tester as recommended by the manufacturer shall be performed by the manufacturer prior to submission of the tester for testing. A certified log of all preliminary running time and calibration data shall be submitted to the procuring activity.

4.5 Inspection requirements.

4.5.1 General inspection requirements. Apparatus used in conjunction with the inspections specified herein shall be laboratory precision type, calibrated at proper intervals to ensure laboratory accuracy.

4.5.2 Data. During all testing specified herein, at least the following data, unless not applicable, shall be recorded at intervals not to exceed 30 minutes. Additional data or shorter intervals shall be provided as appropriate for any specific test.

a. Date.

b. Time started.

c. Time finished.

d. Ambient temperature.

e. Ambient humidity.

4.5.3 Test rejection criteria. Throughout all tests specified herein, the tester shall be closely observed for the following conditions, which shall be cause for rejection. Note that these conditions are not related to reliability failures:

a. Failure to conform to design or performance requirements specified herein or in the contractor's technical proposal.

b. Any spillage or leakage of any liquid, including fuel, coolant, lubricant, or hydraulic fluid, under any condition, except as allowed herein.

c. Structural failure of any component, including permanent deformation, or evidence of impending failure.

d. Evidence of excessive wear. If excessive wear is suspected, the original equipment manufacturer's (OEM's) specifications or tolerances shall be utilized for making a determination.

e. Evidence of corrosion or deterioration.

f. Misalignment of components.

g. Conditions that present a safety hazard to personnel during operation, servicing, or maintenance.

h. Interference between the tester components or between the tester, the ground, and all required obstacles, with the exception of normal contact by the tires.

i. Evidence of undesirable mobility characteristics, including instability in handling during cornering, braking, and while traversing all required terrain.

j. Shutdown faults from:

   (1) Engine cooling system.

   (2) Engine lubrication system.

   (3) Engine protective circuits.

4.5.4 Failure reporting, analysis, and corrective action system (FRACAS). A closed loop system shall be used to collect data, analyze, and record timely corrective action for all potential failures that occur during the First Article tests. The contractor's existing FRACAS shall be utilized with the minimum changes necessary to conform to this specification. The system shall cover all test samples, interfaces between test samples, test instrumentation, test facilities, test procedures, test personnel, and the handling and operating instructions. The contractor shall establish and maintain a FRACAS database; all information shall be entered into the database. Authorized procuring activity personnel shall have read-only access to the FRACAS database.

4.5.4.1 Problem and failure action. At the occurrence of a problem or potential failure that affects satisfactory operation of a test sample, entries shall be made in the appropriate data logs and the failed test sample shall be removed from test, with minimum interruption to the other test samples continuing on test.

4.5.4.1.1 Problem and failure reporting. A failure report shall be initiated at the occurrence of each problem or potential failure of the contractor hardware or software. The report shall contain the information required to permit determination of the origin and correction of the failure. The contractor's existing failure report form may be used with minimum changes necessary to conform to the requirements of this specification. The failure report form shall include the information specified in a through c:

a. Descriptions of failure symptoms, conditions surrounding the failure, failed hardware identification, and operating time (or cycles) at the time of failure.

b. Information on each independent and dependent failure and the extent of confirmation of the failure symptoms, the identification of failure modes, and a description of all repair actions taken to return the test sample to operational readiness.

c. Information describing the results of the investigation, the analysis of all part failures, an analysis of the system design, and the corrective action taken to prevent failure recurrence. If no corrective action is taken, the rationale for this decision shall be recorded.

4.5.4.1.2 Identification and control of failed tester. A failure tag shall be affixed to the failed part immediately upon the detection of any failure or suspected failure. The failure tag shall provide space for the failure report serial number and for other pertinent entries from the test sample failure record. All failed parts shall be marked conspicuously or tagged and controlled to ensure disposal in accordance with contract requirements. Failed parts shall not be handled in any manner which may obliterate facts which might be pertinent to the analysis. Failed parts shall be stored pending disposition by the authorized approval agency of the failure analysis.

4.5.4.1.3 Problem and failure investigations. An investigation and analysis of each reported failure shall be performed. Investigation and analysis shall be conducted to the level of hardware or software necessary to identify causes, mechanisms, and potential effects of the failure. Any applicable method (for example, test, microscopic analysis, applications study, dissection, X-ray analysis, spectrographic analysis) of investigation and analysis which may be needed to determine failure cause shall be used. When the removed part is not defective or the cause of failure is external to the part, the analysis shall be extended to include the circuit, higher hardware assembly, test procedures, and subsystem if necessary

4.5.4.1.4 Failure verification. Reported failures shall be verified as actual failures or an acceptable explanation provided to the procuring activity for lack of failure verification. Failure verification is determined either by repeating the failure mode of the reported part or by physical or electrical evidence of failure (for example, leakage residue or damaged hardware). Lack of failure verification, by itself, is not sufficient rationale to conclude the absence of a failure.

4.5.4.1.5 Corrective action. When the cause of failure has been determined, a corrective action shall be developed to eliminate or reduce the recurrence of the failure. Repairs shall be made in accordance with normal field operating procedures and manuals. The procuring activity shall review the corrective actions at the scheduled test status review prior to implementation. In all cases the failure analysis and the resulting corrective actions shall be documented.

4.5.4.1.6 Problem and failure tracking and closeout. The closed loop failure reporting system shall include provisions for tracking problems, failures, analyses, and corrective actions. Status of corrective actions for all problems and failures shall be reviewed at scheduled test status reviews. Problem and failure closeout shall be reviewed to assure their adequacy.

4.6 Test methods.

4.6.1 Examination of product. The tester shall be examined to verify compliance with the requirements herein prior to accomplishing any other demonstrations or tests listed in 4.6. A contractor-generated, Government-approved checklist (part of the test procedure) shall be used to identify each requirement not verified by an analysis, certification, demonstration, or test, and shall be used to document the examination results. Particular attention shall be given to materials, workmanship, dimensions, surface finishes, protective coatings and sealants and their application, welding, fastening, and markings. Proper operation of each tester function shall be verified. Certifications and analyses shall be provided in accordance with Table VII. Each production tester shall be inspected to a Government-approved reduced version of the checklist.

TABLE VII. Certifications and analyses.

Paragraph	**Required Certifications and Analyses**
3.3.4.1 System safety.	System safety hazard analysis (see 4.6.14).
3.4.3.2 Snow.	Contractor analysis of the snow load requirement (see 4.6.3.4).
3.4.4 Solar radiation.	Contractor certification that the tester performance is not adversely affected by full time exposure to solar radiation, such as those conditions encountered in desert environments.
3.4.5 Fungus.	Contractor certification that the materials used in construction of the tester are fungus resistant or suitably treated to resist fungus.

TABLE VII. Certifications and analyses – Continued.

Paragraph	Required Certifications and Analyses
3.6.1 Surface transportability.	Contractor surface transportability analysis (see 4.6.16) and certification that the tester is transportable via all modes of surface shipment (highway, rail, and water) in accordance with MIL-STD-1366, and shall be capable of withstanding the mechanical shock and vibration characteristics of highway, rail, and water transport.
3.6.2 Tie downs.	Contractor tie down provision analysis (see 4.6.12.1).
3.7 Reliability.	4.6.13 Reliability analysis and tests
3.10 Engine and related equipment., 3.10.3 engine cooling system., 3.10.4 Engine lubrication system., 3.10.6.1 Engine operating fuels., and 3.10.6.2 Engine emergency fuels.	Engine manufacturer certification that the engine is in accordance with all applicable requirements, including exhaust emissions standards and fuels. Engine manufacturer application approval for the engine and its installation, including cooling system, lubrication system, and mounting system.
4.19 Electrical certification	4.19 Electrical certification

4.6.2.Calibration test. The 25-foot length of 3-inch supply hose and 25-foot length of 1/2inch static hose shall be connected to their respective fittings on the tester and connected to similar fittings on a 16-cubic-foot test tank. The output of the test tank shall be directed through a throttling valve into measuring instrument specified in 4.4.3. A laboratory test gage with an accuracy of 0.50 of 1 percent of full scale shall be installed to read the pressure within the test tank. Other gauges, manometers, and thermometers in accordance with 4.4.2 shall be installed as required. The calibration of the tester shall then be checked at 400, 300, 200, 100, and 10 CFM standard air at each pressure condition of 10, 7.5, 6, 4.5, 3, and 1.5 PSIG. The pounds per minute airflow readings of the tester (as determined by the testers, gages, flowmeter, conversion and correction charts shall be within 3 percent or less of the readings of the calibration equipment at all pressure-flow settings listed. The accuracy of the pressure equalization indicator specified in 3.17.4 and the cabin pressure indicator specified in 3.17.5 shall be checked against the test tank gage and a stopwatch (lowering and raising pressure in the test tank at the 5,000-foot rate). The pressure regulating valve shall be checked for compliance with 3.16.5 and 3.16.5.1.

4.6.3 Environmental test. The tester shall be subjected to the following tests. Upon completion of each environmental test, with hoses installed, the operation of the tester shall be checked at 400, 200, 100, and 10 CFM standard air at each pressure condition of 12.5, 7.5, and 2.0 PSIG. All valves, gages, meters, adjustable louvers, accessories, and canopy seal system shall be checked for satisfactory performance during the test. Failure of the tester to operate as required during or after each exposure; failure of the tester or assembly due to deterioration from exposures in this test; or formation of any undesirable condition that cannot be remedied by routine maintenance procedures shall be cause for rejection.

4.6.3.1 Low temperature. The tester shall be subjected to low temperature in accordance with the following procedure to demonstrate compliance with MIL-STD-810 502.6, and section 3.4.1 and 3.4.2 of this specification: After a continuous 168 hour exposure period at -40° F, the ambient temperature shall be increased to -20° F and starting procedure accomplished. The motor shall start within 5 seconds and shall reach rated output of 400 CFM standard air at 12.5 PSI within 15 minutes after starting. All gages, valves, meters, accessories, louvers and regulators shall be operated and shall perform satisfactorily in the -20° F ambient temperature condition. With the louvers fully closed, the temperature of the outlet air shall be not less than 60° F.

4.6.3.2 High temperature. The tester shall be subjected to high temperature in accordance with the following procedure to demonstrate compliance with MIL-STD-810 501.6, and sections 3.4.1 and 3.4.2 of this specification: Upon completion of the 50-hour exposure, the ambient temperature shall be lowered to 125° F. With hoses installed, the operation of the tester shall be checked at 400, 200, 100, and 10 CFM standard air at each pressure condition of 12.5, 7.5, and 2.0 PSIG. All valves, gages, meters, adjustable louvers, accessories, and canopy seal system shall be checked for satisfactory performance during the test. Failure of the aftercooler system to limit the temperature of the pressurized air leaving the tester to a minimum of 125° F while the tester is operating at full capacity of 400 CFM standard air and 12.5 PSI in the 125° F ambient shall be cause for rejection.

4.6.3.3 Rain test. The tester shall be subjected to rain in accordance with the following procedure to demonstrate compliance with MIL-STD-810 506.6, and section 3.4.3.1 of this specification: The tester shall be positioned on the test chamber floor in its normal operating position. After exposure to rain for the allotted time, the tester shall be started and operated at 400 CFM and 12.5 psig for a period of 30 minutes. Failure of the tester to start or operate satisfactorily during the rain test shall be cause for rejection.

4.6.3.4 Snow load analysis. An engineering analysis shall be performed to demonstrate compliance with the snow load requirement of 3.4.3.2, using a specific gravity of snow of 0.1 (Ref. 5.3 of MIL-STD-810, Part Three).

4.6.3.5 Ice accretion test. The tester shall be tested in accordance with MIL-STD-810, Method 521.4 with an ice thickness of 1.5-inches to demonstrate compliance with the ice accretion requirement of 3.4.3.3. The contractor shall identify those areas of the tester where ice removal is required prior to operation.

4.6.3.6 Salt fog test. The tester shall be tested in accordance with MIL-STD-810, Method 509.6, to demonstrate compliance with 3.4.6. Test duration shall be alternating 24-hour periods of salt fog exposure and drying conditions for 24-hour periods (two wet and two dry).

4.6.3.7 Sand and dust test. The tester shall be tested in accordance with MIL-STD-810, Method 510.6, Procedures I (12 hours) and II (90 minutes per side), to demonstrate compliance with 3.4.7.

4.6.4 Air compressor test. The canopy seal air compressor shall be operated at least 25 percent of the time during all endurance tests accomplished under 4.6.4. The performance of the compressor shall be checked periodically during each test. Failure of the drive coupling or any marked decrease in performance or failure of a component part of the pressurizing system shall be cause for rejection.

4.6.5 Electromagnetic interference test. The tester shall be tested in accordance with MIL-STD-461: CE102, CE106, CS101, CS103, CS104, CS105, CS114, CS115, CS116, RE102, and RS103 to demonstrate compliance with 3.3.5. When applicable, any engine fuel in accordance with 3.10.6.1 may be utilized.

4.6.6 Noise level. The noise level of the tester shall be measured 10 feet from the perimeter of the tester being tested to demonstrate compliance with 3.3.4.5. Measurements shall be taken outside on a paved surface in at least 12 different operator positions 30° apart in a horizontal plane parallel to the trailer bed. During this test, the tester shall be operated at full rated load. The tester shall be operated during this test with a 200 standard cubic feet per minute (SCFM) by-pass.

4.6.7 Operation in tilted position. The tester shall rest on a platform with the parking brakes set to prevent it from rolling. The platform supporting the tester shall be tilted in eight different directions, 45° apart, on an 8 1/2° incline with the true horizontal plane. The tester shall be started and operated at 400 CFM and 12.5 PSI for 15 minutes in each position.

4.6.8 Electrical system test. The electrical system shall be inspected and shall meet all requirements specified herein. During the last hour of the full capacity endurance run specified in 4.6.4.b., above, the temperature rise in the motor windings shall be determined by the resistance method. If the temperature rise exceeds the safe-temperature limits for the class of insulation used, as prescribed by NEMA MG1, the tester shall be rejected. A certified test report shall be submitted showing that the motors do not exceed safe temperature-rise limits when operating at a 6,000-foot pressure altitude and full load.

4.6.9 Overload relay. The blower motor (for EMD class only) shall be overloaded to 125 percent of full load current and sustained until overload relays trip and shut off the motor. The overload relays shall trip before any damage is caused to the motor and in no case shall it take longer than 15 minutes to open the main contractor. The same test shall also be run on the canopy seal compressor motor.

4.6.10 Reverse rotation preventive device. The device specified in para 3.13.7, above shall be tested by incorrectly phasing the blower motor in the opposite direction of rotation. The device shall prevent the motor from running in the reverse direction and from damaging any components that might otherwise be damaged by incorrect phasing.

4.6.11 Mobility. The tester shall be tested in accordance with Table VIII of SAE AS8090 to demonstrate compliance with the mobility requirements of 3.9.1, 3.9.2, 3.9.3, and 3.9.5. Note that the maximum towing force is 75 pounds per ton of gross weight, in accordance with 3.3.4 of SAE AS8090, rather than 50 pounds per ton of gross weight as stated in Table VIII of SAE AS8090.

4.6.12 Tiedowns and lifting provisions analyses.

4.6.12.1 Tiedowns analysis. An engineering analysis shall be performed to demonstrate compliance with 3.6.2.

4.6.12.2 Lifting provisions analysis. An engineering analysis shall be performed to demonstrate compliance with 3.6.3.

4.6.13 Reliability analysis and tests.

4.6.13.1 Reliability model and prediction. The contractor shall develop and maintain a basic reliability model for the system in accordance with A.4.1. The contractor shall prepare and maintain a basic reliability prediction for the system in accordance with A.4.2; it shall be based upon the associated basic reliability model.

4.6.13.2 Reliability tests. All of the first article testers shall be subjected to a reliability qualification test (RQT) in accordance with 4.6.13.2.1. All of the testers shall be operated continuously throughout the entire test period, except as approved by the procuring activity or when a tester is taken off line for a PMI or investigation or repair of a failure or implementation of a corrective action (see A.3.1). The time accumulated while a tester is off line shall not be included in the test time. PMIs shall be staggered, if possible, so that only one tester is off line for a PMI at any time. All requirements of Appendix A shall apply to the reliability tests. Failure definitions shall be in accordance with A.3.3—A.3.8.

4.6.13.2.1 RQT. A 2150 hour fixed-duration RQT shall be performed to demonstrate compliance with 3.7. Nominal consumer's and producer's risks shall be 20 percent; the discrimination ratio shall be 2.0, and no more than 2 failures shall be allowed. (Ref. Test Plan XVII-D of MIL-HDBK-781.) Failure suppression, the removal of a failure from the RQT based upon the assumption that a future corrective action will eliminate that failure mode, shall not be allowed.

The tester (EMD or DMD) shall be connected through the 25 ft long, 3.5 in diameter, collapsible air hose as described in 3.20 f, to a throttling device to create the required pressure and flow conditions (pressures and flows shall be measured at the hose outlet) for the following endurance tests. Readings shall be recorded every 30 minutes for all gages, meters, and instruments of the tester and output flow, pressure. Barometric pressure and ambient temperatures shall be recorded for each reading. If 24 hour manning is not possible, the test periods may be fragmented and the data recorded for each period of operation to achieve the total number of hours for each case listed below:

a. Conduct the calibration tests specified in 4.6.2 above.

b. 192 hours of operation at 400 CFM and 12.5 PSI.

c. 42 hours operation at 400 CFM and 8 PSI.

d. 42 hours operation at 400 CFM and 2 PSI.

e. 42 hours operation at 200 CFM and 3.5 PSI.

f. 42 hours operation at 100 CFM and 8 PSI.

g. 42 hours operation at 10 CFM and 2 PSI.

h. Conduct the calibration tests specified in 4.6.2 below.

The periods of operation above will complete a cycle. This cycle shall be repeated until a total time of accumulated 2150 hours is completed.

•Note: Comparison of data from item h above with data from a above shall indicate whether a failure or undue wear has resulted during the endurance test.

4.6.14 System safety hazard analysis. A system safety hazard analysis of the tester shall be conducted in accordance with 4.3.1 through 4.3.8 of MIL-STD-882 to demonstrate compliance with the mishap risk requirement of 3.3.4.1.

4.6.15 Weight and dimension tests.

4.6.15.1 Weight and center of gravity test. The weight of the tester shall be measured to demonstrate compliance with the weight requirement of 3.5. The center of gravity shall be measured in accordance with 4.4 of TOP 2-2-800.

4.6.15.2 Dimension measurement. The tester shall be measured to demonstrate compliance with the dimensional requirements of 3.5 and 3.9.3.

4.6.16 Surface transportability analysis. An engineering analysis shall be performed to demonstrate compliance with 3.6.1. The engineering analysis shall utilize the data for road transportation in accordance with MIL-STD-810, Method 514.6, Table 514.6C-II.

4.6.17 Brake tests.

4.6.17.1 Parking brake test. The tester shall be tested in accordance with 4.5.7.1 of SAE AS8090 to demonstrate compliance with 3.9.6.1.

4.6.17.2 Service brake test. The tester shall be tested in accordance with 4.5.7.2 and 4.5.8 of SAE AS8090 to demonstrate compliance with 3.9.6.2.

4.6.18 Maintainability demonstration. All recommended preventive maintenance tasks shall be performed and task times recorded to demonstrate compliance with 3.8.1. Forces required to accomplish tester maintenance tasks shall be measured and recorded to demonstrate compliance with 3.8. Check accessibility when performing maintenance of tester parts to demonstrate compliance with 3.8.3. All preventive maintenance tasks recommended to be performed daily and during routine PMI shall be performed by personnel wearing arctic mittens to demonstrate compliance with 3.3.6.

The tester shall be inspected and evaluated from the standpoint of ease of maintenance, servicing, operation and safety. Particular note shall be made with regard to provisions made to prevent accumulation of snow, ice and any element which may hinder servicing and operation.

4.6.19 Electrical certification. The contractor shall submit documentation that the electrical system specified in 3.10.9 that will be supplied under this specification meets the requirements of pamphlet 70. The label or listing of the Underwriters' Laboratories, Inc. will be accepted as evidence of conforming to the specification requirements.

4.6.20 Compatibility test. After successful completion and Government approval of all first article inspection analyses, demonstrations, examinations, and tests described in 4.6.1 through 4.6.21, the tester shall be subjected to the compatibility test. The tester shall be shipped to Edwards AFB for the compatibility test, and the tester shall be shipped back to the contractor's facility when the compatibility test is complete. After arrival of the tester, commencement of compatibility test will occur. The Air Force will conduct all compatibility tests, but on-site contractor support shall be required for up to 5 consecutive business days. Compatibility test shall be completed within 60 days of tester being shipped from contractor facility (includes shipping time). Compatibility test shall be satisfactorily completed prior to first article acceptance.

5. PACKAGING

5.1 For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The TYPE I or TYPE II testers covered by this specification are intended for use in ground checking and maintenance of aircraft pressurized cabins.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this PD.

b. If first article inspection is required (see 3.1).

c. DED or EMD Classification required (see 1.2, 3.10, 3.14)

d. Packaging requirements (see 5.1).

6.3. International standardization agreement implementation. This specification implements NATO STANAG 3315, Aircraft Cabin Pressurizing Test Connections. When amendment, revision, or cancellation of this specification is proposed, the preparing activity must coordinate the action with the U.S. National Point of Contact for the international standardization agreement, as identified in the ASSIST database at https://assist.daps.dla.mil.

6.4 Key Words

Electric Motor
Diesel Engine

6.5 Definitions.

6.5.1 Commercial item.

(1) Any item, other than real property, that is of a type customarily used by the general public or by non-Governmental entities for purposes other than Governmental purposes, and—

(i) Has been sold, leased, or licensed to the general public; or

(ii) Has been offered for sale, lease, or license to the general public;

(2) Any item that evolved from an item described in paragraph (1) of this definition through advances in technology or performance and that is not yet available in the commercial marketplace, but will be available in the commercial marketplace in time to satisfy the delivery requirements under a Government solicitation;

(3) Any item that would satisfy a criterion expressed in paragraphs (1) or (2) of this definition, but for—

(i) Modifications of a type customarily available in the commercial marketplace; or

(ii) Minor modifications of a type not customarily available in the commercial marketplace made to meet Federal Government requirements. Minor modifications means modifications that do not significantly alter the non-Governmental function or essential physical characteristics of an item or component, or change the purpose of a process. Factors to be considered in determining whether a modification is minor include the value and size of the modification and the comparative value and size of the final product. Dollar values and percentages may be used as guideposts, but are not conclusive evidence that a modification is minor;

(4) Any combination of items meeting the requirements of paragraphs (1), (2), (3), or (5) of this definition that are of a type customarily combined and sold in combination to the general public;

(5) Installation services, maintenance services, repair services, training services, and other services if—

(i) Such services are procured for support of an item referred to in paragraph (1), (2), (3), or (4) of this definition, regardless of whether such services are provided by the same source or at the same time as the item; and

(ii) The source of such services provides similar services contemporaneously to the general public under terms and conditions similar to those offered to the Federal Government;

(6) Services of a type offered and sold competitively in substantial quantities in the commercial marketplace based on established catalog or market prices for specific tasks performed or specific outcomes to be achieved and under standard commercial terms and conditions. For purposes of these services—

(i) "Catalog price" means a price included in a catalog, price list, schedule, or other form that is regularly maintained by the manufacturer or vendor, is either published or otherwise available for inspection by customers, and states prices at which sales are currently, or were last, made to a significant number of buyers constituting the general public; and

(ii) "Market prices" means current prices that are established in the course of ordinary trade between buyers and sellers free to bargain and that can be substantiated through competition or from sources independent of the offerors.

(7) Any item, combination of items, or service referred to in paragraphs (1) through (6) of this definition, notwithstanding the fact that the item, combination of items, or service is transferred between or among separate divisions, subsidiaries, or affiliates of a contractor; or

(8) A nondevelopmental item, if the procuring agency determines the item was developed exclusively at private expense and sold in substantial quantities, on a competitive basis, to multiple State and local Government. (Reference the Federal Acquisition Regulation (FAR) 2.101)

6.5.2 Common hand tool. A non-powered tool that is likely to be found in a typical mechanic's toolbox. Common hand tools include open end, boxed end, combination, socket (both 6- and 12-point in both standard and deep-well), and hex key wrenches, in SAE sizes up to and including 1-inch and metric sizes up to and including 25-mm; ratchet handles, extensions, and swivels; slotted and Phillips-head screwdrivers; regular and snap-ring pliers; and a ball-peen hammer.

6.5.3 Special tool. A tool that is not commercially and readily available from a source other than the tester contractor.

6.5.4 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes."

RELIABILITY AND MAINTAINABILITY

A.1 SCOPE

A.1.1 Scope. This appendix provides definitions of reliability and maintainability terms for use during the first article and operational tests. It provides procedures for performing reliability models and predictions, a Failure Modes, Effects, and Criticality Analysis (FMECA), a Reliability-Centered Maintenance (RCM) analysis, and maintainability predictions. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

A.2 APPLICABLE DOCUMENTS.

A.2.1 Government documents.

A.2.1.1 Specifications, standards, and handbooks. The following standard and handbooks of the exact revision listed below form a part of this specification to the extent specified herein.

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-189	Reliability Growth Management
MIL-HDBK-217	Reliability Prediction of Electronic Equipment
MIL-HDBK-338	Electronic Reliability Design Handbook
MIL-HDBK-470	Designing and Developing Maintainable Products and Systems
MIL-HDBK-781	Handbook for Reliability Test Methods, Plans, and Environments for Engineering, Development, Qualification, and Production

(Copies of these documents are available online at http://quicksearch.dla.mil/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

A.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications of the exact revision level shown form a part of this document to the extent specified herein.

NAVAL SURFACE WARFARE CENTER CARDEROCK DIVISION (NSWCCD)

NSWC-11	Handbook of Reliability Prediction Procedures for Mechanical Equipment

(Copies of this document are available online at:
http://www.navsea.navy.mil/nswc/carderock/pub/mechrel/products/handbook.aspx

or from Naval Surface Warfare Center, Carderock Division, West Bethesda MD 20817-5700.)

A.2.2 Non-Government publications. The following documents of the exact revision listed below form a part of this document to the extent specified herein.

RELIABILITY INFORMATION ANALYSIS Center (RIAC)

NPRD-11	Nonelectronic Parts Reliability Data
NPRD-95	Nonelectronic Parts Reliability Data
FMD-97	Failure Mode/Mechanism Distributions

(Application for copies should be addressed to Reliability Information Analysis Center, 201 Mill Street, Rome NY 13440.)

A.2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

A.3 DEFINITIONS

A.3.1 Corrective action. A fix; that is, a change to the design, operation, and maintenance procedures, or to the manufacturing process of the item for the purpose of improving the reliability. (Reference MIL-HDBK-189)

A.3.2 Discrimination ratio (d). The discrimination ratio (d) is one of the standard reliability qualification test (RQT) plan parameters; it is the ratio of the upper test MTBF (θ_0) to the lower test MTBF (θ_1) that is, $d = \frac{\Theta_0}{\Theta_1}$. (Reference MIL-HDBK-781)

A.3.3 Failure. The event, or inoperable state, in which any item, or part of an item, does not, or would not, perform as previously specified. (Reference MIL-HDBK-470)

A.3.4 Failure, chargeable. A failure that is not non-chargeable. Replacement of a consumable item (such as a filter or a fan belt) at the preventive maintenance interval (PMI) is not a chargeable failure.

A.3.5 Failure, non-chargeable. A failure that is a non-relevant (see A.3.6); that is induced by Government furnished equipment (GFE) operating, maintenance, or repair procedures; or of a part having a specified life expectancy and operated beyond the specified replacement time of the part. A nonrecurring fluid or recurring fluid leak that does or does not result in formation of a droplet shall be non-chargeable unless the leak causes the system to be unsafe. A recurring fluid leak where a droplet forms and falls and any recurring fluid leak where the frequency of droplets makes a measurable stream shall be chargeable. Light bulb and label failures shall be non-chargeable.

A.3.6 Failure, intermittent. Failure for a limited period of time, followed by the item's recovery of its ability to perform within specified limits without any remedial action. (Reference MIL-HDBK-470)

A.3.7 Failure, non-relevant. A failure caused by installation damage; accident or mishandling; failure of the test facility or test-peculiar instrumentation; an externally applied overstress condition, in excess of the approved test requirements; normal operating adjustments specified in the approved operating instructions; or human error. A secondary failure within the test sample, which is directly caused by a non-relevant or relevant primary failure, is also a non-relevant failure. The secondary failure has to be proved to be dependent on the primary failure.

A.3.8 Failure, relevant. An intermittent failure; an unverified failure (a failure which cannot be duplicated, which is still under investigation or for which no cause could be determined); a verified failure not otherwise excluded as a non-relevant failure; or a pattern failure.

A.3.9 Fix. A fix is a corrective action that results in a change to the design, operation, and maintenance procedures, or to the manufacturing process of the item for the purpose of improving the reliability. (Reference MIL-HDBK-189)

A.3.10 Functionally Significant Item (FSI). A Functionally Significant Item (FSI) is an item whose failure meets one of the following criteria.

a. Could affect safety.

b. Could result in severe damage or equipment loss.

c. Could degrade or negate mission accomplishment (including survivability provisions).

d. Could have a significant economic impact.

e. Could have one or more of the above effects in combination with another item failure (hidden function).

f. Could have secondary consequences leading to one or more of the above effects.

g. Could have one or more of the above effects due to environmental deterioration or accidental damage.

A.3.11 Mean time between failure (MTBF). Mean time between failure (MTBF) is a basic measure of reliability for repairable items. The mean number of life units during which all parts of the item perform within their specified limits, during a particular measurement interval under stated conditions.

A.3.12 MTBF, lower test (θ_1). Lower test MTBF (θ_1) is that value which is the minimum acceptable. The standard RQT plans will reject, with high probability, equipment with a true MTBF that approaches (θ_1). The lower test MTBF is the required MTBF. (Reference MIL-HDBK-781)

A.3.13 MTBF, upper test (θ_0). Upper test MTBF (θ_0) is an acceptable value of MTBF equal to the discrimination ratio (d) times the lower test MTBF (θ_1). The standard RQT plans will accept, with high probability, equipment with a true MTBF that approaches (θ_0). This value (θ_0) should be realistically attainable, based on experience and information. The upper test MTBF is also known as the “design to” MTBF. (Reference MIL-HDBK-781)

A.3.14 MTBF, predicted (θ_p). Predicted MTBF (θ_p) is that value of MTBF determined by reliability prediction methods; it is a function of the equipment design and the use environment. Predicted MTBF (θ_p) should be equal to or greater than the upper test MTBF (θ_0) in value, to ensure, with high probability, that the equipment will be accepted during the RQT. (Reference MIL-HDBK-781)

A.3.15 Mean time to repair (MTTR). Mean time to repair (MTTR) is the sum of corrective maintenance times at any specific level of repair, divided by the total number of failures within an item repaired at that level during a particular interval under stated conditions. (Reference MIL-HDBK-470)

A.3.16 Replaceable item (RI). A replaceable item (RI) is any of those physical entities normally removed and replaced to effect repair at the maintenance level for which the prediction is being made. (Reference MIL-HDBK-470)

A.3.17 Repair. A repair is the refurbishment of a failed part or replacement of a failed part with an identical unit in order to restore the system to be fully mission capable. (Reference MIL-HDBK-189).

A.3.18 Risk, consumer’s (β). Consumer’s risk (β) is the probability of accepting equipment with a true MTBF equal to the lower test MTBF (θ_1). The probability of accepting equipment with a true MTBF less than the lower test MTBF (θ_1) will be less than the consumer’s risk (β). (Reference MIL-HDBK-781)

A.3.19 Risk, producer’s (α). Producer’s risk (α) is the probability of rejecting equipment which has a true MTBF equal to the upper test MTBF (θ_0). The probability of rejecting equipment with a true MTBF greater than the upper test MTBF (θ_0) will be less than the producer’s risk (α). (Reference MIL-HDBK-781)

A.4 REQUIREMENTS

A.4.1 Basic reliability model. The contractor shall develop and maintain a basic reliability model for the entire tester. All equipment and associated quantities comprising these parts shall be included in the model to at least Level 3 of the Bill of Materials (BOM). All equipment, including those intended solely for item redundancy and alternate modes of operation, shall be modeled in series. A basic reliability block diagram shall be developed and maintained for the items with associated allocations and predictions in each reliability block. The basic reliability block diagram shall be keyed and traceable to functional block diagrams, drawings, and schematics, and shall provide the basis for accurate mathematical representation of basic reliability. Nomenclature of elements of the item used in the basic reliability block diagrams shall be consistent with that used in functional block diagrams, drawings, schematics, weight statements, power budgets, and specifications.

A.4.2 Basic reliability prediction. The contractor shall prepare and maintain a basic reliability prediction for the relevant subsystems of the tester as described in 3.7; it shall be based upon the associated basic reliability model (see A.4.1). All equipment and associated quantities comprising these parts shall be included in the model except for documented exclusions approved by the procuring activity. Failure rate data (or equivalent reliability parameters) shall be consistent with the level of detail of the basic reliability model. The prediction shall be based upon the worst-case service use profile. All data sources for failure rates, failure distribution, and failure rate adjustment factors (for example, stress factors, duty cycle, etc.) shall be identified for each reliability block. Data sources shall be MIL-HDBK-217, NPRD-11, NPRD-95, NWSC-11, or as otherwise approved by the procuring activity; ground mobile (G_M) data shall be used. Note that these data sources do not contain failure rate data for all possible components in all possible environments and the data for a specific component may not be relevant for any particular application; these data sources shall be supplemented as required.

A.4.3 Failure Modes, Effects, and Criticality Analysis (FMECA). The contractor shall perform a FMECA on all FSIs utilizing the basic reliability model (see A.4.1). The body of the FMECA shall be a table with following information provided for each failure mode. In the discussion below, the term "item" refers to the part, subsystem, system, or end item, as appropriate.

A.4.3.1 Identification number. The contractor shall assign an identification number to each failure mode of each item for traceability purposes; it shall identify both the block in the reliability model and the specific failure mode related to that block.

A.4.3.2 Nomenclature. The nomenclature for the item shall be listed; the nomenclature shall be consistent with that used in the basic reliability model.

A.4.3.3 Functions. A concise statement of the functions performed by the hardware item shall be listed. These functions shall include the inherent function(s) of the item, secondary function(s), and relationship(s) to interfacing items.

A.4.3.4 Failure modes and causes. All predictable failure modes for each indenture level analyzed shall be identified and described. Potential failure modes shall be determined by examination of item outputs and functional outputs identified in applicable block diagrams and schematics. Failure modes of the individual item function shall be postulated on the basis of the stated requirements in the system definition narrative and the failure definitions included in the ground rules. The most probable causes associated with the postulated failure mode shall be identified and described. Since a failure mode may have more than one cause, all probable independent causes for each failure mode shall be identified and described. The failure causes within the adjacent indenture levels shall be considered. For example, failure causes at the third indenture level shall be considered when conducting a second indenture level analysis. Where functions shown on a block diagram are performed by a replaceable module in the system, a separate FMECA shall be performed on the internal functions of the module, viewing the module as a system. The effects of possible failure modes in the module inputs and outputs describe the failure modes of the module when it is viewed as an item within the system. To assist in assuring that a complete analysis is performed, each failure mode and output function shall, as a minimum, be examined in relation to the following typical failure conditions:

a. Premature operation.

b. Failure to operate at a prescribed time.

c. Intermittent operation.

d. Failure to cease operation at a prescribed time.

e. Loss of output or failure during operation.

f. Degraded output or operational capability.

g. Other unique failure conditions, as applicable, based upon system characteristics and operational requirements or constraints.

FMD-97 shall be used as a data source for failure modes and distributions.

A.4.3.5 Mission phase and operational mode. A concise statement of the mission phase and operational mode in which the failure occurs shall be provided. Where subphase, event, or time can be defined from the system definition and mission profiles, the most definitive timing information should also be entered for the assumed time of failure occurrence.

A.4.3.6 Failure effects. The consequences of each assumed failure mode on item operation, function, or status shall be identified, evaluated, and recorded. Failure effects shall focus on the specific block diagram element which is affected by the failure under consideration. The failure under consideration may impact several indenture levels in addition to the indenture level under analysis; therefore, "local," "next higher level," and "end item" effects shall be evaluated. Failure effects shall also consider the mission objectives, maintenance requirements, and personnel and system safety.

A.4.3.6.1 Local effects. Local effects concentrate specifically on the impact an assumed failure mode has on the operation and function of the item in the indenture level under consideration. The consequences of each postulated failure affecting the item shall be described along with any second-order effects which result. The purpose of defining local effects is to provide a basis for evaluating compensating provisions and for recommending corrective actions. It is possible for the "local" effect to be the failure mode itself.

A.4.3.6.2 Next higher assembly effects. Next higher level effects concentrate on the impact an assumed failure has on the operation and function of the items in the next higher indenture level above the indenture level under consideration. The consequences of each postulated failure affecting the next higher indenture level shall be described.

A.4.3.6.3 End item effects. End item effects evaluate and define the total effect an assumed failure has on the operation, function, or status of the uppermost system. The end item effect described may be the result of a double failure. For example, failure of a safety device may result in a catastrophic end effect only in the event that both the prime function goes beyond limit for which the safety device is set and the safety device fails. Those end effects resulting from a double failure shall be indicated on the worksheets.

A.4.3.7 Failure detection method. A description of the methods by which occurrence of the failure mode is detected by the operator shall be recorded. The failure detection means, such as visual or audible warning devices, automatic sensing devices, sensing instrumentation, other unique indications, or none shall be identified.

A.4.3.7.1 Other indications. Descriptions of indications which are evident to an operator that a system has malfunctioned or failed, other than the identified warning devices, shall be recorded. Proper correlation of a system malfunction or failure may require identification of normal indications as well as abnormal indications. If no indication exists, identify if the undetected failure could jeopardize the mission objectives or personnel safety. If the undetected failure allows the system to remain in a safe state, a second failure situation shall be explored to determine whether or not an indication would be evident to an operator. Indications to the operator shall be described as follows:

a. Normal. An indication that is evident to an operator when the system or equipment is operating normally.

b. Abnormal. An indication that is evident to an operator when the system has malfunctioned or failed.

c. Incorrect. An erroneous indication to an operator due to the malfunction or failure of an indicator (that is, instruments, sensing devices, visual or audible warning devices, etc.).

A.4.3.7.2 Isolation. Describe the most direct procedure that allows an operator to isolate the malfunction or failure. An operator will know only the initial symptoms until further specific action is taken such as performing a more detailed built-in-test (BIT). The failure being considered in the analysis may be of lesser importance or likelihood than another failure that could produce the same symptoms and this shall be considered. Fault isolation procedures require a specific action or series of actions by an operator, followed by a check or cross reference either to instruments, control devices, circuit breakers, or combinations thereof. This procedure shall be followed until a satisfactory course of action is determined.

A.4.3.8 Compensating provisions. The compensating provisions, either design provisions or operator actions, which circumvent or mitigate the effect of the failure shall be identified and evaluated. This step is required to record the true behavior of the item in the presence of an internal malfunction or failure.

A.4.3.8.1 Design provisions. Compensating provisions which are features of the design at any indenture level that nullify the effects of a malfunction or failure, control, or deactivate system items to halt generation or propagation of failure effects, or activate backup or standby items or systems shall be described. Design compensating provisions include:

a. Redundant items that allow continued and safe operation.

b. Safety or relief devices such as monitoring or alarm provisions which permit effective operation or limits damage.

c. Alternative modes of operation such as backup or standby items or systems.

A.4.3.8.2 Operator actions. Compensating provisions which require operator action to circumvent or mitigate the effect of the postulated failure shall be described. The compensating provision that best satisfies the indication(s) observed by an operator when the failure occurs shall be determined. This may require the investigation of an interface system to determine the most correct operator action(s). The consequences of any probable incorrect action(s) by the operator in response to an abnormal indication should be considered and the effects recorded.

A.4.3.9 Risk Priority Number (RPN). The contractor shall perform a Criticality Analysis (CA) by calculating a Risk Priority Number (RPN) for each potential failure mode. The RPN shall be calculated by:

$$RPN = S \times O \times D$$

where:

S = Severity (see A.4.3.9.1),
O = Occurrence (see A.4.3.9.2), and
D = Detection (see A.4.3.9.3).

A.4.3.9.1 Severity (S). Severity (S) is an assessment of the effect of the potential failure mode. It shall be estimated on a scale of "1" to "10" using Table 7.8-3 of MIL-HDBK-338B. Severity applies only to the effect of the failure.

A.4.3.9.2 Occurrence (O). Occurrence (O) is the likelihood that a specific failure mode will occur. The likelihood of occurrence ranking number is an index number, rather than a probability, although it is based upon a probability. Removing or controlling one of more of the causes or mechanisms of the failure mode, through a design change, is the only way a reduction in occurrence ranking can be obtained. The likelihood of occurrence ranking number shall be estimated on a scale of "1" to "10" using Table 7.8-4 of MIL-HDBK-338B.

A.4.3.9.3 Detection (D). Detection (D) is an assessment of the ability of the design control to detect a potential cause or mechanism or to detect the failure mode. In order to achieve a lower detection ranking, the planned design control has to be improved. The detection ranking number shall be estimated on a scale of "1" to "10" using Table 7.8-5 of MIL-HDBK-338B.

A.4.4 Reliability-Centered Maintenance (RCM).

A.4.4.1 Purpose. The purpose of RCM is to identify both field and depot level preventive maintenance requirements.

A.4.4.2 Analysis method. The decision logic described below shall be applied to each significant item (system, subsystem, module, component, accessory, unit, part, etc.) using the technical data available. Principally, the evaluations are based on the item's functional failures and failure causes. The method is to:

a. Identify the Functionally Significant Items (FSIs). Select the FSIs beginning at the system level descending as necessary through the part level. All items whose known or anticipated failure could adversely affect safety and mission success or have significant economic effects shall be included in the list of FSIs.

b. Identify "Other Items". During the identification process for FSIs, some items may be recognized as not meeting the criteria for an FSI, but past experience with like or similar items and recommendations for unique items may indicate a maintenance task is desirable. These nonsignificant items are categorized as "other items" and are dispositioned separately in the decision logic.

c. Accomplish a FMECA on each FSI in accordance with A.4.3. All predictable and potential failure modes and causes shall be fully considered in the FMECA, including those for environmental deterioration and accidental damage.

d. Utilizing the RCM decision logic, identify the tasks to be accomplished. If no applicable and effective task can be identified, redesign of equipment is required in the safety effects categories, redesign may be required in the mission effects categories, and redesign may be desirable in the nonmission economic effects categories.

(1) Failures with direct adverse mission affects that cannot be prevented through preventive maintenance compromise the ability of the equipment to accomplish its intended functions. Since equipment may have multiple capabilities and a failure may not affect all of them or affect them all to the same degree, redesign shall be considered within the total set of equipment capabilities and mission scenarios. Redesign is required to allow full mission capability. If the equipment after the failure has partial mission capabilities, redesign shall be weighed against the degree and criticality of the mission impact to determine if the use of program resources for redesign is warranted.

(2) Failures with nonmission economic effects that are not preventable through preventive maintenance will not compromise safety or mission; however, the economic penalties to allow items to fail may be so severe that it would be more advantageous to redesign.

e. Identify the intervals for task development.

f. Identify the recommended level of maintenance for accomplishing the tasks.

A.4.4.2.1 Task analysis. Prior to applying the RCM decision logic to an item, the FSI, its function, functional failure, failure mode, failure effect, and any additional data pertinent to the item, such as the manufacturer's part number, a brief description of the item, expected failure rate, hidden functions, redundancies, etc., shall be documented. Each functional failure and failure mode shall be processed through the logic so that a judgment can be made as to the necessity of a task. The resultant tasks and intervals shall be included in the preventive maintenance program.

A.4.4.2.2 Decision logic. The decision logic shall be used for analysis of systems and equipment items. The decision logic has three levels.

a. The first level (questions 1 and 2) categorize the FSIs and “other items.” The logic for “other items” leads to appropriate tasks and intervals based on past experience or manufacturers' recommendations. No further analysis is required for "other items.” The logic for FSIs leads to the second and third level questions.

b. The second level (questions 3, 4, 5, 6, and 7) requires evaluation of each functional failure for determination of the ultimate effect category, that is, evident safety, mission, or nonmission economic effects, or hidden safety, mission, or nonmission economic effects.

c. The third level (questions A through F or A through E, as applicable) then takes the failure modes for each functional failure into account for selecting the specific type of tasks for each FSI.

In level 3 (the task selection section) paralleling and default logic has been introduced. Regardless of the answer to the first question (regarding lubrication or servicing), the next task selection question shall be asked in all cases. When following the hidden or evident safety effects paths or mission effects paths, all subsequent questions shall be asked. In the remaining nonmission economic effects paths, a "YES" answer subsequent to the first question allows exiting the logic.

A.4.4.2.2.1 Default logic. In the absence of adequate information to answer "YES" or "NO" to questions in the third level, default logic dictates a "NO" answer be given and the subsequent question be asked. As "NO" answers are generated, the only choice available is the next question, which in most cases provides a more conservative, stringent, or costly route.

A.4.4.3 Procedures. Step by step instructions to guide the analyst through the RCM decision logic are provided below.

A.4.4.3.1 First level (categorization of items).

a. FSIs versus "Other Items."

   Question 1: Is this item being evaluated as an FSI?

   For a "YES" answer, the analyst shall proceed to question 3 (A.4.4.3.2a). For a "NO" answer, the analyst shall categorize it as "Other Item" and proceed to question 2 (A.4.4.3.1b).

b. Requirements for nonsignificant items. Question 2 shall be asked of each "Other Item".

   Question 2: Is this item similar to existing items?

   For a "YES" answer, task selection shall be based on past experience with like or similar equipment. For a "NO" answer, task selection shall be based on manufacturer's recommendations.

   Tasks resulting from question 2 should be kept to a minimum, but may include items necessary to meet minimum requirements for the comfort and morale of the operators, maintainers, etc. Further analysis of these items is not required.

A.4.4.3.2 Second level (consequence of failure).

a. Evident versus hidden functional failure.

   Question 3: Is the occurrence of a functional failure evident to the operator during the performance of normal duties?

   Question 3 shall be asked for each functional failure of the item being analyzed. The intent is to segregate the evident and the hidden functional failures.

   A "YES" answer indicates the functional failure is evident; proceed to question 4 (A.4.4.3.2b). A "NO" answer indicates the functional failure is hidden; proceed to question 6 (A.4.4.3.2d).

b. Direct adverse effect on safety.

Question 4: Does the functional failure or secondary damage resulting from the functional failure have a direct adverse effect on operating safety?

For a "YES" answer the functional failure or secondary damage resulting from functional failure has to have a direct adverse effect on operating safety.

Direct: To be direct, the functional failure has to achieve its effect by itself, not in combination with other functional failures (no redundancy exists and it is a minimum essential equipment item).

Adverse effect on safety: This implies that the consequences are extremely serious or possibly catastrophic and might cause injury to personnel or extensive damage to equipment.

Operating: This is defined as the time interval from the moment of equipment start for the purpose of maintenance or mission to equipment shutdown.

For a "YES" answer, tasks shall be developed in accordance with A.4.4.3.3.1. For a "NO" answer, the analyst shall proceed to question 5 (A.4.4.3.2c).

c. Direct adverse effect on mission.

Question 5: Does the functional failure have a direct adverse effect on mission capability?

For a "YES" answer, task selection shall be handled in accordance with A.4.4.3.3.2. For a "NO" answer, task selection shall be handled in accordance with A.4.4.3.3.3.

d. Hidden functional failure safety effect.

Question 6: Does the combination of a hidden functional failure and one additional failure of a system or back-up function have an adverse effect on safety?

For a "YES" answer, task development shall be handled in accordance with A.4.4.3.3.4. For a "NO" answer, proceed to question 7 (A.4.4.3.2e).

e. Hidden functional failure mission effect.

Question 7: Does the combination of a hidden functional failure and one additional failure of a system or backup function have an adverse effect on mission capability?

For a "YES" answer, task selection shall be handled in accordance with A.4.4.3.3.5. For a "NO" answer, task selection shall be handled in accordance with A.4.4.3.3.6.

A.4.4.3.3 Third level (effect categories). Once the applicable second level questions are answered, the analyst is directed to one of the six effects categories:

a. Evident safety effects.

b. Evident mission effects.

c. Evident nonmission economic effects.

d. Hidden safety effects

e. Hidden mission effects.

f. Hidden nonmission economic effects.

A.4.4.3.3.1 Evident safety effects. The evident safety effects category is to be approached with the understanding that tasks are required to assure safe operation. All questions in this category shall be asked. If no effective tasks result from this category analysis, redesign is mandatory.

A.4.4.3.3.2 Evident mission effects. The evident mission effects category is to be approached with the understanding that tasks are required to assure mission success. All questions in this category shall be asked. If' no effective tasks result from this category analysis, a redesign may be required depending on the extent of impact a failure would have on mission success (see A.4.4.2d.(l)).

A.4.4.3.3.3 Evident nonmission economic effects. The evident nonmission economic effects category indicates tasks are desirable if the cost is less than the cost of repair. Analysis of the failure modes through the logic requires the first question (lubrication or servicing) to be answered. Either a "YES" or "NO" answer to question "A" requires movement to the next level; from this point on a "YES" answer completes the analysis and the resultant tasks satisfy the requirements. If all answers are "NO", no task has been generated. If economic penalties are severe, a redesign may be desirable (see A.4.4.2d.(2)).

A.4.4.3.3.4 Hidden function safety effects. The hidden function safety effect requires tasks to assure the availability necessary to avoid the safety effects of multiple failures. All questions shall be asked. If there are no tasks found effective, then redesign is mandatory.

A.4.4.3.3.5 Hidden function mission effects. The hidden function mission effect category requires tasks to assure the availability necessary to avoid the mission effects of multiple failures. All questions shall be asked. If no effective tasks result from this category analysis, the extent of impact a failure may have on mission success could make redesign mandatory (see A.4.4.2d.(l)).

A.4.4.3.3.6 Hidden function nonmission economic effects. The hidden function nonmission economic effect category indicates that tasks are desirable to assure the availability necessary to avoid the economic effects of multiple failures. Movement of the failure modes through the logic requires the first question (lubrication or servicing) to be answered. Either a "YES" or "NO" answer requires movement to the next level; from this point on, a "YES" answer completes the analysis and the resultant tasks satisfy the requirements. If all answers are "NO", no tasks have been generated. If economic penalties are severe, a redesign may be desirable (see A.4.4.2d(2)).

A.4.4.3.3.7 Third level (task development). Task development is handled in a similar manner for each of the effect categories. For task determination, it is necessary to apply the failure modes for the functional failure to the third level of the logic diagram. There are seven possible task resultant questions in the effect categories.

a. Lubrication or servicing (all categories).

   Question A: Is a lubrication or servicing task applicable and effective?

   Applicability criterion: The replenishment of the consumable has to reduce the rate of functional deterioration.
   Effectiveness criterion – safety: The task reduces the risk of failure.
   Effectiveness criterion – mission: The task reduces the risk of failure.
   Effectiveness criterion – nonmission-economic: The task is cost-effective.

b. Operator monitoring (evident functional failure categories only).

   Question B: Is the ability to detect degradation of the function by normal operator monitoring applicable and effective?

   Applicability criteria: Reduced resistance to failure is detectable and rate of reduction in failure resistance is predictable. Indicators that annunciate failures at the time of occurrence are not applicable.
   Effectiveness criteria – safety: The monitoring is part or the normal duties of the operator and reduces the risk of failure to assure safe operation.
   Effectiveness criteria – mission: The monitoring is part of the normal duties of the operator and reduces the risk of failure to assure mission success.
   Effectiveness criterion – nonmission economic: The monitoring is part of the normal duties of the operator.

c. Operational check (hidden functional failure categories only).

   Question B: Is a check to verify operation applicable and effective?

   Applicability criterion: Verification of operation is possible.
   Effectiveness criterion – safety: The task ensures adequate availability of the hidden function to reduce the risk of multiple failures.
   Effectiveness criterion – mission: The task ensures adequate availability of the hidden function to reduce risk of multiple failures.

Effectiveness criteria – nonmission economic: The task ensures adequate availability of the hidden function in order to avoid economic effects of multiple failures and has to be cost-effective.

d. Inspection or functional check (all categories).

Question C: Is the ability to detect degradation of the function by on-equipment or off-equipment task(s) applicable and effective?

Applicability criteria: Reduced resistance to failure is detectable and rate of reduction in failure resistance is predictable.
Effectiveness criterion – safety: The task reduces the risk of failure to assure safe operation.
Effectiveness criterion – mission: The task reduces the risk of failure to assure mission success.
Effectiveness criterion – nonmission economic: The task is cost effective, that is, the cost of the task is less than the cost of the failure.

e. Restoration (all categories).

Question D: Is a restoration task to reduce failure rate applicable and effective?

This task includes work (on or off equipment) necessary to return the item to a specific standard.

Applicability criteria: The item shows functional degradation characteristics at an identifiable age and a large proportion of units survive to that age. It has to be possible to restore the item to a specific standard of failure resistance.
Effectiveness criterion – safety: The task reduces the risk of failure to assure safe operation.
Effectiveness criterion – mission: The task reduces the risk of failure to assure mission success.
Effectiveness criterion – nonmission economic: The task is cost effective, that is, the cost of the task is less than the cost of the failures prevented.

f. Condemn (all categories).

Question E: Is a condemn task to avoid failures or to reduce the failure rate applicable and effective?

This task includes the removal from service of an item at a specified life limit. Condemn tasks are normally applied to parts such as cartridges, canisters, engine disks, durability structural members, etc.

Applicability criteria: The item shows functional degradation characteristics at an identifiable age and a large proportion of units survive to that age.

Effectiveness criterion – safety: A safe-life limit reduces the risk of failure to assure safe operation.
Effectiveness criterion – mission: A safe-life limit reduces the risk of failure to assure mission success.
Effectiveness criterion – nonmission economic: An economic-life limit is cost-effective, that is, the cost of the task is less than the cost of the failures prevented.

g. Combination (safety categories only).

Question F: Is there a task or combination of tasks which is applicable and effective?

Since this is a safety category question and a task is required, all possible avenues shall be analyzed. The most effective task or combination of tasks shall be selected.

h. Combination (mission categories only).

Question F: Is there a task or combination of tasks which is applicable and effective?

For the mission category, a review of all applicable tasks is necessary to assure mission success. From this review, the most effective task or combination of tasks shall be selected.

A.4.4.4 Setting preventive maintenance task frequencies or intervals. Determine whether real and applicable data is available which suggest an effective interval for task accomplishment. If there is no prior knowledge from similar systems or if there is insufficient similarity between the previous and current systems, the task interval or frequency can only be established initially by experienced personnel using good judgment and operating experience in concert with accurate data (reliability, redundancy, dispatch, etc.).

A.4.5 Corrective maintenance prediction.

A.4.5.1 Corrective maintenance prediction assumptions. The following assumptions shall be used for corrective maintenance predictions:

a. Failure rates experienced are all in the same proportion to those predicted,

b. Only one failure at a time is considered,

c. Maintenance is performed in accordance with established maintenance procedures,

d. Maintenance is performed by maintainers possessing the appropriate skills and training, and

e. Only active maintenance time is addressed; administrative and logistic delays and cleanup are excluded.

A.4.5.2 Corrective maintenance elements. Corrective maintenance actions consist of the following tasks: Preparation, Fault Detection and Isolation (FD&I), and Fault Correction. Fault Correction is further broken down into Disassembly, Interchange, Reassembly, Alignment, and Checkout. The time to perform each of these tasks is an element of MTTR; the associated task times are MTTR elements. The definitions and abbreviations for the MTTR elements used in prediction models are shown in Table A-1.

TABLE A-1. MTTR elements.

MTTR Element (abbreviation)[1]	Definition
Preparation Time (PT_n)	Time associated with those tasks required to be performed before fault isolation can be executed.
Fault Isolation Time (FIT_n)	Time associated with those tasks required to isolate the fault to the level at which fault correction begins.
Disassembly Time (DT_n)	Time associated with gaining access to the replaceable item or items identified during the fault detection process.
Interchange Time (IT_n)	Time associated with the removal and replacement of a faulty replaceable item or suspected faulty item.
Reassembly Time (RT_n)	Time associated with closing up the equipment after interchange is performed.
Alignment Time (AT_n)	Time associated with aligning the system or replaceable item after a fault has been corrected.
Checkout Time (CT_n)	Time associated with the verification that a fault has been corrected and the system is operational.
Start-Up Time (ST_n)	Time associated with bringing a system up to the operation state it was in prior to failure, once a fault has been corrected and the operation status of the system verified.

The n subscript indicates that the n^{th} replaceable item (RI) is the object of the maintenance action.

A.4.5.3 Corrective mathematical model. MTTR shall be calculated by the following equation, derived from Equation D-1 in Appendix D of MIL-HDBK-470A:

$$MTTR = \frac{\sum_{n=1}^{N} \lambda_n R_n}{\sum_{n=1}^{N} \lambda_n}$$

where: N is number of replaceable items (RI),
λ_n is the failure rate of the n^{th} RI, and
R_n is the mean repair time of the n^{th} RI.

(Reference MIL-HDBK-470A)

[1] The abbreviations have been changed from those of MIL-HDBK-470A so as to eliminate subscripts of subscripts, which can be confusing and difficult to read, and to delete the index for multiple FD&I indications.

This essentially says that the MTTR is the weighted average repair time for each possible repair, weighted by the failure rate corresponding to that repair.

A.4.5.4 MTTR prediction procedure. For each repairable item, estimate the failure rate and a time for each of the MTTR elements (see Table A-1), ensuring that the model and failure rate data are consistent with that of the basic reliability prediction (see A.4.2). The mean repair time for any repairable item is the sum of the times for its MTTR elements; the weighted mean repair time for the repairable item is the product of its failure rate and its mean repair time. Remember that identical repairable items used in different locations may have different mean repair times, as its accessibility may affect the disassembly, interchange, reassembly, and alignment times. Using the equation in A.4.6.3, sum the weighted repairable item mean repair times and divide by the sum of the repairable item failure rates to calculate the MTTR.

A.4.5.5 Maintenance action time standards. Task times shall be developed from the following sources in the order given:

a. Actual times experienced on the subject equipment,

b. Standard times from Tables D-IV and D-V of MIL-HDBK-470A,

c. Actual times experienced on similar equipment,

d. Other recognized time sources, or

e. Engineering judgment.

A.5 TESTING PROVISIONS

A.5.1 Reliability test requirements. The reliability tests shall be conducted in accordance with the reliability test procedures which have been approved by the procuring activity. Testing shall be continued until a reject decision has been reached or the total required test time has been completed, whichever comes first.

A.5.2 Reliability test records. Reliability test records shall be maintained as specified in the approved test procedure.

A.5.3 Performance parameter measurements. The test sample performance parameters to be measured and the frequency of measurement shall be as specified herein. When the value of any required performance parameter is not within specified limits, a failure shall be recorded. If the exact time of failure cannot be determined, the failure shall be presumed to have occurred at the time of the last recorded observation or successful measurement of that same parameter. Observations and measurements shall be made at the specified interval and recorded during the test cycle. At least one set of measurements shall be recorded when a test sample is first energized after any specified shutdown period.

A.5.4 Reliability compliance. Reliability compliance shall be reviewed by the procuring activity after each test sample failure is categorized or at any other appropriate time. Compliance shall be based on the total accumulated test time and the total number of chargeable failures at the time of the review.

A.5.5 Failure reporting, analysis, and corrective action system (FRACAS). A closed loop system shall be used to collect data, analyze, and record timely corrective action for all potential failures that occur during the first article and operational tests. The FRACAS shall be established and conducted in accordance with 4.5.4.

A.5.6 Classification of failures. All failures shall be classified as relevant or non-relevant. Relevant failures shall be further classified as chargeable or non-chargeable. The procuring activity will make the final determination of failure classifications.

A.5.7 Corrective maintenance demonstration.

A.5.7.1 Corrective maintenance demonstration task selection and performance. At least 30 corrective maintenance tasks shall be performed. Task selection shall be as follows.

a. Step 1. Column 1 – Identify the major units which comprise the equipment.

b. Step 2. Column 2 – Subdivide each unit to the functional level at which maintenance for the demonstration is to be performed in accordance with the approved maintenance plan. This level may be an assembly, module, printed circuit card, or piece part.

c. Step 3. Columns 3 & 4 – For each functional level of maintenance identified in Column 2, identify in Column 3 the type of maintenance task or tasks to be performed and in Column 4 the estimated mean maintenance time for the task. The maintenance tasks and estimated maintenance time would be derived from a maintenance engineering analysis, a maintainability prediction effort, or from historical data. The same maintenance task, such as "remove and replace" of a module may result from different faults within the module. Column 3 would identify the maintenance task and not the fault or failure which results in the occurrence of the task.

d. Step 4. Column 5 – Determine the failure rate [failures per million hours] for each module, printed circuit card, etc., for which the maintenance task was identified in Column 3. The failure rates used should be the latest available from an associated reliability program.

e. Step 5. Column 6 – Determine the quantity of items in each major unit associated with each task in Column 3.

f. Step 6. Column 7 – Determine the duty cycle for each item associated with each task in Column 3 (such as operating time of a receiver to the operating time of the radar; engine operating hours to aircraft flight hours).

g. Step 7. Column 8 – Group together the maintenance tasks identified in Column 3 which have both:

(1) Similar maintenance actions. NOTE: A maintenance action is an element of a maintenance task. Although the estimated maintenance time for different maintenance tasks may be similar, the actions may be different, that is, one task may involve significant diagnostics and another involve minimum diagnostics but significant access time.

(2) Similar estimated maintenance times. The maintenance times in each group should be within a range that shall not exceed the smallest value in the group by more than 50 percent.

Task grouping should be limited to within major units identified in Column 1.

h. Step 8. Column 9 – Determine the total failure rate for each task grouping identified in Column 8. The total failure rate is equal to the sum of the products of Columns 5, 6, and 7 for all tasks within the group.

i. Step 9. Column 10 – Determine the relative frequency of occurrence for each task grouping by dividing the sum of the total failure rate (sum of Column 9) into the individual total failure rate for each group.

j. Step 10. Column 11 – Fixed Sample – A sample of maintenance tasks equal to four times the sample size specified for the selected test method (see … B.4.0 of [MIL-HDBK-470A]) or as specified or agreed upon with the procuring activity should be allocated among the task groups in accordance with the relative frequency of occurrence of the task group. ….

k. Step 11. Column 12 – The maintenance tasks to be demonstrated … are allocated among the task groups in accordance with the relative frequency of occurrence of maintenance for the group. The maintenance task to be demonstrated is then randomly selected from the maintenance tasks allocated to the group or modules, assemblies, etc., within the group (Column 11). The maintenance task to be demonstrated is not returned to the sample pool and is therefore demonstrated only once.

l. Step 12. Column 1 – Identify the maintenance task of interest.

m. Step 13. Column 2 – Determine the failure modes which will result in the maintenance task of interest.

n. Step 14. Column 3 – Determine the effect of each failure mode identified in column 2.

o. Step 15. Column 4 – Determine the relative frequency of occurrence of each failure mode.

A.5.7.2 Corrective maintenance demonstration accept and reject criterion. The accept and reject criterion shall be calculated by:

Accept if the specified maximum $MTTR \geq \overline{X_C} + \frac{\phi \hat{d}_C}{\sqrt{n_C}}$

where:

$\overline{X_C}$ is the average corrective maintenance time for the demonstration,

φ is the value of the normal distribution function for the specified level of consumer's risk, β (see Table A-2, below), and

$\hat{d}_C$ is the standard deviation of sample of the corrective maintenance tasks.

Reject if the specified maximum $MTTR < \overline{X_C} + \frac{\phi \hat{d}_C}{\sqrt{n_C}}$.

TABLE A-2. φ vs. **β**.

ϕ	β (percent)
0.84	20
1.04	15
1.28	10
1.65	5

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