REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
25-04-2013	Final	

4. TITLE AND SUBTITLE
Test Operations Procedure (TOP)
01-2-500A Transportability

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHORS

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Support Equipment Division (TEDT-AT-WFE)
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8. PERFORMING ORGANIZATION REPORT NUMBER
TOP 01-2-500A

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Range Infrastructure Division (CSTE-TM)
US Army Test and Evaluation Command
2202 Aberdeen Boulevard
Aberdeen Proving Ground, MD 21005-5001

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
Same as item 8

12. DISTRIBUTION/AVAILABILITY STATEMENT
Distribution Statement A. Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES
Defense Technical Information Center (DTIC), AD No.:
This TOP supersedes TOP 01-2-500,dated 15 September 2008; and TOP 01-2-501, dated 15 September 2008

14. ABSTRACT
This TOP provides guidance for preparing test plans and conducting test programs to evaluate the transportability characteristics of military equipment whether towed, self propelled, or moved by carrier over highway, off-road terrain, railway, waterway, or by air.

15. SUBJECT TERMS

Fixed wing	Lift provisions	Air dropped	Shelter	Rail movement
Rotary wing	Tiedown provisions	Containers	Free-fall	

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	B. ABSTRACT	C. THIS PAGE			19b. TELEPHONE NUMBER *(include area code)*
Unclassified	Unclassified	Unclassified	SAR	72	

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

*Test Operations Procedure (TOP) 01-2-500A 25 April 2013
DTIC AD No.:

TRANSPORTABILITY

*This TOP supersedes TOP 01-2-500, dated 15 September 2008; and TOP 01-2-501, dated 15 September 2008.

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1. SCOPE.

a. This Test Operations Procedure (TOP) provides guidance for preparing test plans and conducting test programs to evaluate the transportability characteristics of military equipment whether towed, self-propelled, or moved by carrier over highway, off-road terrain, railway, waterway, or by air. Transportability is an important factor in maintaining the "inventory in motion" concept of the modern, highly mobile army. Materiel must be able to survive transportation in a military environment without a reduction in functional performance. The environment imposes numerous constraints involving impacts, vibrations, interferences, and repetitive motions requiring attention to blocking, bracing, lifting, tiedown, and containerization in connection with the stowage, orientation, suspension, or transfer of cargo. Adequacy of design depends upon compatibility with the transportation media and performance after handling and transport.

b. All tests specified herein are not applicable to all test items. The test planner will be selective to include only those tests needed to satisfy the requirements for the specific item to be tested. Data from previous and similar tests and data obtained by concurrent testing will be considered to avoid duplication and reduce the scope of testing.

c. The Director, Military Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA), will be consulted by all Army materiel developers for transportability guidance and approval of their equipment that meets the definition of a transportability problem item as outlined in Department of Defense (DOD) Instruction (DODI) 4540.07[1]**. Equipment and systems are considered a problem item when any of the following conditions apply:

** Superscript numbers correspond to those in Appendix G, References.

(1) Item is wheeled or tracked, and is to be towed, hauled, or self-propelled off highway or on highway.

(2) Materiel exceeds any of the following conditions:

(a) Length - 6.1 meters (m) (20.0 feet (ft)).

(b) Width - 2.4 m (8.0 ft).

(c) Height - 2.4 m (8.0 ft).

(d) Weight - 4,535 kilograms (kg) (10,000 pounds (lb)).

(e) Weight per linear foot - 726 kg (1,600 lb).

(f) Floor contact pressure - 345 kilopascal (kPa) (50 pounds per square inch (psi).

(g) Maximum axle load (pneumatic tires) - 2,268 kg (5,000 lb).

(h) Maximum wheel load (pneumatic tires) - 1,134 kg (2,500 lb).

(i) Tire pressure - 621 kPa (90 psi).

(j) Inadequate ramp clearance for ramp inclines of 15 degrees.

(3) The item increases the physical characteristics of the designated transport assets.

(4) The item requires special handling or specialized loading procedures.

d. Testing will provide SDDCTEA the data necessary to analyze and assess the transportability capabilities and limitations of the equipment. Specific agencies are responsible for certain aspects/modes of transportability and these agencies consult with and report their findings to SDDCTEA for inclusion in the SDDCTEA final engineering analysis. The agencies and their responsibilities are referenced in applicable test procedures herein. Direct consultation with SDDCTEA for guidance and verification of requirements and procedures is encouraged.

e. Military Standard (MIL-STD)-1366E[2], Transportability Criteria, is the primary document for all modes of transport per DODI 4540.07. This standard establishes basic transportability interface criteria for use by the DOD acquisition community, to include the private sector, in the development and shipment of items of materiel. The standard covers dimensional and weight limitations for all modes of transport to ensure that new and modified systems meet the interface requirements of the Defense Transportation System (DTS) and the DTS lift assets. It also covers lifting and tiedown provisions, containerization criteria, overloads, assembly/disassembly, air delivery, shelter criteria, transportability testing, and modeling and simulation of the transportation environment.

f. In regard to Terminals Handling and Movement, the International Organization for Standardization (ISO) Standard 1496/1:1990[3] contains specifications and tests which are required for American National Standards Institute/International Organization for Standardization (ANSI/ISO) certification of all intermodal freight containers, but the contents may require rail impact testing. SDDCTEA accepts such certification of intermodal freight containers in lieu of additional transportability testing. Therefore, the provisions of this TOP need not be applied to certified containers. In the event certification is sought for a container or rigid-wall shelter, a list of ANSI/ISO test facilities may be obtained through SDDCTEA, ATTN: SDTE-DPE, Building 1900, 1 Soldier Way, Scott AFB, IL 62225-5006. Additionally, shelter transportability certifications must be obtained from the US Army Natick Soldier Research, Development and Engineering Center (NSRDEC), Kansas Street, Natick, MA 01760.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

2.1.1 Lifting and Tiedown Provisions.

Item	Requirement
Bedplate/embedded channels.	Vertical pull restraint.
Deadman anchors.	Longitudinal and lateral pull restraints.
Boom/overhead crane anchors.	Vertical (up/down) load application.
Horizontal load application device.	To apply load in longitudinal and lateral direction.
Blocking, tiedown chains or straps.	To restrain item to bedplate or deadman anchor.
Chains, cables, key flex or roundslings.	To apply vertical loads.
Video recording equipment.	To provide video documentation for review and analysis.

2.1.2 Rail Transportability.

Item	Requirement
Straight dry level section of railroad track 61 m (200 ft) minimum length, with additional track in order to reverse the test railcar/buffer car(s) for impacting in the opposite direction.	To provide distance to accelerate locomotive and the test item railcar to specified impact speeds.

Item	Requirement
Locomotive, inclined ramp, tug car, or other mechanical drive.	To accelerate the railcar with the test item to the required pre-impact velocity.
Test railcar equipped with end-of-car cushioned draft gear and a conventional underframe (without cushioning) and chain tiedowns.	To transport the test item into the buffer car(s).
Buffer car(s) (1 to 5) with total weight of 113,400 kg (250,000 lb), with the first buffer car equipped with standard (friction) draft gear and remaining buffer cars (if any) equipped with either standard draft gear or cushioned draft gear, with the draft gear compressed for either case.	To act as buffer car(s) into which the test item car is impacted.
Use of other railcar types for testing to be representative of the intended shipping methods.	Advanced approval of Director, SDDCTEA, Attn: SDTE-DPE, 1 Soldier Way, Bldg 1900W, Scott AFB, IL 62225.
Temperature conditioning chamber (if required).	To provide the required temperature environment for the test item.
Video recording equipment.	To provide video documentation for review and analysis.

2.1.3 Highway Transportability.

Item	Requirement
Automotive road courses.	For road transport and mobility/handling testing.
Recovery vehicles.	For recovery vehicle test operations.

2.1.4 Marine Transportability.

Item	Requirement
Marine vessel.	Means of loading cargo with ship crane.
Dockside or on-board.	Trial loading and unloading.

2.1.5 Terminals Handling and Movement.

Item	Requirement
Material handling equipment (MHE).	Transportation of item.
Sling cables and fittings.	Lifting and drop test.
Concrete pad.	Drop test surface.
Towing bar bridle and safety chains.	Skid resistance testing.
Quick-release crane hook.	Mechanism for release of item for drop testing.

2.1.6 Air Transportability - Fixed Wing Internal.

Item	Requirement
Fixed-wing aircraft.	Loading demonstration with functioning loading facility.
Cargo handling equipment.	To assist in loading material in aircraft.

2.1.7 Air Transportability - Rotary Wing Internal.

Item	Requirement
Helicopter.	To perform form-fit function test loading with functioning loading facilities.
Cargo handling equipment.	To assist in loading material in aircraft.
Tiedown fittings and tiedown devices.	To restrain item to helicopter’s cargo deck.

2.1.8 Air Transportability - Rotary Wing External.

Item	Requirement
Military cargo helicopter.	To perform flight demonstration.
Controlled airspace.	To serve as designated flight area.
Helipad or airstrip.	To serve as designated staging, pickup, and delivery area.

Item	Requirement
Chase aircraft equipped with video equipment.	For video and photographic documentation.
Boom/overhead crane.	To perform static sling trials.
Spreader bar or theodolite.	Simulate helicopter's cargo hooks distance for dual-point lift.
Standard sling sets.	Rigging of test item for static/flight demonstration.
Rigging materials including cargo straps, nylon cord, cotton webbing, tape.	Restraint of all internal and external components for flight test.
Video recording equipment.	To provide video documentation for review and analysis.

2.1.9 Air Transportability - Airdropped Materiel.

Item	Requirement
Controlled airspace and ranges.	To serve as designated flight area and drop zones.
Fixed-wing aircraft.	To perform airdrop/Low Altitude Parachute Extraction (LAPE) or Low Velocity Air Drop (LVAD).
Static drop facility.	To perform ground impact test.
Slings, parachutes, and/or airdrop platforms.	Rigging of test item for airdrop.
Rigging materials.	Restraint and cushioning of all components for airdrop.
Boom/overhead crane.	Load placement for rigging.
Aircraft loader.	Load items into aircraft.
High-speed film/video equipment.	Document airdrop characteristics.

2.2 Instrumentation.

2.2.1 Lifting and Tiedown Provisions.

Devices for Measuring	Measurement Accuracy
Load cell (force)	± 1% of reading
Caliper (length)	± 0.025 centimeter (cm) (± 0.001 inch (in.))
Tape (length)	± 0.159 cm (± 0.06 in.)
Inclinometer (angle)	± 1 degree
Stopwatch (time)	± 1 second

2.2.2 Rail Transportability.

Devices for Measuring	Measurement Accuracy
Scale (weight)	± 0.5% of reading
Timers (rail impact speed)	± 0.16 kilometer per hour (km/hr) (± 0.1 mile per hour (mph))
Speedometer (locomotive speed)	± 0.16 km/hr (± 0.1 mph)
Strain-gauged coupler (coupler force) (if required)	± 2.2 kilonewton (kN) (± 500.0 pound force (lbf))
(Torque wrench (tiedown bolt torque) (if required)	± 5% of reading
Accelerometer (acceleration) (if required)	± 0.05 *g* (*g* is the acceleration due to gravity at the Earth's surface)
Strain gauges (strain) (if required)	± 5 microstrain
Thermocouple (temperature) (if required)	± 2.0 °Celsius (C) (± 3.6 °Fahrenheit (F))
High-definition optical instruments (video, movie, and still camera)	As required

2.2.3 Highway Transportability.

Devices for Measuring	Measurement Accuracy
Accelerometer (deceleration)	± 0.05 *g*

Devices for Measuring	Measurement Accuracy
Fifth wheel (distance, brake stopping)	± 0.1 m (± 0.3 ft)
Walking wheel (distance, road)	± 0.1 km (± 0.06 mile)
Speedometer (speed)	± 0.1 km/hr (± 0.06 mph)
Scale (weight)	± 0.5% of reading
Tape (physical dimensions)	± 0.159 cm (± 0.06 in.)

2.2.4 Marine Transportability.

Devices for Measuring	Measurement Accuracy
Approach/departure/ breakover angles of test item	± 1 degree
Ground clearance of test item	± 1 cm (± 0.4 in.)
Time (rigging time)	± 1 minute
Time (voyage time)	± 1 minute
Acceleration/deceleration	± 1% of reading
Strain	± 1% of reading
Vessel pitch, roll and yaw angles	± 1 degree
Ramp angles of approach, departure and crest	± 1 degree

2.2.5 Terminals Handling and Movement.

Devices for Measuring	Measurement Accuracy
Accelerometer (acceleration)	± 0.05 *g*
Load cell (force)	± 1% of reading
Scale (weight)	± 1% of reading
Tape (height, drop test)	± 0.159 cm (± 0.06 in.)

Various (deflections, stackability)	± 0.2 cm (± 0.08 in.)

2.2.6 Air Transportability - Fixed Wing Internal.

Devices for Measuring	Measurement Accuracy
Scale (weight)	± 1% of reading
Tape (physical dimensions)	± 0.159 cm (± 0.06 in.)
Articulation measure (bogie articulation)	± 1 degree
Gauge (tire pressure)	± 7 kPa (± 1 pounds per square inch gauge (psig))
Various (ground pressure)	± 1% of reading

2.2.7 Air Transportability - Rotary Wing Internal.

Devices for Measuring	Measurement Accuracy
Various (ground pressure)	± 1% of reading
Inclinometer (ramp angle)	± 1 degree
Scale (weight)	± 0.5% of reading
Tape (physical dimensions)	± 0.159 cm (± 0.06 in.)

2.2.8 Air Transportability - Rotary Wing External.

Devices for Measuring	Measurement Accuracy
Scale (weight)	± 0.5% of reading
Various (center of gravity location)	± 2.5 cm (± 1 in.)
Thermometer (ambient temperature)	± 2.0 °C (± 3.6 °F)
Anemometer (wind speed)	± 1 knot
Wind vane (wind direction)	± 30 degrees
Inclinometer (angle of inclination of load when suspended) (static test)	± 1 degree

Various (airspeed, angle of bank, rates of descent and climb)	As required

2.2.9 Air Transportability - Airdropped Materiel.

Devices for Measuring	Measurement Accuracy
Scale (weight)	± 1% of reading
Vertical distance (ground impact test)	± 1 cm (± 0.4 in.)
Time (rigging)	± 0.1 hour
Position (during airdrop)	± 2 m (± 7 ft)
Time (frequency response)	± 200 meters per second (m/sec) (± 656 feet per second (ft/sec))
Impact velocity	± 0.5 m/sec (± 1.6 ft/sec)
Acceleration	± 10% of reading

3. REQUIRED TEST CONDITIONS.

a. Coordinate test requirements and procedures with SDDCTEA and other applicable component transportability agencies prior to conducting any and all transportability tests. In many cases, the representative(s) are required to witness the testing.

b. The use of spreader bars is not permitted for testing purpose unless approved by SDDCTEA or the appropriate component transportability agent. Ensure that stowage is provided for the spreader bars on the item as basic issue item (BII) equipment. If authorized, use spreader bars during provision testing.

c. Do not use shackles as lifting, equipment tiedown, or multipurpose provisions unless they meet the requirements of a high strength, safety (bolt/nut) anchor shackle in RR-C-271F[4] and are approved by SDDCTEA.

d. Ensure that the test item is in the designed load configuration – full payload configuration (real or simulated payload). The gross weight condition or the gross weight rating (GWR) of the test item, whichever is greater, is mandatory; other load conditions (e.g., curb weight) are as required. Use of real payload/cargo is required of most test procedures to verify survivability following the shock or vibration environment induced. Vehicles not typically transported with payload such as wreckers, truck tractors, and dump trucks are exceptions and may be tested at a curb weight or weight less than the gross weight. Consult with SDDCTEA for these types of vehicles.

e. Specific vehicle configuration standards are defined in Military and Federal standards.

(1) The following are standard definitions derived from MIL-STD-209K[5]:

(a) Gross weight is defined as the weight of the basic equipment plus the weight of any associated support items of equipment and cargo attached to, contained within, or projected as payload for the equipment (e.g., shelter). The weight of ammunition, fuel, water, and lubricant necessary to render a system combat ready are considered as payload and included in the gross weight. The gross weight equals the gross vehicle weight rating (GVWR) or the maximum projected weight of the equipment, which ever is greater.

(b) GVWR is defined as the unloaded vehicle weight, including all fluids, and its maximum payloaded (to include the weight of the crew), where the payload weight is based upon the manufacturer's rating of the structural capability of the vehicle.

(2) The Federal Motor Vehicle Safety Standard (FMVSS) 571.3[6] "Definitions" provides specific definitions for the following commercial vehicle configurations:

(a) GVWR means the value specified by the manufacturer as the loaded weight of a single vehicle.

(b) Curb weight means the weight of a motor vehicle with standard equipment; maximum capacity of engine, fuel, oil, and coolant; and, if so equipped, air conditioning and additional weight optional engine.

(c) Gross combination weight rating (GCWR) means the value specified by the manufacturer as the loaded weight of the combination vehicle.

(d) Gross axle weight rating (GAWR) means the value specified by the vehicle manufacturer as the load carrying capacity of a single axle system, as measured at the tire-ground interfaces.

(3) Other pertinent vehicle configurations may be required based on the test plan or physical circumstance. Documentation of the vehicle configuration is critical. Written and photographical documentation is required.

f. Ensure that the test item has been fully serviced (i.e., fuel, oil, coolant) or serviced to the levels specified in the rigging/tiedown procedures or applicable equipment publications. All auxiliary equipment must be installed and secured properly.

g. Ensure that Standing Operating Procedures (SOPs) for the specific test procedures are adhered to at all times.

h. If military personnel are required, ensure a Test Schedule and Review Committee (TSARC) request is submitted within one year from the start of testing or as early as possible.

4. TEST PROCEDURES.

4.1 Lifting and Tiedown Provisions.

a. The objective of this subtest is to determine whether the lifting and tiedown provisions of military equipment comply with dimensional and/or directional limits and design, positioning, and strength requirements for transportability.

b. Method.

(1) Categorize the lifting and tiedown provisions regarding equipment type (Type I-II) in accordance with MIL-STD-209K. Inspect the provisions regarding location to determine if any interference with functioning equipment exists and that required accessibility is provided. Measure the provisions to determine compliance with dimensional requirements. Check to determine whether the working angles for equipment tiedown provisions are attainable. Specific location, clearance, dimensional and directional requirements are defined in MIL-STD-209K. System center of gravity and provision location measurements relative to a fixed position are required for calculation of applied loadings per MIL-STD-209K.

(2) Subject the tiedown provisions to calculated lateral, longitudinal, and vertical forces, as applicable, specified by MIL-STD-209K or provided by SDDCTEA. Perform a static lift to establish lifting parameters (i.e., sling lengths, sling leg angles, item attitude in suspension, and apex height) for crane movements at marine terminals. Subject all lift provisions to an apex loading specified by MIL-STD-209K, or provided by SDDCTEA. Prior to load application, secure the equipment to a bedplate, deadman, or some means of attachment for anchoring purposes. Photograph and record the restraint method and equipment employed. Load application will be provided by a hydraulic actuator system. Accomplish the provision loading for the durations specified in MIL-STD-209K. Measure the loads with calibrated devices such as load cells. Record and photograph any weld cracking or visible permanent deformation or set in the provision(s) or other structural component resulting from load application.

(3) See MIL-STD-913A[7] for equipment requiring Helicopter Sling Load (HSL) tests (also known as External Air Transport or EAT tests).

(4) US Navy (USN)/US Marine Corps (USMC) equipment with internal air transport (IAT) requirements shall also comply with the US Navy Naval Air Systems Command (NAVAIR) Cargo Restraint Requirements.

(5) Air droppable materiel tiedowns and attachments are tested for conformance with MIL-STD-814D[8] (see Paragraph 4.9).

(6) Aircraft cargo tiedown device testing is described in MIL-DTL-25959G[9].

4.2 Rail Transportability.

The objective of this subtest is to determine whether the test item meets the specified requirements for rail transportability certification.

4.2.1 Method.

Rail impact testing is required of all items designated for rail transport to verify the structural/functional integrity of the provisions, test item, the adequacy of the tiedown system, and the tiedown procedures. Based on the Materiel Developer's or contractor's developed rail tiedown procedures, any special railcar requirements are submitted to SDDCTEA for approval and then to a test activity for rail impact testing. An engineering analysis is performed by SDDCTEA to determine if the test item's weight and physical dimensions are compatible with the Strategic Rail Corridor Network (STRACNET) and North Atlantic Treaty Organization (NATO) rail facilities. The requirements for unrestricted and restricted transport are specified in MIL-STD-1366E. The physical dimensions of the item and tiedown must fall within prescribed templates illustrated in MIL-STD-1366E. Blocking and bracing is not permitted; however, wood stanchions may be allowed for trailers without prime movers. Consult with SDDCTEA if any type of wood dunnage is required. Prior to rail impact testing, MIL-STD-209K tiedown provision strength testing (paragraph 4.1) must be accomplished to verify the strength of the tiedown provisions. Following successful tiedown provision testing, rail impact testing must be accomplished. A summary of physical characteristic measurements to be recorded specifically for rail transport of a system are identified in Appendix A, Table A-1.

a. Accomplish clearance measurements by measuring the outermost profile points of the test item, as secured to a railroad flatcar, using geodetic surveying equipment. The geodetic scan of the test item/ flatcar combination is then superimposed into a computer-aided design file with the base of the item set at a railcar deck height corresponding to each of the applicable rail clearance diagrams.

b. Accomplish the rail impact by securing the test item on the railcar and propelling the car into one to five stationary buffer cars using a locomotive or inclined ramp. Measure actual impact speeds by determining the speed of the loaded railcar immediately prior to impact or at the point of impact if feasible.

c. Position the stationary railcar(s) with its coupler compressed and its air and hand brakes set. Position the knuckles of the buffer and test cars for coupling.

d. Subject the moving railcar to impacts at speeds of 6.4 and 9.7 km/hr (4.0 and 6.0 mph) ± 0.8 km/hr (± 0.5 mph), and 12.9 km/hr (8 mph) + 0.8, - 0.0 km/hr (+ 0.5, - 0 mph). If the speed is less than 12.9 km/hr (8 mph), repeat the impact. Conduct the impact by accelerating the railcar to the desired speed using a locomotive equipped with a speed-measuring device or inclined ramp. Release the railcar loaded with the test item an appropriate distance from the stationary buffer railcar(s) and allow it to coast until it impacts.

e. Turn the railcar with the test item around and subject the moving railcar to an impact at a speed of 12.9 km/hr (8.0 mph) + 0.8, - 0.0 km/hr (+ 0.5, - 0.0 mph), impacting the opposite end of the test railcar from first three impacts for a total of four impacts. If it is not possible to turn the test car around the buffer car(s) because of track layout, ensure that the fourth impact is accomplished in the reverse direction.

f. No tiedown chain adjustment is permissible after rail impact testing commences. If an adjustment of the restraint occurs, the entire rail impact procedure (e.g. four impacts beginning at 6.4 km/hr (4.0 mph)) must be repeated.

g. At the conclusion of each impact, inspect the test item for equipment damage, to include the tiedown provisions for evidence of damage or failure, and verify the integrity of the tiedown devices. Take photographs of the damage as needed. Once the test has started, there will be no readjustment of the test item, nor any reconditioning of the tiedown devices. If the initial tiedown devices fail, repeat the entire test provided a revised method of securing is feasible and approved by SDDCTEA. After the completion of the test, examine the test item for any permanent displacement of system components contained in or mounted on the test item, or item damage, and conduct a functional and operational checkout. Compare the results with the pretest data.

h. If the test item is exposed to test conditions that exceed allowable limits, conduct an appropriate physical examination of the test item and perform an operational check (when practical) before testing is resumed.

i. If the test item can be transported in more than one orientation, such as lengthwise and crosswise on the railcar, repeat the four impacts for each orientation.

4.2.2 Temperature Conditioning.

a. If the rail impact test is to be conducted at temperature extremes (only when facilities exist to expose the entire flatcar and test item to temperature conditioning), conduct the following prior to impacting:

(1) Secure the test item on the railcar and place the test item in the temperature chamber/enclosure and adjust the chamber air temperature to the test temperature. The temperature chamber/source should be located as close to the rail impact site as possible for best efficiency.

(2) Following temperature stabilization of the test item, maintain the storage temperature for the period specified in the test plan before rail impact testing. Temperature stabilization is attained for non-operating systems when the temperature of the functional part(s) of the test item considered to have the longest thermal lag reaches a temperature that is within the temperature tolerance of the air surrounding the test item.

(3) Disconnect the temperature conditioning chamber/source, if employed, and perform the rail impact test as stated in paragraph 4.2.1.

b. If the test item is being conditioned when detached from the railcar, conduct the following after the conditioned item is mounted on the railcar:

(1) Replace the test item in the temperature chamber and adjust chamber air temperature to the test temperature.

(2) Following temperature stabilization of the test item, maintain the storage temperature for a minimum of twice the amount of time that the test item has been out of the temperature chamber.

(3) Perform the rail impact test as stated in paragraph 4.2.1.

c. If the test item is being conditioned when attached to the railcar, but the railcar is not to be conditioned, conduct the following after the item is mounted on the railcar:

(1) Enclose the test item within the portable chamber as mounted on the railcar and adjust chamber air temperature to the test temperature.

(2) Following temperature stabilization of the test item, maintain the storage temperature for the period specified in the test plan before rail impact testing. Temperature stabilization is attained for non-operating systems when the temperature of the functional part(s) of the test item considered to have the longest thermal lag reaches a temperature that is within the temperature tolerance of the air surrounding the test item.

(3) Perform the rail impact test as stated in paragraph 4.2.1.

d. If the test item remains outside the conditioning chamber for more than 15 minutes, then reconditioning is required. If more impacts are required after 15 minutes, recondition the test item for 30 minutes after the test item has stabilized at the required test temperature.

4.2.3 Failure Definition.

a. A test item is classified as not having survived the rail impact test, and the test is deemed a failure, if any item that is attached to or included as an integral part of the test item breaks free, loosens, or shows any sign of permanent deformation beyond specification tolerances.

b. The test item must be fully functional after the rail impact test. Inability of the test item to operate as designed (i.e., move, shoot, and communicate) or damage resulting in a compromise of mission essential functions will constitute a test failure.

c. Breaking of any tiedown chain will constitute a non-test. With the restraint replaced, the test must be re-started at the 6.4-km/hr (4.0-mph) impact.

d. Loosening of any tiedown chain will not constitute a test failure. If any of the tiedown chains are tightened between impacts, the test must be re-started at the 6.4-km/hr (4.0-mph) impact.

e. Test controls should be adequate to assure repeatability of the process and maintain test parameters within prescribed tolerances. Nevertheless, any impact in which the measured speed of the test car is greater than the upper limit of the test tolerance, + 0.8 km/hr (+ 0.5 mph), is considered a valid test at that incremental impact speed provided that the materiel tested, its restraint system, and the rail car are not adversely affected (i.e., damage, permanent deformation,

and/or performance degradation), and the next incremental impact speed is not exceeded. This contingency does not alter the need to perform four successive impacts at progressively escalating impact speeds, thus imparting a nominally increasing amount of strain energy to the restrained test item. For example, a rail impact test in which impact speeds of 8.9, 9.7, 13.1, and 13.4 km/hr (5.5, 6.0, 8.1, and 8.3 mph) were recorded and no equipment damage was noted would be considered a satisfactory test, the 8.9 km/hr (5.5 mph) impact qualifying as the incremental 6.4 km/hr (4.0 mph) impact.

4.3 Highway Transportability.

a. The objective of this subtest is to determine whether the test item can be transported over and off highways.

b. SDDCTEA is responsible for performing an engineering evaluation of equipment designated for highway transportability. Weight and physical characteristics will be compared against requirements for highway transport. Any restrictions will be noted.

(1) Prepare the test item for shipment in accordance with the procedures contained in the appropriate technical manuals for movement over highways. Measure the physical parameters including width, height, length, gross weight, and axle wheel loading. A summary of all characteristic measurements and those specified to be recorded at a minimum for this mode of transport are identified in Appendix A, Table A-1.

(2) Load, block, brace, and tie down the item on a semitrailer or other vehicle designated as the prime mover. If the technical manuals do not contain tiedown instructions, use procedures recommended by the test agency and concurred with the developing agency, where appropriate. Once the item is securely loaded, measure the physical parameters of the combination, including width, height, length, gross weight, and axle wheel loading. Record the measurements and weight.

4.4 Marine Transportability.

The objective of this subtest is to determine whether the test item can be transported by marine vessels. Marine transportability is composed of lifting and vessel and test item compatibility in accordance with MIL-STD-209K and MIL-STD-1366E, respectively. The US dry cargo fleet consists of four conventional ship types: breakbulk, container, barge carriers, and roll on/roll off (RORO). Various combinations of these four ship types also exist. The following paragraphs offer a short summary of each type. Specific measurements and space constraints are detailed in MIL-STD-1366E. A summary of all characteristic measurements and those specified to be recorded at a minimum for this mode of transport are identified in Appendix A, Table A-1.

a. Breakbulk General Cargo Ships. The hold configuration on most breakbulk ships is generally the same, consisting of five to seven holds. Each hold has three to five decks and hatch covers that allow access to the different decks. Cargo operations on breakbulk vessels are lift on/lift off (LOLO). Each hold on a breakbulk vessel is served by ship's gear.

b. Containerships. Modern containerships, to include combination ships, are designed to carry all or part of their cargo load in containers. The containership allows containers to be secured without the use of dunnage. Containerships also have the capability for transporting containers that are stacked on the vessel deck.

c. Barge Carriers. The Lighter Aboard Ship (LASH) and Sea Barge (SEABEE) transportation systems operate similar to a containership. In these systems, cargo is stowed in unitized lighters or barges. The barges or lighters are then stowed aboard a barge carrier or mother ship. One major difference between containerships and barge carriers is the amount of cargo that barges or lighters can handle. LASH lighters and SEABEE barges have cubic capacities of 570 and 1130 m^3 (20,000 and 40,000 ft^3), respectively. The barge carrier/mother ship is self-sustaining. The LASH system uses a gantry crane to load its lighters, while the SEABEE system has an elevator to load its barges.

d. RORO Ships. The RORO ship is primarily a vehicle transporter that allows vehicles to drive on or off the ship via ramps. RORO cargo includes wheeled, tracked, self-propelled, and towed vehicles and equipment. Most modern RORO vessels not only carry vehicles, but also carry a combination of containers and/or breakbulk cargo. A series of external and internal ramps facilitate the loading and discharge of RORO cargo. To maintain safe operations, the ramp angle for loading and unloading procedures is no greater than 15 degrees.

e. Method.

(1) Vessel and Test Item Compatibility. Upon completion of physical parameter measurements and lifting and tiedown testing in accordance with MIL-STD-209K (paragraph 4.1), vessel and test item compatibility is evaluated. Using MIL-STD-1366E, SDDCTEA determines the compatibility of the test item with marine stowage and handling provisions of the various oceangoing vessels. A comparison of test item physical characteristics with the hatch and hold dimensions and cargo handling gear is made. A summary of all general requirements and those specified to be recorded at a minimum for this mode of transport are identified in Appendix A, Table A-1. From this comparison, an estimate is made regarding the capability of the item to be transported by various types of vessels. An evaluation is also made of the capabilities of amphibious vehicles and landing craft with respect to loading and securing the test item and unloading it onto the beach. The study, depending on requirements, encompasses the physical aspects of ramp negotiation, roll on/roll off maneuvering, loading, and tiedown arrangements. Complete logistics-over-the-shore (LOTS) performance test requirements are addressed in TOP 01-2-510.[10]

(2) Cargo Movement. Conduct a trial loading of the test item on actual oceangoing vessels, using the ship's cargo handling gear or customary dockside lifts. Once loaded, stow and secure the test item using specific cargo restraints. Representative marine tiedown configurations are illustrated in Transportation Engineering Agency (TEA) Pamphlet 55-22[11]. Note the presence of test item combustibles, if any. Apply recording instrumentation, including strain gages and accelerometers, to select points of the item to record angles of pitch, roll, and yaw to correlate the environmental data logged by the ship during its voyage. When practical, inspect the test item periodically during transport in addition to the beginning and end of the voyage.

4.5 Terminals Handling and Movement.

a. The objectives of this subtest are to determine the ability of:

(1) The test item to withstand the mechanical stresses experienced when moved with MHE, in vehicles, or by personnel.

(2) The packaging and packing methods to provide protection to the contents.

b. Method.

(1) The procedures referenced in this paragraph provide simulations of the conditions typically encountered by freight containers, shelters, palletized loads, and equipment contained in transit cases or shipping crates in the course of their handling and movement at points of embarkation for and debarkation from multi-mode (rail, highway, marine, air) transportation media. A summary of all characteristic measurements and those specified to be recorded at a minimum for this mode of transport are identified in Appendix A, Table A-1.

(2) Standardization of Containers and Shelters. Intermodal freight containers and members of the Army Standard Family of Shelters (ASFS) designated as ISO shelters must be certified as meeting the requirements for multi-mode transport, or be tested to ISO Standard 1496/1:1990 (paragraph 1 of this TOP for ANSI/ISO test facilities information) and satisfy the engineering and design requirements of American Society of Testing and Materials (ASTM) E1925-10[12].

(3) Forklift Handling. The adequacy of the forklift provisions of shelters, pallets, and shipping crates, and their ability to be safely lifted and restrained during movement by forklift without experiencing more than superficial damage is determined in this procedure. Given the variety of MHE types available at transportation terminals, any forklift of sufficient capacity and tine characteristics (load center) may be used; tactical, conventional, or non-DOD. The impact of forklift handling on the test item, not the ability of accepted MHE to handle its load, is the issue, thus allowing this flexibility in MHE application. Inspect the item to identify the forklift pockets, and determine any recommendations and restrictions listed on the data plates. The size of most shelters necessitates the use of forklifts with tines of at least 2.4 m (8 ft) in length or the application of tine extenders. The procedure for testing shelters is contained in ASTM E1925-10, paragraph 10.5, Forklift Handling Test; while ASTM D6055-07[13] and ASTM D6179-07[14] provides a means of testing unitized loads and large shipping cases and crates. In each case, load the test item to its gross shipping weight (GSW), with center of gravity as near as practicable to the actual service conditions, and affix the load to the forklift with slack safety chains or cabling to minimize the possibility of loss of the load.

(4) Towing and Dragging. The ability of shelter skids, pallets, and shipping crates to withstand lateral loads incurred during placement adjustments of these items and their movement in the absence of forklifts is determined. Load the test item to its GSW, with center of gravity as near as practicable to the actual service conditions. Shelters with skids should be tested in accordance with ASTM E-10, paragraph 10.28; and pallets and shipping crates with skids are

presented in ASTM D6055-07, Test Method D, paragraph 9.4. Connect a load cell to the towing medium in order to measure and thus control the applied force.

(5) Lifting. The adequacy of lifting provisions and the structural integrity of the test item when lifted are examined in this test. Test procedures for lifting in general and for external (rotary wing and tiltrotor aircraft) air transport are discussed in paragraphs 4.1 and 4.8, respectively, of this TOP. Procedures for the testing of shipping crates are provided in ASTM D6055-07, Test Method E, Grabhook Test Procedures, paragraph 10-1; and Test Method F, Sling Test Procedure, paragraph 10.2. Intermodal freight containers shall be certified as compliant with ISO Standard 1496/1:1990 or tested to this document.

(6) Drop Tests.

(a) The structural integrity of the test item and the effectiveness of any internal shock attenuation mechanisms are determined in this series of tests. Procedures relevant to handling of shipping crates and palletized loads (except for munitions) such as corner drop, edgewise drop, and free fall drop are found in the following documents:

1 Rotational Corner Drop Test ASTM D6179-07, Test Method B.

2 Rotational Edge Drop Test, ASTM D6179-07, Test Method A.

3 Unsupported Free Fall Drop Test, ASTM D6179-07, Test Method D.

4 Rotational Flat Drop Test, ASTM D6179-07, Test Method C.

(b) The free-fall test is limited to packages or containers of up to 70 kg (150 lb) in weight and not exceeding 152 cm (60 in.) on any edge or diameter, whereas the other tests of ASTM D6179-07 are intended for materiel with physical characteristics exceeding these parameters. Separate procedures for flat (free-fall) and rotational (edgewise) drop testing of shelters both with and without skids are contained in ASTM E1925-10, paragraphs 10.29 (without skids) and 10.30 (with skids). Procedures for drop testing of munitions are available in International Test Operations Procedure (ITOP) 04-2-601[15]. Each of these tests employs a quick-release mechanism at the apex of the rigging to release the test item from its point of suspension at the initiation of the drop. If the test item has no provisions for protection from impact by falling rigging, the sling set is tethered to the overhead crane hook such that it neither strikes the test item nor interferes with its motion in dropping. The test item may be instrumented to measure mechanical shock and vibration, and strain incurred by selected components or members. Any shock and vibration measurements of internal components or members should be accompanied by comparable recordings at the base of the test item (forcing function).

(7) Rough Handling. This procedure is used to determine the capability of the test item to withstand the shocks normally induced by loading and unloading of equipment in routine service usage, not to simulate handling the logistics shipping environment. Measurement of shock and vibration imparted to the test item must be consistent with the guidance provided for drop testing (paragraph 4.5b(6)); however, the application of instrumentation may not be feasible

in the case of small items. The guidance provided in MIL-STD-810G[16], Test Method 516.6, Procedure IV, Transit Drop; is applicable for equipment packaged in its transit case(s) as prepared for field use. Simulation of conditions experienced by items carried by individuals on their person or as unsecured cargo in trucks is described in ITOP 04-2-602[17]. Munitions, rifles, rockets, radios, and mortars are covered in this latter document.

(8) Cargo Compatibility. Methods for determining the susceptibility of vehicles for loading and unloading of cargo are found in TOP 02-2-537[18]. This document prescribes procedures for trucks, aircraft, ships, and railroad car carriers. These tests can usually be integrated with other terminals handling and movement procedures.

(9) Stackability. The ability of shipping crates or packages to withstand loads such as these imposed on the bottom container in a stack, or support loads on their tops, with or without dunnage present, is determined through the use of the test procedures of Superimposed Load Test; Stackability, with Dunnage , and Superimposed Load-Test; Uniformly Distributed, without Dunnage as prescribed in ASTM D4169-09[19]. Strain measurements of stressed members may be taken if required.

4.6 Air Transportability - Fixed Wing Internal.

a. The objective of this subtest is to determine the suitability of the test item to be transported by US Air Force (USAF) and Civil Reserve Air Fleet (CRAF) fixed-wing aircraft.

b. Method.

Certification of military equipment for transport on USAF and CRAF aircraft is performed by the US Air Force Air Transportability Test Loading Activity (ATTLA) through coordination with SDDCTEA. The required data for each test item are recorded and forwarded to ATTLA through SDDCTEA.

(1) Item Inspection and Physical Characteristics. Inspect the item and record the location of, and data on, all tiedown points. The tiedown fixtures must conform with the design criteria of MIL-STD-209K. Measure and record the weight and physical characteristic measurements of the item as illustrated in Figures 1 through 3. A summary of all characteristic measurements and those specified to be recorded at a minimum for this mode of transport are identified in Appendix A, Table A-1.

(2) Forward the data recorded in paragraph 4.6b through SDDCTEA to ATTLA. ATTLA will perform an analysis of the test item measurements in accordance with MIL-HDBK-1791[20] to determine the item's suitability for transport on USAF aircraft. Approval status is based upon an engineering evaluation of load characteristics and tiedown provisions, proof load testing of applicable provisions, and a validation test loading, when deemed necessary. ATTLA provides the engineering analysis results and approval to USAF Air Mobility Command (AMC), USAF Air Combat Command (ACC) or US Air Force Special Operations Command (AFSOC), which are responsible for certification of material. If ATTLA determines that there are no significantly limiting factors involved in loading the item on all aircraft in the USAF fleet, they will issue a letter through SDDCTEA stating such. Should ATTLA determine that the test item

or aircraft may be damaged during loading or transport of the item in aircraft, they will require a test loading of the item.

(3) When required, coordinate test loading with ATTLA and the USAF operating commands. These agencies will oversee the test with particular attention paid to those factors highlighted as potential hazards to the aircraft and the test item during the analysis. All test loadings are conducted in accordance with MIL-HDBK-1791.

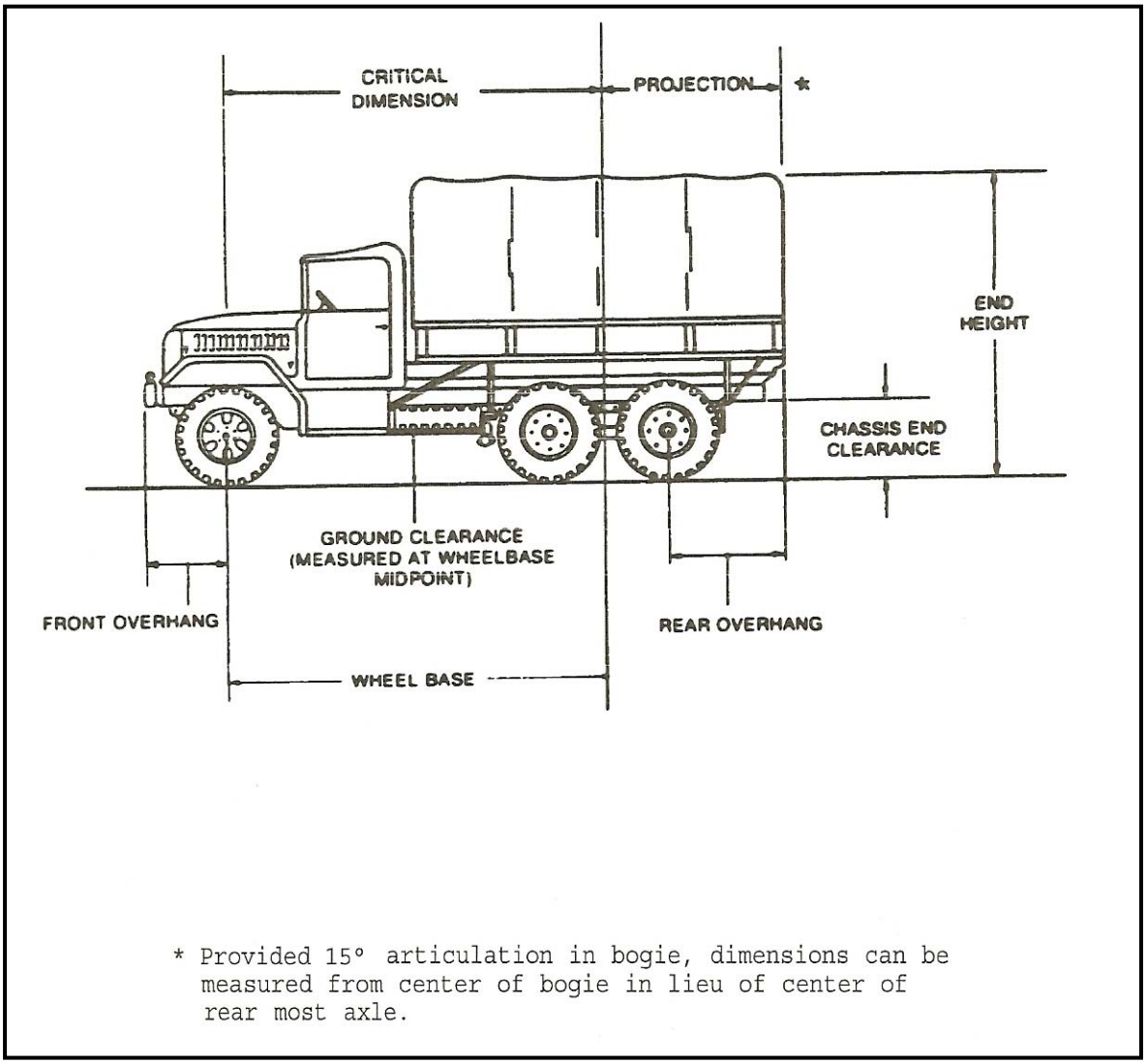

Figure 1. Illustration for determining dimensions of physical characteristics for a truck.

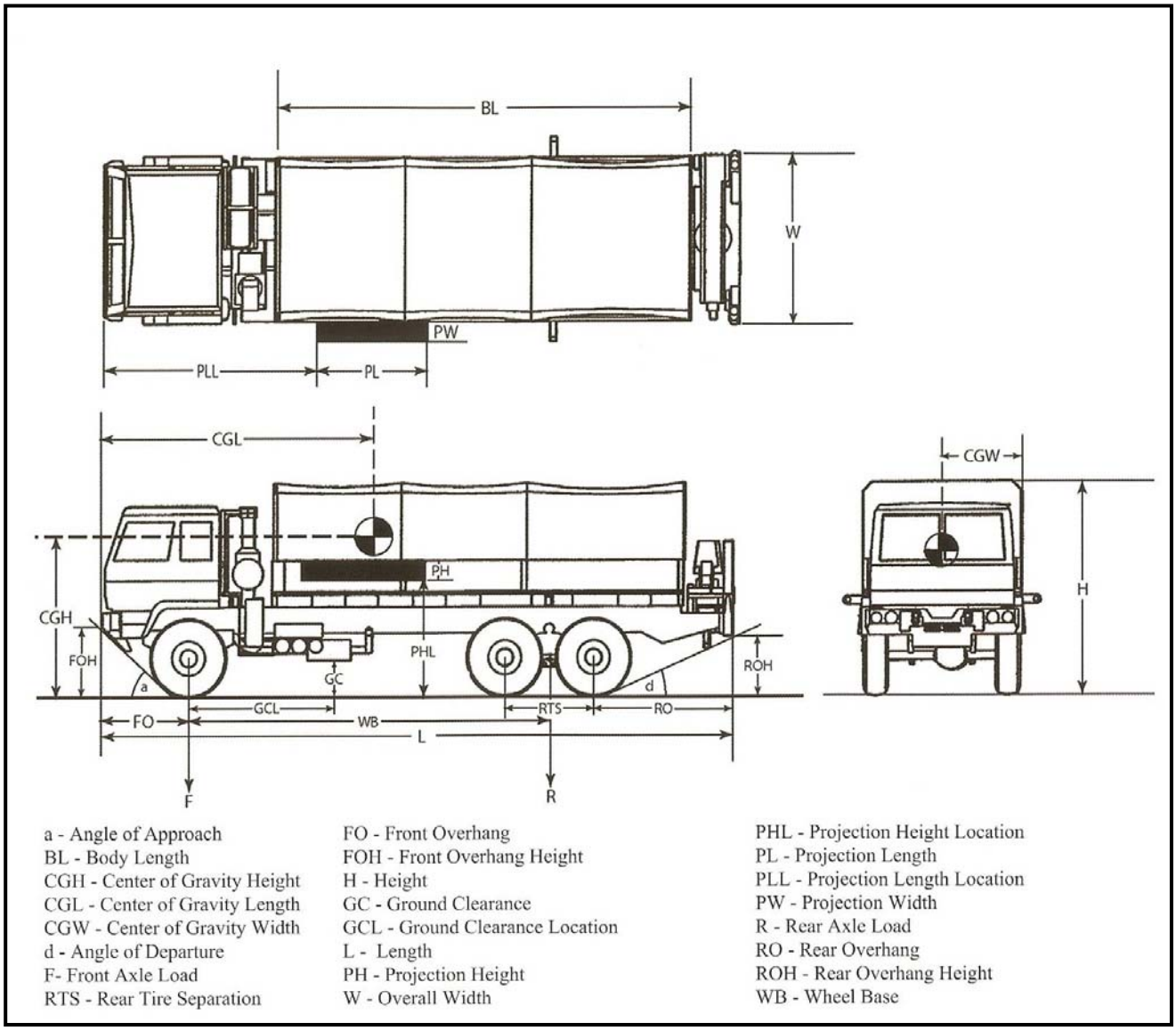

Figure 2. Illustration for determining dimensions of physical characteristics for a truck.

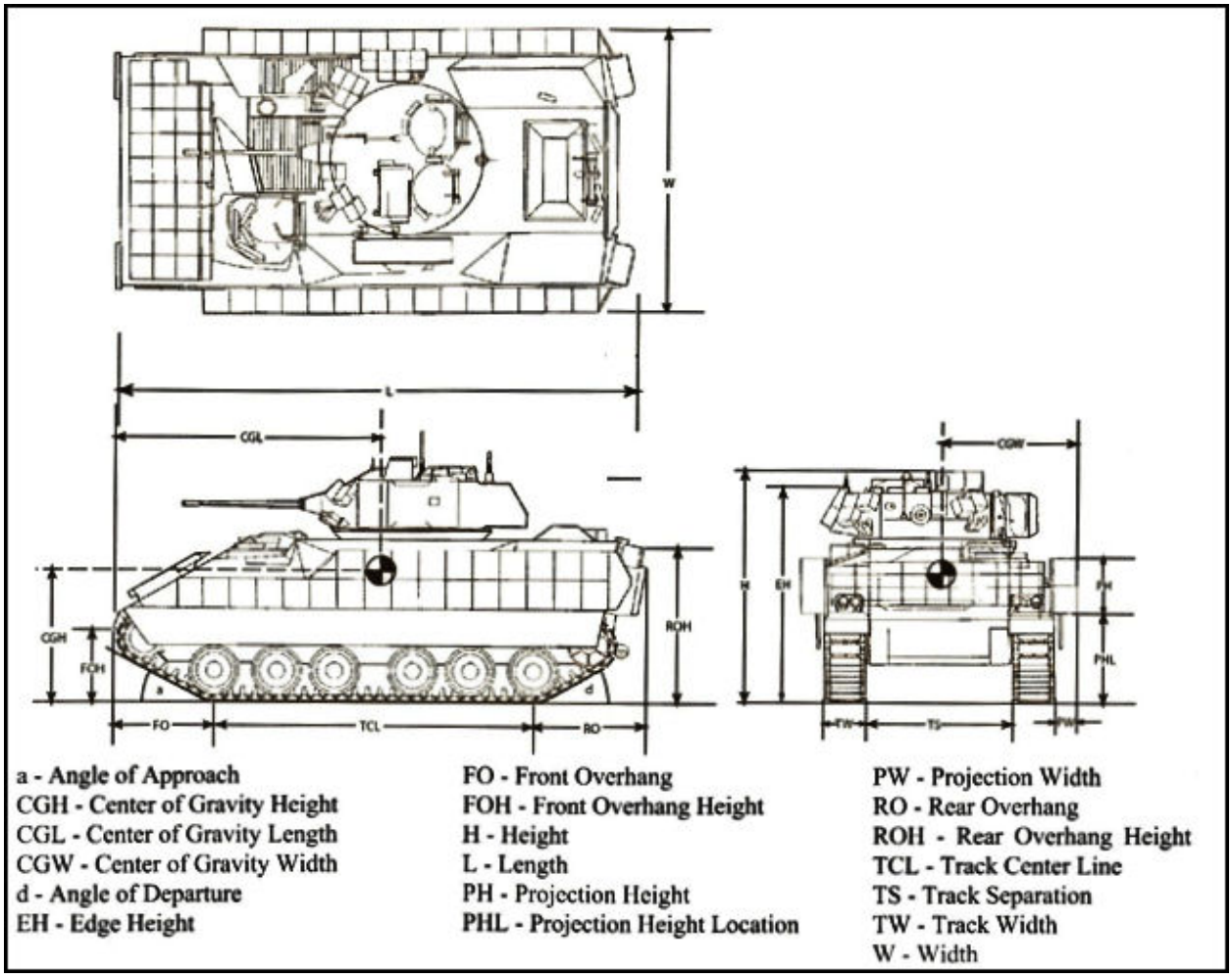

Figure 3. Illustration for determining dimensions of physical characteristics for a track vehicle.

4.7 Air Transportability - Rotary Wing/Tiltrotor Internal.

The objective of this subtest is to determine the capability of the test item to be transported in an internal configuration by rotary-wing aircraft. The Aerial Delivery Engineering Support Team, AMSRD-NSR-WP-AD, of the US Army NSRDEC is responsible for certification of equipment transported internally via US Army rotary-wing aircraft. NAVAIR has been designated for USN and USMC internal load certifications. The NSRDEC certification is based on an engineering evaluation of load characteristics and the tiedown provisions accomplished by NSRDEC, proof load testing of the tiedown provisions in accordance with MIL-STD-209K and a validation test loading, when deemed necessary. The NSRDEC engineering evaluation includes the following:

a. Identification of the helicopters that are capable of transporting the test item based on each helicopter's size and weight limitations specified in MIL-STD-1366E and provided as Appendix B.

b. Determination of restraint criteria based on aircraft requirements specified in MIL-STD-1366E and provided as Appendix B.

c. Calculation of tiedown provision proof loads.

d. Evaluation of load weight distribution versus aircraft floor and/or ramp loading limitations specified in individual helicopter technical manuals.

e. Determination of item clearances during loading and flight. An item must maintain 15 cm (6 in.) of vertical clearance and 13 cm (5 in.) of clearance on each side of the aircraft structure at all times during loading and flight.

f. Method.

(1) Test the tiedown provisions in accordance with MIL-STD-209K (paragraph 4.1). Compliance with MIL-STD-209K satisfies the crash load restraint criteria for military rotary-wing aircraft with the exception of the US Army UH-60. The UH-60 12-*g* forward crash load restraint criterion will require additional testing or equipping the item(s) with a greater number of forward tiedowns. Each tiedown provision and its supporting structure shall withstand its proportionate share of the loadings. All tiedown provisions must undergo proof testing. No visible permanent deformation or set in the provisions or supporting structure shall result from the application of the loads. In addition, the contractor or manufacturer will provide a material analysis illustrating that the ultimate load is not less than 1.5 times the required design limit load for the provisions.

(2) Conduct test loading of the item if the NSRDEC engineering analysis reveals that the characteristics of the test item are such that analytical means alone are insufficient to determine whether it meets the clearance, projection, overhang, and ramp cresting requirements. Load the test item in the designated aircraft and secure it in accordance with the procedures outlined in Field Manual (FM) 55-450-2[21]. During the test loading, document and photograph any special procedures for loading and/or tiedown developed. If any restrictions are revealed, attempt to disassemble the item to enable loading and document the disassembly required.

4.8 Air Transportability - Rotary Wing/Tiltrotor External.

a. The objective of this subtest is to determine the capability of the test item to be transported as an externally suspended load by rotary-wing and/or tiltrotor aircraft.

b. Method.

(1) Inspect the test item lift provisions to determine the locations, type, and measurements of the provisions for conformance to MIL-STD-913A. Weigh the item and determine the center of gravity. Communicate this information to the NSRDEC (AMSRD-NSR-WP-AD) which is responsible for performing an engineering analysis and developing draft rigging procedures. The aircraft that are capable of transporting the item are identified in the engineering analysis. The maximum external payload capabilities of US Army, USN, and USMC rotary-wing and tiltrotor aircraft are specified in MIL-STD-1366E and provided in

Appendix C. A prerequisite to a flight demonstration is the successful accomplishment of proof load testing of the lift provisions and/or compression testing of the item in accordance with MIL-STD-913A, described previously in paragraph 4.1. Prior to a flight demonstration, inspect all lift provisions and adjacent structural components to ensure integrity. If any damage or deformation exists, the item should not be flown pending repair or replacement.

(2) The test item shall undergo static lift testing to verify sling leg clearances and load orientation prior to a flight demonstration. Rig the item with a standard military sling set in accordance with the draft rigging procedures provided by NSRDEC and in accordance with Technical Manual (TM) 4-48.09[22]. The sling set nomenclature and capacities are listed in Table 1.

TABLE 1. MILITARY SLING SETS FOR EXTERNAL AIR TRANSPORT

SERVICE	SLING SET CAPACITY		NSN	SLING LEG LOAD LIMIT		TYPE
	kg	lb		kg	lb	
Army	4,536	10,000	1670-01-027-2902	5,126	11,300	Rope
Army	11,340	25,000	1670-01-027-2900	10,206	22,500	Rope
USMC	18,144	40,000	3940-01-183-2118	18,053	39,800	Rope
USN and USMC (V/STOL V-22/ MV-22 Aircraft)	11,340	25,000	1670-01-027-2900	10,206	22,500	Rope

(a) Employment of a spreader bar to avoid sling-to-item interference is discouraged due to the logistics burden and additional rigging time required. A spreader bar used for EAT must be stowed with the test item as On-Vehicle Equipment (OVE) or a BII. Additionally, compressive load testing of the spreader bar, unless previously tested or type classified will be required prior to flight testing.

(b) Once rigged, attach the sling set apex to the cargo hook of a mobile or overhead crane and hoist the item from the ground. Note any sling-to-item contact or interference. Measure and record the angle of inclination of the load with respect to the ground. If the desired orientation identified by NSRDEC was not achieved (i.e., level, 5 degree nose downward), adjust the rigging until the desired orientation is attained. Record the final rigging configuration (link counts).

(3) Position the test item on the test pad with its designated front facing into the prevailing wind. Engage the parking brakes on vehicles, trailers or weapon systems equipped with parking brake systems. Secure loose brake lines, inter-vehicular cables and safety chains of towed items with tape or nylon cord. Remove, stow, and secure all soft-top covers in a designated shelter or to the item in some fashion. Secure all external and internal equipment, and vents and access doors using tape, nylon cord, or cargo straps if a positive means of securement

is not already provided. Rig the sling set in a breakaway fashion to prevent any interference during load hookup. Photograph the resultant rigging configuration.

(4) Fly the item as an externally suspended load with each military aircraft specified and for each rigging configuration desired (i.e., single and dual point rigging). The rigging crew will access the highest point of the load. Document any difficulties experienced in accessing or departing the load due to a lack of adequate footholds, handles, etc. As the aircraft hovers over the load, the static discharge wand handler contacts the wand (if required) to the cargo hook of the aircraft as the second rigger attaches the apex fitting to the cargo hook. Once the rigging crew has departed the load, the aircrew performs the flight demonstration in accordance with the process listed in the Multi-Service Flight Data Collection Sheet (MSFDCS), provided as Appendix D. The aircraft will accomplish the flight demonstration in a predetermined flight path/area that is predominately uninhabited. Photograph the test item slung under each aircraft to document load orientation. Record (video) the flight demonstration by both an on-board camera and chase aircraft. After the completion of the flight demonstration, the aircrew returns the load to the test pad. Perform visual and functional inspections of the item. Record and photograph any evidence of physical damage as a result of the flight demonstration.

4.9 Air Transportability - Airdropped Materiel.

a. The objective of this test is to determine the suitability of the test item to be airdropped from fixed-wing aircraft. NSRDEC is responsible for certification of Army equipment for airdrop. NSRDEC is recognized in the DOD as the subject matter expert for cargo airdrop. And as a result, the other services request that NSRDEC support their cargo airdrop certification requirements.

b. Method.

(1) Lift/Tiedown Provision Compatibility. Inspect the test item for location and compatibility of tiedown and lifting points. Employ data obtained from the lifting and tiedown provisions subtest (paragraph 4.1) when appropriate. Verify compatibility of test item points with load anchoring points on the aircraft or airdrop platform. Inspect and measure tiedown, suspension, and extraction provisions to identify their number, location, dimensions, and clearances as required by MIL-STD-814D.

(2) Provision Integrity and Aircraft Compatibility. Prepare the test item for airdrop by either the suspension or extraction method, or both, as identified by NSRDEC in accordance with TM 10-500-2[23] and MIL-HDBK-669[24]. Weigh and measure overall physical characteristics of the rigged load to determine conformance with MIL-STD-814D and for compatibility with the designated carrier aircraft. Accomplish static pull tests of suspension or extraction provisions and components to verify compliance with MIL-STD-814D (paragraph 4.1).

(3) Energy Dissipation. If specific provisions for energy dissipation are not provided, subject the prepared test item to deceleration force levels less than the *g* +1, or 19.5 times the item airdrop weight, specified by MIL-HDBK-669, using trial force levels as recommended by the developer. Progressively increase low force levels, making observations for any indications

of damage, up to the maximum ratio of *g* +1 or 19.5 ± 10 percent. However, the energy dissipation kit should be provided by NSRDEC.

(4) Simulated Airdrop Impact Test (SAIT) (Low Velocity). Assemble, secure, balance, and cushion the test item on a pallet or other appropriate carrier in accordance with NSRDEC draft procedures and MIL-HDBK-669. Attach the test item to the cargo lifting hook of a static drop facility. The facility and lifting device will be high enough to permit the bottom of the cargo to be raised a minimum of 3.87 m (12.7 ft), the equivalent of 8.7 m/sec (28.5 ft/sec) free-fall, above the ground. The impact area will be level, constructed of a minimum of 0.3-m (1.0-ft) thick reinforced concrete or similar rigid material. Affix an accelerometer(s) to a centrally located hard point and/or to any sensitive items within the load. Attach the rigged item to the lifting hook of the facility and raise the item off the ground until its lower edge is positioned 3.87 m (12.7 ft) above the ground. Adjust the rigging material to achieve a level suspension attitude, as necessary. Record the vertical distance from the ground to the load. Release the cargo hook, allowing the item to free-fall to the ground. Record the accelerometer readings. Conduct visual and functional inspections of the load and record the results.

(5) Airdrop. Prior to live airdrop testing, an airdrop Proposed Test Plan (PTP) must be submitted to the US Air Force Aeronautical Systems Center (HQ ASC) at Wright-Patterson AFB, and US Air Force Air Mobility Command (HQ AMC) at Scott AFB. A PTP approval from HQ ASC and HQ AMC is required before live airdrop testing can be conducted from Air Force fixed wing aircraft. Rig the test item in accordance with instructions provided/approved by NSRDEC. Document any deviations or additions to the instructions. After completion of the rigging, conduct a Joint Aircraft Inspection (JAI) to verify procedures and load worthiness. Transfer the load to the aircraft by any safe means available and acceptable to the aircrew. Document the load transfer procedure, including the identification of aircraft loader employed, when applicable. Secure the item to the aircraft in accordance with USAF instructions. Document any deviations or additions to the instructions. Following item securement, conduct a second and final JAI. Upon completion of the JAI and acceptance of the load, all responsibility for the mission is transferred to the USAF. The altitude, air speed, and drop zone for the test are identified and coordinated with the air crew, test facility, and USAF. Employ ground tracking, photography, and instrumentation to record position versus time, flight trajectory, and impact velocity and acceleration. After load impact, conduct a visual inspection of the test item, instrumentation and parachute system (airdrop only). Record and photograph any evidence of physical damage as a result of the airdrop. After the completion of de-rigging, conduct a visual and functional inspection of the load. Record the results of the inspections.

5. DATA REQUIRED.

5.1 Lifting and Tiedown Provisions.

a. Dimension and location measurements of lifting and tiedown provisions, number of provisions, and directional capabilities.

b. Record of any sling-to-item interference or provision accessibility problems.

c. Description of procedure employed in securing test item for load application.

d. Measurement of static force(s) applied, the direction of each static pull, and any physical changes in the lifting/tiedown provisions(s) subjected to the pull.

e. Measurement of the sling lengths, sling leg angles, inclination, and apex height of the suspended item.

f. Identification of spreader bar(s) employed, as necessary, and the configuration of the lifting assembly (photographs when available).

g. Record of any visual or measured permanent deformation or settling or weld cracking resulting from testing (photographs when available).

5.2 Rail Transportability.

a. Documentation of the tiedown devices used to secure the test item (photos, drawings, materials list, etc.).

b. Description of any existing damage of test item or railcars.

c. Description of the test railcar and individual buffer car(s).

d. Description of the test item, including configuration, loading, weight, dimensions, tire pressures, and general location on the test car.

e. Direction of the impact (define forward end of test item).

f. Impact speeds.

g. Results of examination and operational checkout tests.

h. If necessary, transducer measurements (i.e. acceleration, temperature, strain, etc.) of various locations on the test item and railcar.

i. Effects on the test item and tiedown devices including deficiencies, shortcomings, or limitations that occur during rail impacting.

j. Locations and extent of any interference with railroad clearance diagrams.

5.3 Highway Transportability.

a. Weights, gross, curb, and axle loadings of test item and carrier supporting the test item.

b. Configuration and any loading of the test item for highway transportation.

c. Physical dimensions (including length, width, reducible width, overall height, and reducible height) of the test item.

d. Physical dimensions (including overall length, width, height, and any overhang(s)) of the test item as secured on its carrier.

e. Description of the tiedown devices used to secure the test item to its carrier (photos, drawings, materials list, etc.).

5.4 Marine Transportability.

a. Type of ship or simulation gear used.

b. Angles of approach and departure for test vehicle.

c. Ability of test vehicle to negotiate a 15-degree ramp.

d. Minimum ground clearance of test vehicle (identify location).

e. Equipment used in loading and any difficulties encountered.

f. Location of stowage.

g. Method of securing item.

h. Length of time and number of people required to rig the test item for shipment.

i. Measurements of acceleration, deceleration, and strain.

j. Duration of simulation or voyage, and angles and periods of pitch, roll, and yaw encountered.

k. Condition of bracing and securing gear during and after the voyage.

l. Direction of shift, if any.

m. Amount and type of damage, if any.

n. For landing craft trials, vehicle and craft ramp angles of approach, departure, break and crest.

o. For landing craft trials, gradeability capabilities, or limitations of the test item.

5.5 Terminals Handling and Movement.

a. Results of visual inspections, dimensional records, and operational checks, the latter if appropriate, for pre- and post-test examinations.

b. Descriptions and photographs or diagrams of loading the test item, to include any blocking, bracing, or cushioning.

c. Descriptions and photographs of the test facility, including means of item handling and/or lifting, and sling capacity.

d. Measurement of heights of drop tests, and the orientation of the item for each test iteration.

e. Dimensions, type, location, configuration, and number of skids and/or forklifting provisions.

f. Description and photograph of any incompatibility of the container, shelter, or package with its storage or transportation medium.

g. Shock and vibration, or strain data.

h. Video record of forklifting, drop, and rough handling tests.

i. Gross and tare weights of the test item.

j. Prevailing meteorological conditions at the time of the test.

k. Measurements of any deflections obtained during stackability tests.

5.6 Air Transportability – Fixed Wing, Internal.

a. Center of gravity of test item.

b. Maximum ratings of lift and tiedown provisions as determined by physical testing conducted in accordance with MIL-STD-209K.

c. All measurements contained in Appendix A, Table A-1.

5.7 Air Transportability - Rotary Wing/Tiltrotor, Internal.

a. Item description and nomenclature.

b. Weight, dimensions, center of gravity, and cubage of item.

c. Ground contact area (i.e., skids, tires).

d. Calculation of ground pressure = weight and ground contact area.

e. Number, location and load capacity and rating of the tiedowns.

f. Instructions for special servicing and preparation.

g. Orientation for flight, when critical.

h. Identification of cargo handling equipment employed, if any.

i. Precautions and procedures to be observed during loading or unloading.

j. Restrictions and clearances for loading, including ramp.

k. Reduction in vehicle and trailer tire pressure to meet floor loading requirements, if necessary.

l. Any disassembly of the item required for loading.

m. List of tiedown equipment employed.

5.8 Air Transportability – Rotary Wing/Tiltrotor, External.

a. Record of test item condition for test (fuel and lubricant levels, missing, or damaged components).

b. List of test item preparation for flight testing.

c. Configuration and tiedown diagrams for pallet loads, if applicable.

d. Sling set type and number of sling legs employed.

e. Sling set link counts, front and rear.

f. Characteristic photographs of rigged test item.

g. Angle of inclination of the load with respect to the ground during static testing.

h. Record of any difficulties experienced in accessing and departing test item by rigging crew.

i. Photographs of test item slung from each aircraft.

j. Videotape of flight test, when available.

k. Completed and signed MSFDCS, including item weight and prevailing meteorological conditions.

l. Results of post-test visual and functional inspections.

5.9 Air Transportability – Airdropped Materiel.

a. Dimensional and strength measurements of tiedown, lifting and anchoring points, number, and location.

b. Rigging diagrams and procedures.

c. Weight and overall physical characteristics of rigged item.

d. Compatibility of the test item with the airdrop platform and the aircraft.

e. Static pull test results (Paragraph 4.1).

f. Energy dissipation test results.

g. Vertical distance between item and ground (ground impact test).

h. Free-fall acceleration (ground impact test).

i. Time to rig test item.

j. Photographs of the rigged configuration.

k. Position versus time data at a rate of five times per second (airdrop).

l. Impact velocity (airdrop).

m. Impact accelerations (airdrop).

n. Results of visual and functional inspections.

o. Video & High-Speed Video of SAIT.

p. Video for live airdrop.

6. PRESENTATION OF DATA.

6.1 Lifting and Tiedown Provisions.

Compile a list or diagram specifying the location and classification of each lifting and tiedown provision if a data plate or similar information has not been provided by the materiel developer or manufacturer. Describe the method and equipment employed to secure the item for each load application. Tabulate the results of the pull testing. Any deformation or weld cracking of the provisions or adjacent structural components is considered a failure to satisfy the Military Standard. Photographs will document the physical damage or deformation experienced. Close up photographs will document size and location of lift and tiedown provisions. Sample formats for collecting data are provided in Tables 2 through 6.

TABLE 2. SAMPLE TABLE FOR DISPOSITION OF PROVISIONS

PROVISION LOCATION	FITTING TYPE	FUNCTION[a]	NUMBER OF PROVISIONS							LABELING
			TOTAL	BY DIRECTION OF RESTRAINT:					LIFT	STENCILED TEXT
				FORE	AFT	LEFT	RIGHT	VERT.		
Lift and Equipment Tie-down Provisions										
Front	Padeye	▲								
Rear	Padeye	▲								
Front	Padeye	▼								
Rear	Padeye	▼								
Totals, for principal provisions			0	0	0	0	0	0	0	

Supplemental Air Transport Tie-down Provisions								
PROVISION LOCATION	FITTING TYPE	FUNCTION	TOTAL	DIRECTION OF RESTRAINT			LABELING	
				FORE	AFT	FORE AND AFT	RATING, lb	STENCILED TEXT
Front								
Intermediate								
Rear								
Total supplemental provisions			0					

[a] Note: Symbols used in the "Function" column are consistent with those for lifting, tiedown, and multipurpose provisions from MIL-STD-209K.

TABLE 3. SAMPLE TABLE FOR LIFTING AND EQUIPMENT TIEDOWN PROVISION DIMENSIONS

PROVISION	REQUIRED[a], in.,						
	A MAX	B MAX	C_L MIN	C_S MIN	D MIN	E MIN	HEIGHT
Equipment tie-down							
Left Front							
Right Front							
Right Rear							
Left Rear							
Multi-purpose							
Left Front							
Right Front							
Right Rear							
Left Rear							
Lift							
Left Front							
Right Front							
Right Rear							
Left Rear							

[a] Note: The parameters in the "Required" row are specified in MIL-STD-209K, Figure 3.

TABLE 4. SAMPLE TABLE OF CHARACTERISTICS FOR LIFT AND TIEDOWN PROVISIONS

PROVISION	VALUE
S1 – lateral distance from CG to right front tie-down provision	
S2 – lateral distance from CG to left front tie-down provision	
S3 – lateral distance from CG to right rear tie-down provision	
S4 – lateral distance from CG to left rear tie-down provision	
L1 – longitudinal distance from CG to right front tie-down provision	
L2 – longitudinal distance from CG to left front tie-down provision	
L3 – longitudinal distance from CG to right rear tie-down provision	
L4 – longitudinal distance from CG to left rear tie-down provision	
Lf – longitudinal distance from CG to front lifting provisions	
Lr – longitudinal distance from CG to rear lifting provisions	
Hf – height from ground to front lifting provisions	
Hr – height from ground to rear lifting provisions	
Da – lateral distance from CG to front left lifting provision	
Db – lateral distance from CG to front right lifting provision	
Dc – lateral distance from CG to rear right lifting provision	
Dd – lateral distance from CG to rear left lifting provision	
Gross vehicle weight, lb	

TABLE 5. SAMPLE TABLE OF LIFT PROVISION PROOF LOAD SUMMARY

AXIS OF LOADING	TYPE OF LOADING	PROVISION	LOADS, lbf				
			DESIGN	TEST TOLERANCE	APPLIED LOADS		
					AVERAGE	MAXIMUM	MINIMUM
Crane lift	Applied	Apex					
		Front Left	NA				
		Front Right					
		Rear Right					
		Rear Left					

TABLE 6. SAMPLE TABLE OF EQUIPMENT TIEDOWN PROVISION PROOF LOAD SUMMARY

AXIS OF LOADING	TYPE OF LOADING	PROVISION	LOADS, lbf				
			DESIGN	TEST TOLERANCE	APPLIED LOADS		
					AVERAGE	MAXIMUM	MINIMUM
Lateral	Applied						
	Reaction						
	Applied						
	Reaction						
Longitudinal	Applied						
	Reaction						
Vertical, down	Applied						
	Applied						

6.2 Rail Transportability.

a. Tabulate the test configuration and speeds of the rail impact. Prepare photographs and/or sketches of tiedown configurations. Overlay the test item profile on each applicable rail clearance diagram with clearance dimensions and railcar height. Prepare photographs of setup, instrumentation, and any damaged components. Sample formats for collecting data are provided in Tables 7 and 8, and Figure 4.

TABLE 7. SAMPLE TABLE OF RAIL IMPACT TEST CONFIGURATION

CONFIGURATION		TEST ITEM
No. of Restraints		
Type of Restraints		
Test Weight, lb		
Tire pressure (PSI)	Axle 1	
	Axle 2	

TABLE 8. SAMPLE TABLE OF RAIL IMPACT TEST SPEEDS

IMPACT NO.	REQUIRED SPEED	ACTUAL SPEED	ORIENTATION
	mph		
1	4		Forward
2	6		Forward
3	8		Forward
4	8		Reverse

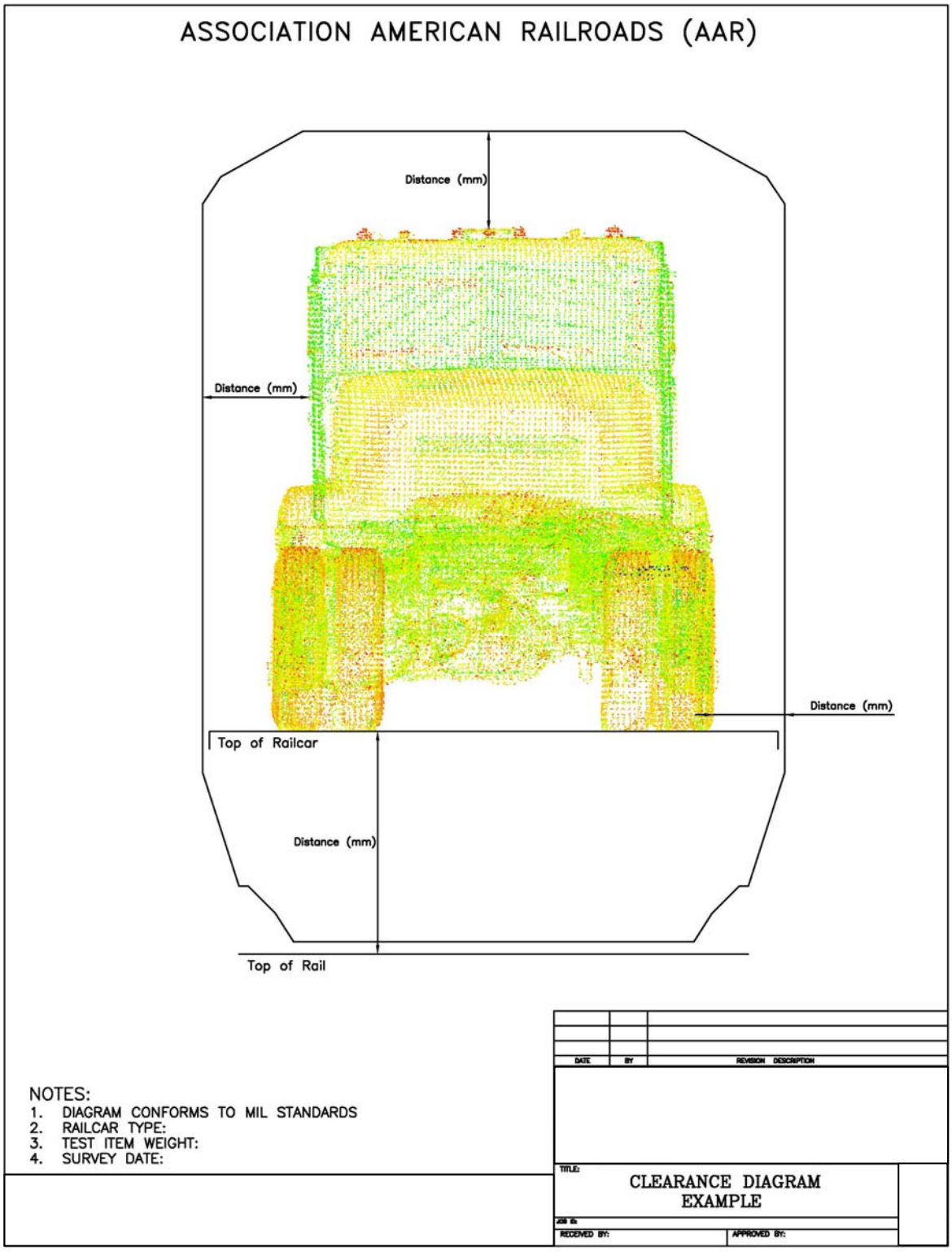

Figure 4. Representation of test item profile with applicable rail clearance diagram.

b. If required, prepare a graph of peak coupler force versus actual impact speed and compile tables of peak acceleration levels and/or plots of time versus acceleration for each impact. Present video documentation of the actual rail impacts as required for Association of American Railroads (AAR) acceptance of DOD rail impact testing. If necessary, prepare any pertinent graphs to represent other transducer measurements (i.e. strain versus time, temperature recordings, etc.).

6.3 Highway Transportability.

Summarize physical parameter measurements in tables. Describe the details of test incidents in narrative form and illustrate physical events with photographs. Verify that loading the test item does not exceed the gross vehicle and component ratings of the carrier. If feasible, compare physical characteristics with federal highway restrictions.

6.4 Marine Transportability.

Summarize and tabulate the data to present peak or critical measurements, displacements, and interferences. Include supporting photographs, sketches and curves as appropriate. Describe the details of test incidents in narrative form and illustrate physical events with photographs.

6.5 Terminals Handling and Movement.

Review and compare measured and observed data to ensure that test objectives and system criteria were achieved. Analyze the degradation of performance from pretest levels, in the case of sheltered systems or packaged equipment, or any item damage with respect to the effect on materiel utility and provisions of the applicable criteria. Analyze shock and vibration data to determine peak values and frequency content. Describe the details of test incidents in narrative form and illustrate physical events with photographs. A sample format for collecting data is provided in Table 9.

TABLE 9. SAMPLE TABLE OF ACHIEVED RIGGING PARAMETERS

PARAMETER	SLING LENGTH
	ft
Longitudinal inclination of test item, degrees	
Apex Height, ft	
Front sling angle relative to ground, degrees	
Rear sling angle relative to ground, degrees	
Plane of provisions or interference, degrees	
Front sling angle relative to the plane of provisions, degrees	
Rear sling angle relative to the plane of provisions, degrees	

6.6 Air Transportability - Fixed Wing Internal.

Analyze the measured data in accordance with MIL-HDBK-1791 to determine the suitability of the test item for transport on USAF and CRAF aircraft. If a test loading is conducted, describe

the measured interferences between the test item and the aircraft. Once all possible interferences are resolved, the test item will be certified for air transport in a letter from the USAF ATTLA.

6.7 Air Transportability - Rotary Wing Internal.

Describe the actions taken to service and prepare the item for aircraft loading. Describe the method employed in loading and unloading the item into the aircraft. Photographs of the item during and upon completion of the loading will document the loading and tiedown configuration. Present in narrative form any incidents or interferences noted during the loading and unloading.

6.8 Air Transportability - Rotary Wing External.

Describe the actions taken to prepare the load for the flight demonstration in a format comparable to that used in relevant field and technical manuals. Photographs of the test item will document the rigging configuration and sling orientation. Summarize the results of the MSFDCS in tabular or narrative form, supplemented by any observations made by a review of the flight test videotape(s). Compare the results of the flight tests to the criteria listed in MIL-STD-913A. Provide the original MSFDCS to the NSRDEC project officer for the test file. Provide a recommendation as to the maximum safe speed for EAT of each load configuration and helicopter combination. Identify any restrictions of EAT load configurations if flight test results were unsatisfactory. Sample formats for collecting data are provided in Tables 10 and 11.

TABLE 10. SAMPLE TABLE OF ROTARY WING EXTERNAL SLING CONFIGURATIONS

HSL WEIGHT, lb	SLING	RIGGING	LINK COUNT, FRONT/REAR	NO. OF EXTENSIONS FRONT/REAR	FLIGHT ATTITUDE, DEGREES	DIRECTION OF TRAVEL
Configuration 1						
Configuration 2						

TABLE 11. SAMPLE TABLE OF RIGGING PROCEDURES

PARAMETER	PROCEDURES
Configuration	Single point
Required rigging	Sling set, 25K (NSN 1670-01-027-2900)
Materials	Tape, adhesive, pressure-sensitive, 2-in.-wide roll
	Cord, nylon, Type III, 550-lb breaking strength
	Web, cotton, 1/4-in., 80-lb breaking strength

TABLE 11. CONT'D

PARAMETER	PROCEDURES
Preparation(s)	Disconnect trailer from prime mover; ensure the front support leg is down and engage the trailer parking brake
	Secure all loose items on exterior of trailer (locks, access panels, trailer electrical connector, cover straps etc.) with tape or Type III nylon cord.
	Cover all lights, markers, and reflectors with tape.
Personnel	2 persons, 15 min
Rigging process	Position apex fitting on the ground next to the item and rigging to each side of the load: outer sling legs No. 1 and 2 to the front, inner sling legs No. 3 and 4 to the rear.
	Loop the chain end of sling leg No. 1 through the front left lifting provision on the trailer. Place the appropriate link number in the grab hook. Repeat with sling leg No. 2 through front right lifting provision.
	Secure excess chain with 2-in. tape or Type III nylon cord.
	Loop the chain end of sling leg No. 3 through the rear left lift provision on the trailer. Place the appropriate link number in the grab hook. Repeat with sling leg No. 4 through rear right lifting provision.
	Secure excess chain with 2-in. tape or Type III nylon cord.
	Cluster and tie (breakaway technique) all sling legs together on top of the trailer to prevent entanglement during hookup and lift-off.
Hookup	The hookup team stands to the side of the item.
	The static wand person discharges the static electricity with the static wand. The hookup person places the apex fitting onto the aircraft cargo hook.
	The hookup team clears the immediate vicinity of the load as the helicopter removes slack from the sling legs.
	When successful hookup is assured, the hookup team quickly exits the area to the designated rendezvous point.
De-rigging	Reverse of rigging

6.9 Air Transportability - Airdropped Materiel.

Summarize physical parameter measurements in a table. Identify any incompatibilities between the airdrop platform and designated aircraft. Describe the actions taken to prepare and rig the load. Photographs of the test item will document the rigging configuration. Summarize the results of each test phase in tabular or narrative form, supplemented by observations made by a review of film and videotapes. Describe the results of visual inspections and functional checks accomplished following each test phase, illustrating physical events with photographs.

APPENDIX A. GENERAL PHYSICAL CHARACTERISTICS FOR TRANSPORTABILITY.

TABLE A-1. GENERAL PHYSICAL CHARACTERISTICS

MEASUREMENT	UNIT*	TRANSPORT MODE							
		RAIL	HIGHWAY	MARINE	TERMINALS	AIR , FIXED,INTERNAL	AIR, ROTARY, INTERNAL	AIR, ROTARY, EXTERNAL	AIRDROPPED MATERIEL
Dimensions									
Length	inches	X	X	X	X	X	X	X	X
Width, overall	inches	X	X	X	X	X	X	X	X
Width, reduced	inches	X	X	X		X	X	X	X
Width, outside wheels	inches	X	X	X		X	X	X	X
Height, overall maximum	inches	X	X	X	X	X	X	X	X
Height, reduced	inches	X	X	X		X	X	X	X
Height at Front of Vehicle/Trailer	inches	X	X	X		X	X		X
Height at Rear of Vehicle/Trailer	inches	X	X	X		X	X		X
Forward Overhang [a]	inches	X	X	X		X	X		X
Forward Projection [b]	inches	X	X	X		X	X		X
Rear Overhang [c]	inches	X	X	X		X	X		X
Rear Projection [d]	inches	X	X	X		X	X		X
Forward Ground Clearance	inches	X	X	X		X	X		X
Mid-Wheelbase Ground Clearance	inches	X	X	X		X	X		X
Rear Ground Clearance	inches	X	X	X		X	X		X
Fifth Wheel/Pintle Distance [e]	inches	X	X	X		X	X		X
Fifth Wheel/Pintle Height [f]	inches	X	X	X		X	X		X
Landing Gear Pad Size (Trailers)	square inches	X	X	X		X	X		X
Kingpin/Lunette Height (Trailers)	inches	X	X	X		X	X		X

APPENDIX A. GENERAL PHYSICAL CHARACTERISTICS FOR TRANSPORTABILITY.

TABLE A-1. CONT'D

MEASUREMENT	UNIT*	TRANSPORT MODE							
		RAIL	HIGHWAY	MARINE	TERMINALS	AIR , FIXED, INTERNAL	AIR, ROTARY, INTERNAL	AIR, ROTARY, EXTERNAL	AIRDROPPED MATERIEL
Wheel/Axle Measurements									
Bogie/Walking Beam Articulation [g]	degrees	X	X	X		X	X		X
Number of Axles	N/A	X	X	X		X	X		X
Distance from Front Axle to 2d Axle	inches	X	X	X		X	X		X
Distance from 2d Axle to 3d Axle	inches	X	X	X		X	X		X
Distance from 3d Axle to 4th Axle	inches	X	X	X		X	X		X
Lunette/Kingpin to first axle distance	inches	X	X	X		X	X		X
Landing gear distance	inches	X	X	X		X	X		X
Wheelbase	inches	X	X	X		X	X	X	X
Track width	inches	X	X	X		X	X	X	X
Number of Wheels on Each Axle	N/A	X	X	X		X	X		X
Tire Size	xx R zz	X	X	X		X	X		X
Tire Radius	inches	X	X	X		X	X		X
Tire Pressure	psig	X	X	X		X	X		X
Tire Contact Length	inches	X	X	X		X	X		X
Tire Contact Width	inches	X	X	X		X	X		X

APPENDIX A. GENERAL PHYSICAL CHARACTERISTICS FOR TRANSPORTABILITY.

TABLE A-1. CONT'D

MEASUREMENT	UNIT*	TRANSPORT MODE							
		RAIL	HIGHWAY	MARINE	TERMINALS	AIR , FIXED, INTERNAL	AIR, ROTARY, INTERNAL	AIR, ROTARY, EXTERNAL	AIRDROPPED MATERIEL
Weight Measurements									
Curb Item Weight	pounds	X	X	X	X	X	X	X	X
Gross Item Weight	pounds	X	X	X	X	X	X	X	X
Weight of Item on Each Axle	pounds	X	X	X		X	X		X
Ratings									
Gross Item Weight Rating	pounds	X	X	X		X	X		X
Rating of Each Axle	pounds	X	X	X		X	X		X
Rating of Suspension of Each Axle	pounds	X	X	X		X	X		X
Weight Capacity of Each Transport Provision	pounds	X	X	X		X	X	X	X
Tire Load Rating at 55 MPH/ 88 KPH	pounds	X	X	X		X	X		X
Fifth Wheel/Pintle Rating	pounds	X	X	X		X	X		X
Landing Gear Rating (Trailers) (One Leg)	pounds	X	X	X		X	X		X

[a] Distance from the forward-most portion of the item at the bottom to the center of the front axle.
[b] Distance from the forward-most portion of the item at the top to the center of the front pivot point (axle, kingpin, etc.).
[c] Distance from the rearward-most portion of the item at the bottom to the center of the rear axle.
[d] Distance from the rearward-most portion of the item at the top to the center of the rear axle.
[e] Distance from the center of the front axle to the center of the fifth wheel or pintle.
[f] Height of the top of the fifth wheel or the center portion of the pintle from the ground.
[g] Maximum articulation (without wheels leaving the ground) of any multi-axled trailer or truck rear. Defines the maximum ramp angle the item can negotiate while maintaining full load distribution on all axles.

* Note: Data are required in English units for direct comparison with aircraft specifications.

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APPENDIX B. FIXED WING AIR TRANSPORTABILITY REQUIREMENTS.

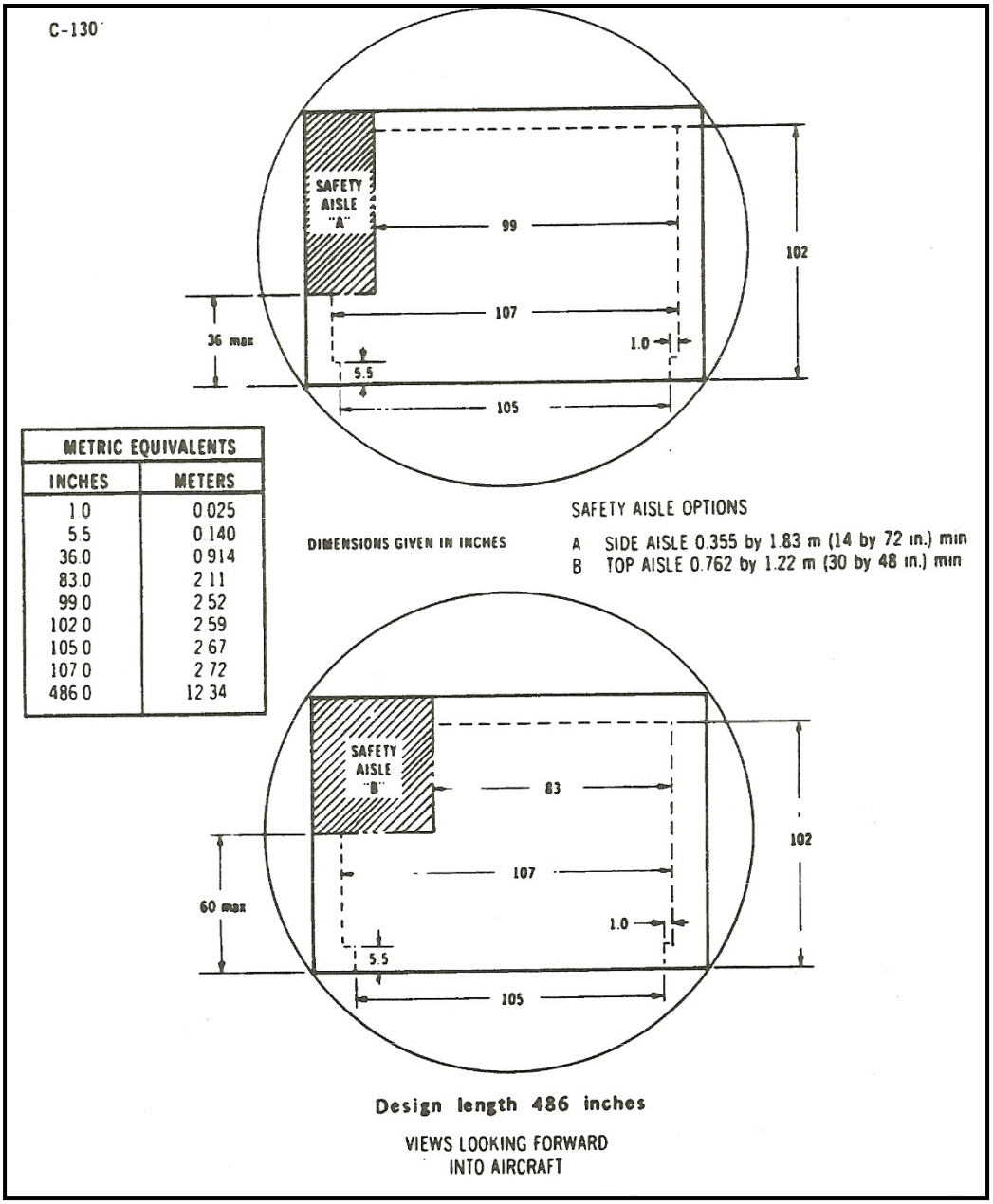

Figure B-1. C-130 cargo dimensional limits.

Note: For vehicle with tracks and non-sensitive steering, 6-in. of rolling shoring is required when the clearance between the side rails and the vehicle is critical. Vehicles with clearance of less than 2-1/2-inches on each side require ATTLA review and approval. These data are derived from MIL-HDBK-1791.

APPENDIX B. FIXED WING AIR TRANSPORTABILITY REQUIREMENTS.

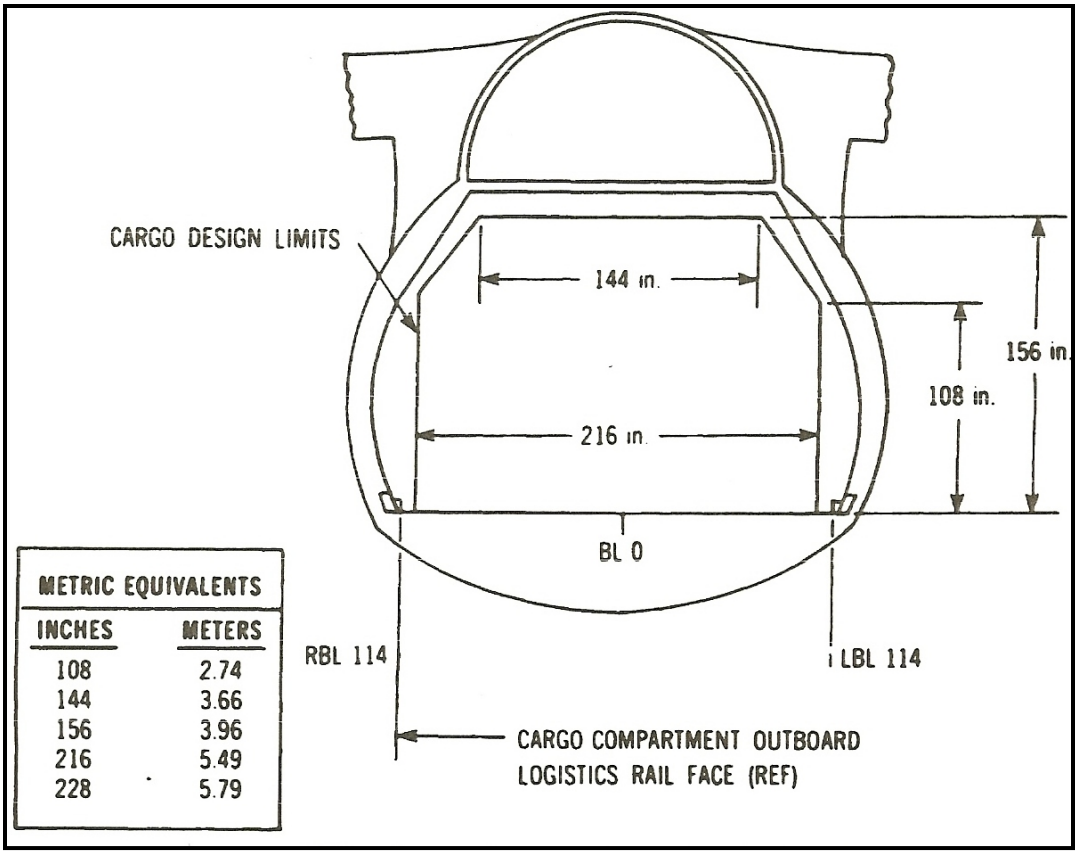

Figure B-2. C-5A/B cargo dimensional limits.

Notes: Cargo dimensional design limits shown above are the maximum deployable dimensions to be used in the design of cargo items to be transported in the C-5/B. Design length is 121 ft and 2 in. These data are derived from MIL-HDBK-1791.

APPENDIX B. FIXED WING AIR TRANSPORTABILITY REQUIREMENTS.

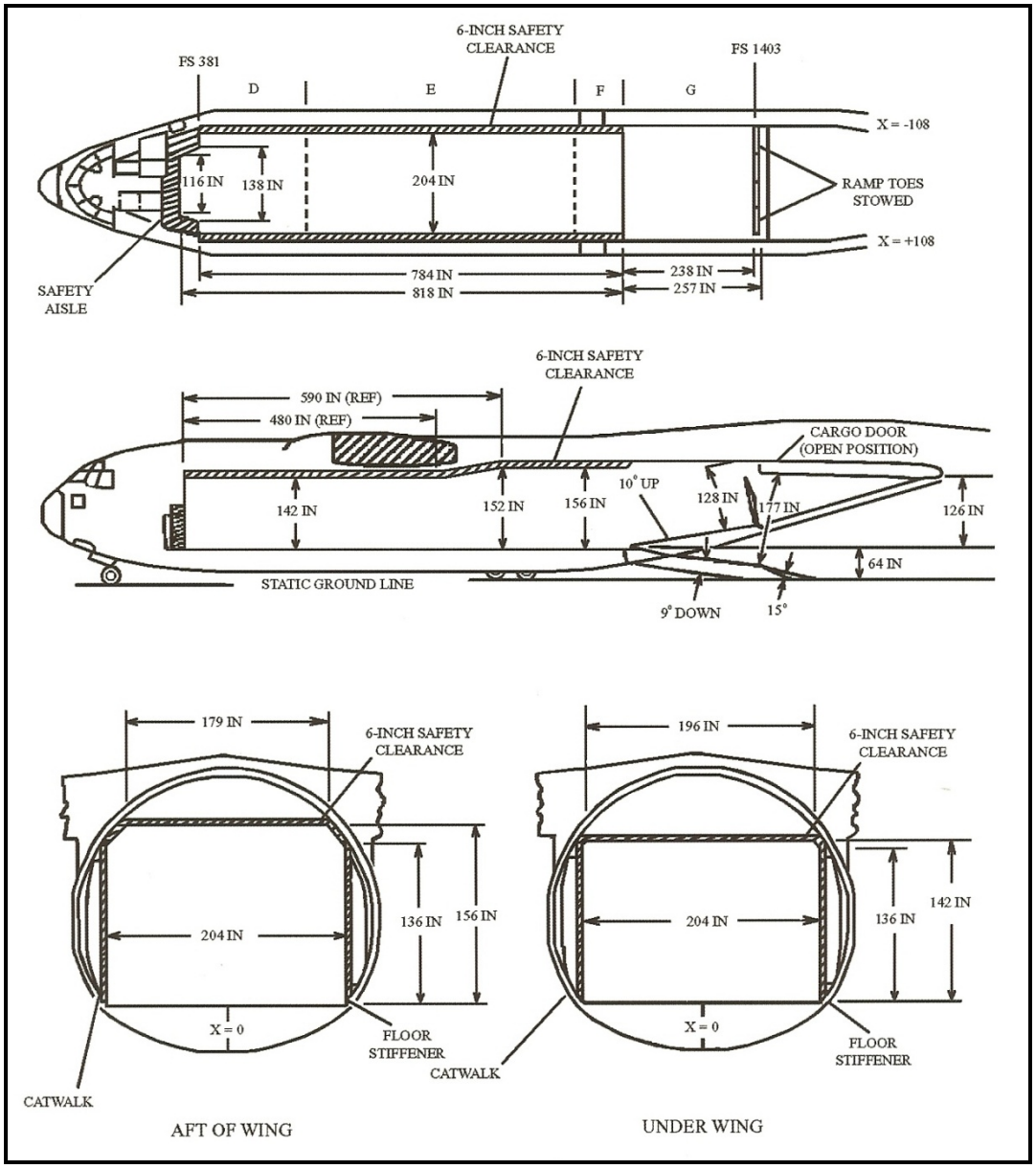

Figure B-3. C-17 cargo dimensional design limits.

APPENDIX B. FIXED WING AIR TRANSPORTABILITY REQUIREMENTS.

TABLE B-1. FIXED WING AIRCRAFT CARGO CAPABILITY

	EFFECTIVE ACL[a]		MAXIMUM ACL[b]	
AIRCRAFT	kg	lb	kg	lb
C-130	6,800	15,000	19,050	42,000
C-5	80,740	178,000	120,200	265,000
C-17	58,970	130,000	77,110	170,000

[a] Effective allowable cabin load (ACL) is defined as the longest leg over a water route. The range and mission payload capability of the aircraft varies depending on crew, fuel and oils on board, temperature, and winds. The weight and balance (center of gravity) of the aircraft is vitally important to its stability.

[b] Maximum ACL is a contingency capability which is defined as a short-range or war-time mission. Designers should use the values for the effective ACL.

APPENDIX C. ROTARY-WING AIRCRAFT INTERNAL PAYLOAD CAPABILITIES.

TABLE C-1. MAXIMUM HELICOPTER INTERNAL LOAD

MISSION SCENARIO	CH-46E	CH-47D	CH-53D	CH-53E	MV-22
	lb	lb	lb	lb	lb
Sea Level, 60F, 30 nautical miles	6,000	23,300	14,770	34,990	13,850
2,000 ft, 70F, 30 nautical miles	5,600	23,350	13,970	28,600	9,840
4,000 ft, 95F, 30 nautical miles	3,890	16,900	7,910	18,600	8,010

TABLE C-2. HELICOPTER INTERNAL TRANSPORT CONSTRAINTS[a]

HELICOPTER	HEIGHT	WIDTH	LENGTH
	in.	in.	in.
CH-46	69	72	290
CH-47D	72	80	331
CH-53E	77	90	450
MV-22	60	66	250

[a]These design limits allow for a 6-in. safety clearance between the equipment and the aircraft overhead and a 5-in. clearance between the equipment and the aircraft sidewalls.

APPENDIX C. ROTARY-WING AIRCRAFT INTERNAL PAYLOAD CAPABILITIES.

TABLE C-3. CONSTRAINTS FOR NAVY MARINE CORPS ROTARY-WING AIRCRAFT

	CARGO OPENING DIMENSIONS[a]			CARGO COMPARTMENT				CRASH LOAD RESTRAINT CRITERIA				
AIRCRAFT	LOCATION	WIDTH, in.	HEIGHT, in.	LENGTH, in.	WIDTH, in.	HEIGHT (AT FLOOR LINE), in.	STRUCTURAL[b] FLOOR LOAD LIMITS, lb/ft^2	FORWARD G's	AFT G's	LATERAL G's	UP G's	DOWN G's
SH-3G	Side	68	60	231	76	71	300	8	4	4	4	4
H-46A/D/E	Rear ramp	70	69	290	72	69	300	10	7.5	3	3	10
SH-608	Side	44	54	130	73	54	225	8	4	4	4	8
SH-60F	Side	44	54	130	73	54	75 Fwd cabin 300 Aft cabin	8	4	4	4	8
HH-60H	Rear ramp	44	54	130	73	54	75 Fwd cabin 300 Aft cabin	8	4	4	4	8
CH-53A	Rear ramp	96	77	450	90	77	300	10	7.5	3	3	10
CH-53D	Rear ramp	96	77	450	90	77	300	10	7.5	3	3	10
RH-53D	Rear ramp	96	77	450	90	77	300	10	7.5	3	3	10
CH-53E	Rear ramp	96	77	450	90	77[c]	300	10	7.5	3	3	10
MH-53E	Rear ramp	96	77	450	90	77[d]	300	10	7.5	3	3	10
V-22	Rear ramp	72	90	290	71	68	300	16	5	10	5	16

[a]Dimensional limits given are airframe dimensions. Clearances must be provided as follows: 6 in. at the top, 10 in. (minimum) on one side for personnel passageway, and 5 in. on the other side.

[b]Structural floor load limits for entire cargo compartment. For wheeled vehicle, conveyor, etc. load limits, see respective cargo, loading manual, Naval Air Training and Operating Procedures Standardization (NATOPS) Program Flight Manual, Aircraft Weight and Balance Manual for each aircraft.

[c]73 in. when single point cargo hook is stowed and 75 in. unstowed.

[d]58. in. aft cabin when Mine Counter Measure (MCM) equipment is installed.
Note: This table was derived from MIL-STD-1366E.

TABLE C-4. CONSTRAINTS FOR ARMY ROTARY-WING AIRCRAFT

AIRCRAFT	CARGO OPENING DIMENSIONS[a]			CARGO COMPARTMENT[c]				CRASH LOAD RESTRAINT CRITERIA				
	LOCATION	WIDTH, in.	HEIGHT, in.	LENGTH, in.	WIDTH, in.	HEIGHT, in.	STRUCTURAL FLOOR LOAD LIMITS, lb/ft^2	FORWARD G's	AFT G's	LATERAL G's	UP G's	DOWN G's
UH-1H	Each side	92/74[b]	49	82/47.5[d]	77/15[d]	46	100	8	8	8	4	8
UH-60 (A/L/K)	Each side	68	52	92/127.5[e]	50/46[e]	46	300	12	3	8	3	-
CH-47 (C/D/E)	Rear ramp	90	78	331	80	72	300 (or 2500 on treadway)	4	2	1.5	2	4

[a]Dimensions given are airframe dimensions. Additional clearance of 6 in. between the equipment and the aircraft ceiling must be provided.

[b]Dimensions are for both doors and sliding door opened respectively.

[c]Dimensions allow a 5 in. clearance inside the centerline of the perimeter tiedown fittings and clearance of 6 in. between the equipment and the aircraft ceiling.

[d]The first length and width dimensions are for the total cargo compartment. However, they do not allow for transmission box. The second length dimension is the unobstructed allowable cargo length form front of cargo compartment to transmission box. The second width dimension is the allowable cargo width for the areas on either side of the transmission box.

[e]Second dimension includes gunner's area.
Note: This table was derived from MIL-STD-1366E.

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APPENDIX D. ROTARY-WING AIRCRAFT EXTERNAL PAYLOAD CAPABILITIES.

TABLE D-1. MAXIMUM HELICOPTER EXTERNAL LOAD

MISSION SCENARIO	UH-1H lb	UH-60A lb	UH-60L lb	CH-46E lb	CH-47D lb	CH-53D lb	CH-53E lb	MV-22[a] lb
Sea Level, 60F, 30 nautical miles	2,585	7,843	9,000	5,915	23,324	14,700	34,770	13,320
2,000 ft, 70F, 30 nautical miles	2,624	7,302	9,000	5,480	23,396	13,900	28,300	9,330
4,000 ft, 95F, 30 nautical miles	1,169	4,700	6,630	3,780	16,644	7,860	18,200	7,500

[a] The Marine V-22 helicopter is under-development.

TABLE D-2. HELICOPTER CARGO HOOK LOAD RATINGS[a]

HELICOPTER	HOOK(S) LOAD RATINGS
UH-1H	4,000 lb
UH-60A/L	9,000 lb
CH-46E	10,000 lb
CH-47D	26,000 lb center hook/17,000 lb fore and aft hooks
CH-53E	36,000 lb
MV-22	15,000 lb single hook/10,000 lb dual hook

[a] Although the primary limitation to EAT is the available payload (Table C-1), an additional limitation is the helicopter hook strength.

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APPENDIX E. EXTERNAL AIR TRANSPORTABILITY MULTI-SERVICE FLIGHT DATA COLLECTION SHEET (MSFDCS) AND RATING CRITERIA.

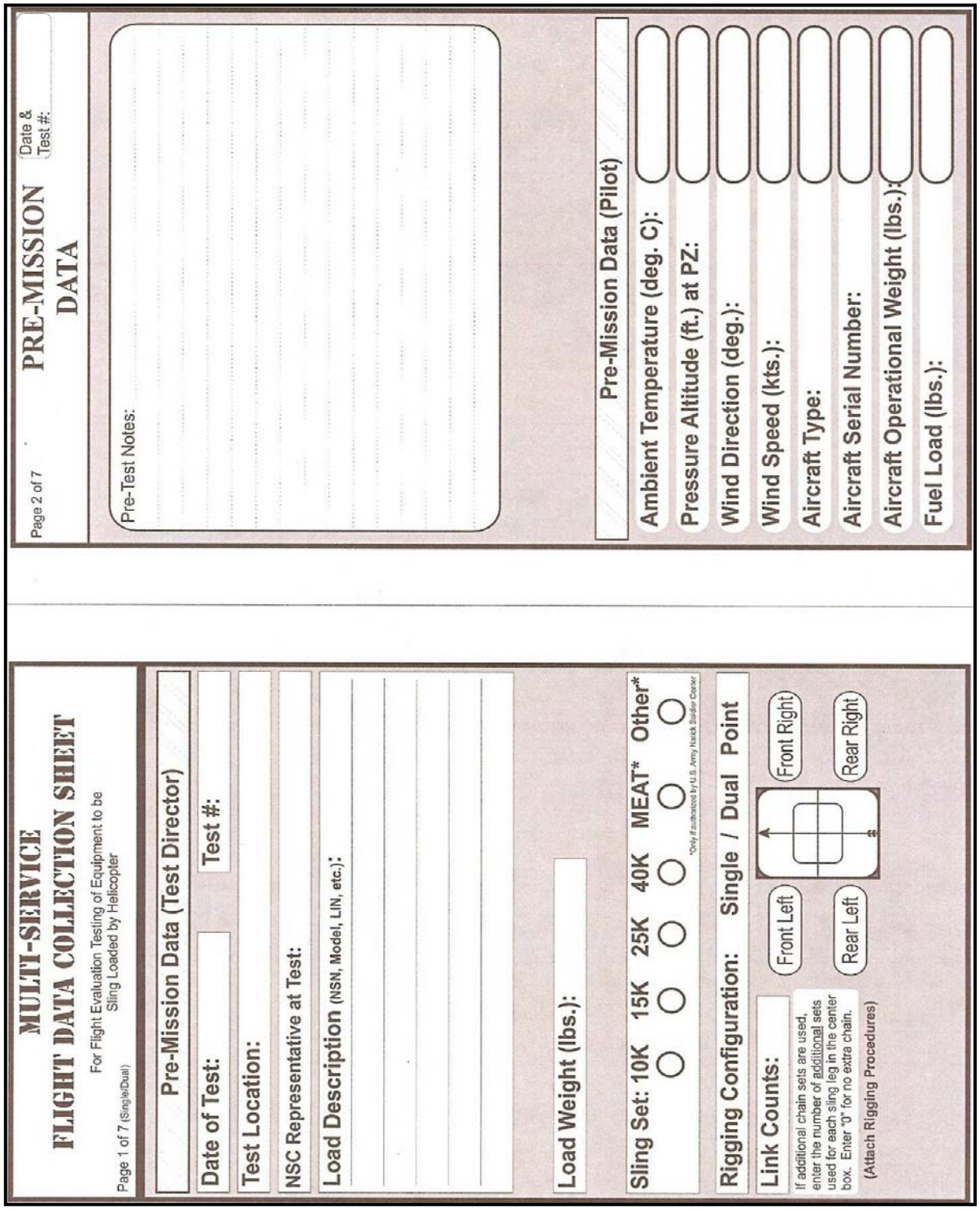


Figure E-1. MSFDCS and rating criteria.

APPENDIX E. EXTERNAL AIR TRANSPORTABILITY MULTI-SERVICE FLIGHT DATA COLLECTION SHEET (MSFDCS) AND RATING CRITERIA.

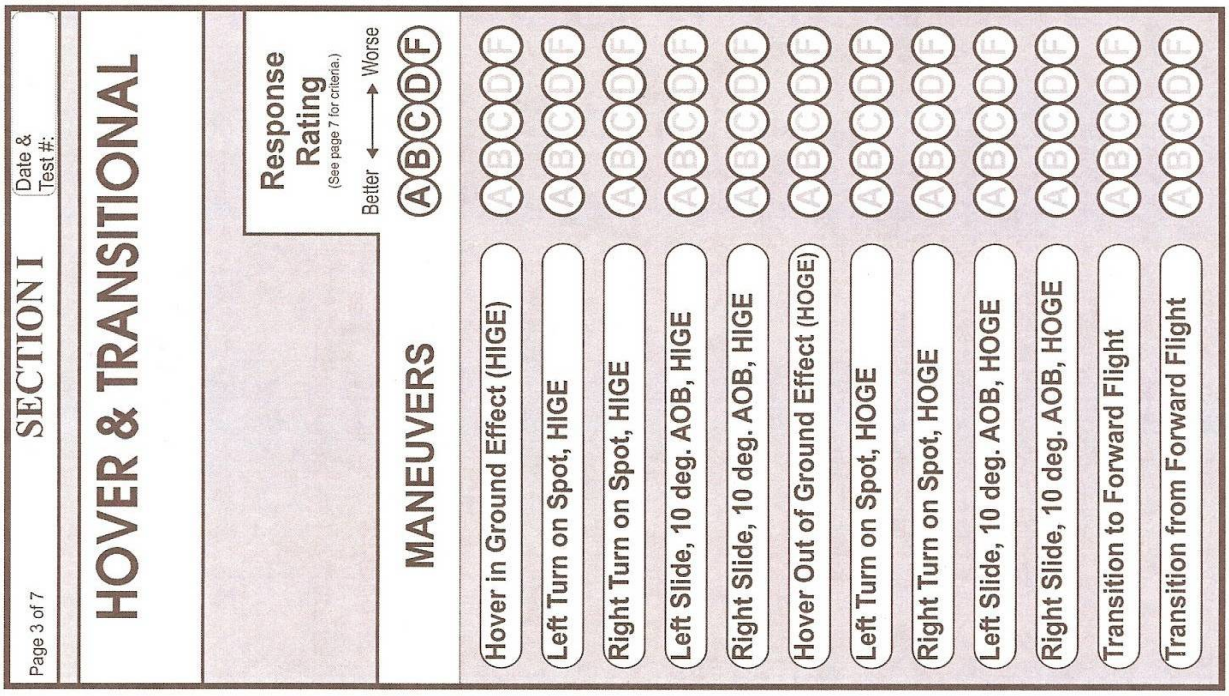
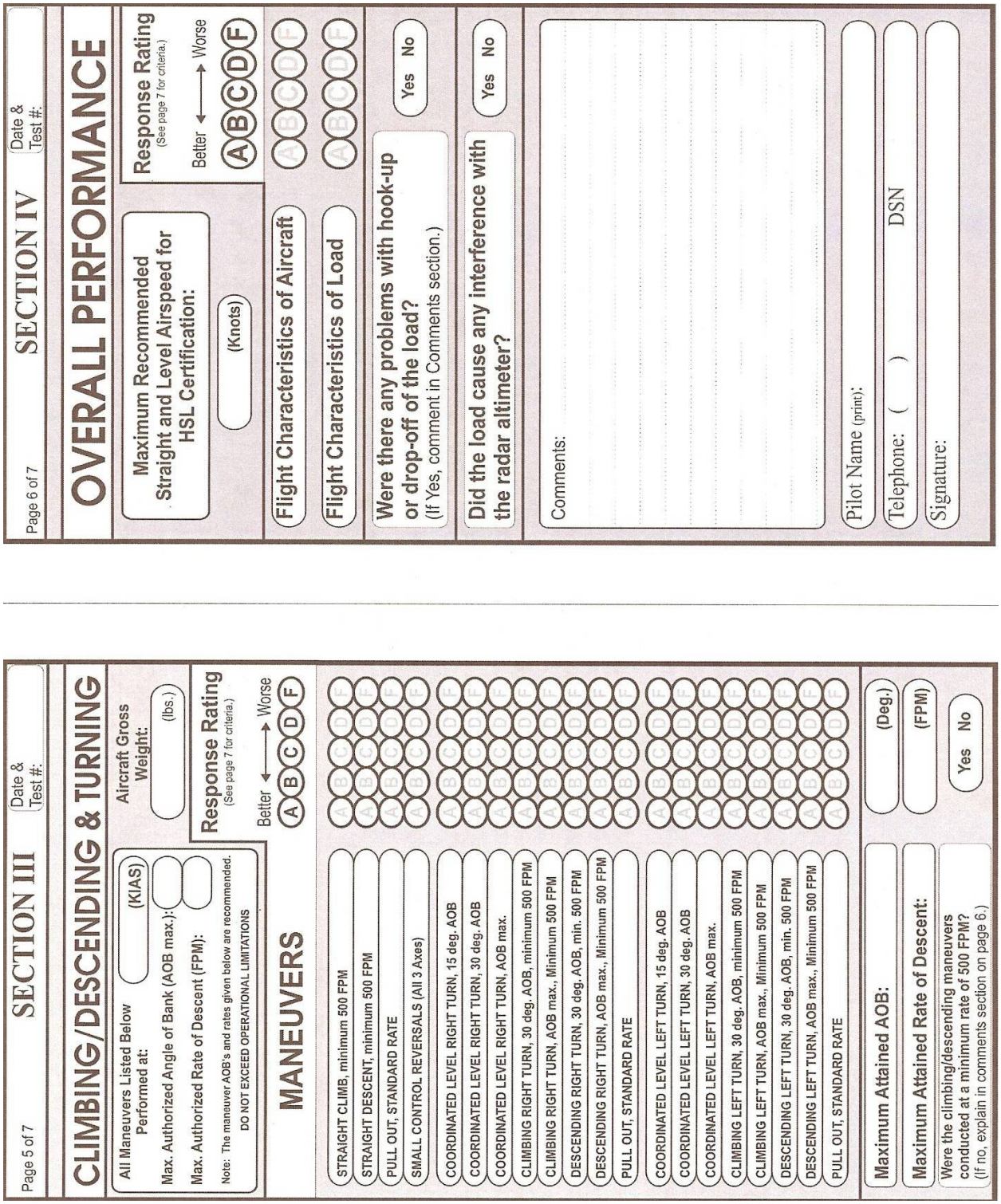


Figure E-1. MSFDCS and rating criteria (cont'd).

APPENDIX E. EXTERNAL AIR TRANSPORTABILITY MULTI-SERVICE FLIGHT DATA COLLECTION SHEET (MSFDCS) AND RATING CRITERIA.



Page 5 of 7 SECTION III Date & Test #:

CLIMBING/DESCENDING & TURNING

All Maneuvers Listed Below Performed at: (KIAS)
Max. Authorized Angle of Bank (AOB max.):
Max. Authorized Rate of Descent (FPM):
Note: The maneuver AOB's and rates given below are recommended. DO NOT EXCEED OPERATIONAL LIMITATIONS

Aircraft Gross Weight: (lbs.)

Response Rating (See page 7 for criteria.)
Better ← → Worse
A B C D F

MANEUVERS	Response Rating
STRAIGHT CLIMB, minimum 500 FPM	A B C D F
STRAIGHT DESCENT, minimum 500 FPM	A B C D F
PULL OUT, STANDARD RATE	A B C D F
SMALL CONTROL REVERSALS (All 3 Axes)	A B C D F
COORDINATED LEVEL RIGHT TURN, 15 deg. AOB	A B C D F
COORDINATED LEVEL RIGHT TURN, 30 deg. AOB	A B C D F
COORDINATED LEVEL RIGHT TURN, AOB max.	A B C D F
CLIMBING RIGHT TURN, 30 deg. AOB, minimum 500 FPM	A B C D F
CLIMBING RIGHT TURN, AOB max., Minimum 500 FPM	A B C D F
DESCENDING RIGHT TURN, 30 deg. AOB, min. 500 FPM	A B C D F
DESCENDING RIGHT TURN, AOB max., Minimum 500 FPM	A B C D F
PULL OUT, STANDARD RATE	A B C D F
COORDINATED LEVEL LEFT TURN, 15 deg. AOB	A B C D F
COORDINATED LEVEL LEFT TURN, 30 deg. AOB	A B C D F
COORDINATED LEVEL LEFT TURN, AOB max.	A B C D F
CLIMBING LEFT TURN, 30 deg. AOB, minimum 500 FPM	A B C D F
CLIMBING LEFT TURN, AOB max., Minimum 500 FPM	A B C D F
DESCENDING LEFT TURN, 30 deg. AOB, min. 500 FPM	A B C D F
DESCENDING LEFT TURN, AOB max., Minimum 500 FPM	A B C D F
PULL OUT, STANDARD RATE	A B C D F

Maximum Attained AOB: (Deg.)

Maximum Attained Rate of Descent: (FPM)

Were the climbing/descending maneuvers conducted at a minimum rate of 500 FPM? (If no, explain in comments section on page 6.) Yes No

Page 6 of 7 SECTION IV Date & Test #:

OVERALL PERFORMANCE

Maximum Recommended Straight and Level Airspeed for HSL Certification: (Knots)

Response Rating (See page 7 for criteria.)
Better ← → Worse
A B C D F

Flight Characteristics of Aircraft A B C D F

Flight Characteristics of Load A B C D F

Were there any problems with hook-up or drop-off of the load? (If Yes, comment in Comments section.) Yes No

Did the load cause any interference with the radar altimeter? Yes No

Comments:

Pilot Name (print):

Telephone: ( ) DSN

Signature:

Figure E-1. MSFDCS and rating criteria (cont'd).

APPENDIX E. EXTERNAL AIR TRANSPORTABILITY MULTI-SERVICE FLIGHT DATA COLLECTION SHEET (MSFDCS) AND RATING CRITERIA.

Page 7 of 7

RATING CRITERIA FOR AIRCRAFT FLIGHT CHARACTERISTICS WITH EXTERNAL LOADS

A. Excellent handling qualities. Effects of the load upon the aircraft performance are negligible at the prescribed airspeed.

B. Good handling qualities. Effects of the load on the aircraft performance are noticeable, but require little or no effort from the pilot to maintain control of the aircraft at the prescribed airspeed.

C. Fair handling qualities. Effects of the load on the aircraft performance are moderate, but readily controllable. The pilot should exercise moderate caution and pay close attention to the effects of the load on the aircraft in order to maintain control of the aircraft at the prescribed airspeed.

D. Poor handling qualities. Effects of the load on the aircraft performance are significant and require constant attention from the pilot to control the aircraft. Caution must be maintained at all times in order to control the aircraft at the prescribed airspeed.

F. Unacceptable handling qualities. Flight under these conditions is dangerous and requires constant attention from the pilot to avoid loss of control of the aircraft. Aircraft is constantly unstable. Flight at this or higher air speed is not recommended.

RATING CRITERIA FOR EXTERNAL LOAD STABILITY CHARACTERISTICS DURING FLIGHT

A. Excellent Load Stability: Load maintains directional stability throughout maneuvers. Minimal load oscillation and/or minimal load rotation or weathervaning. Requires minimal concentration by the flight crew.

B. Good Load Stability: Load maintains directional stability for most maneuvers. Only moderate load oscillation and/or moderate load rotation or weathervaning occurs. Requires minimal concentration by the flight crew.

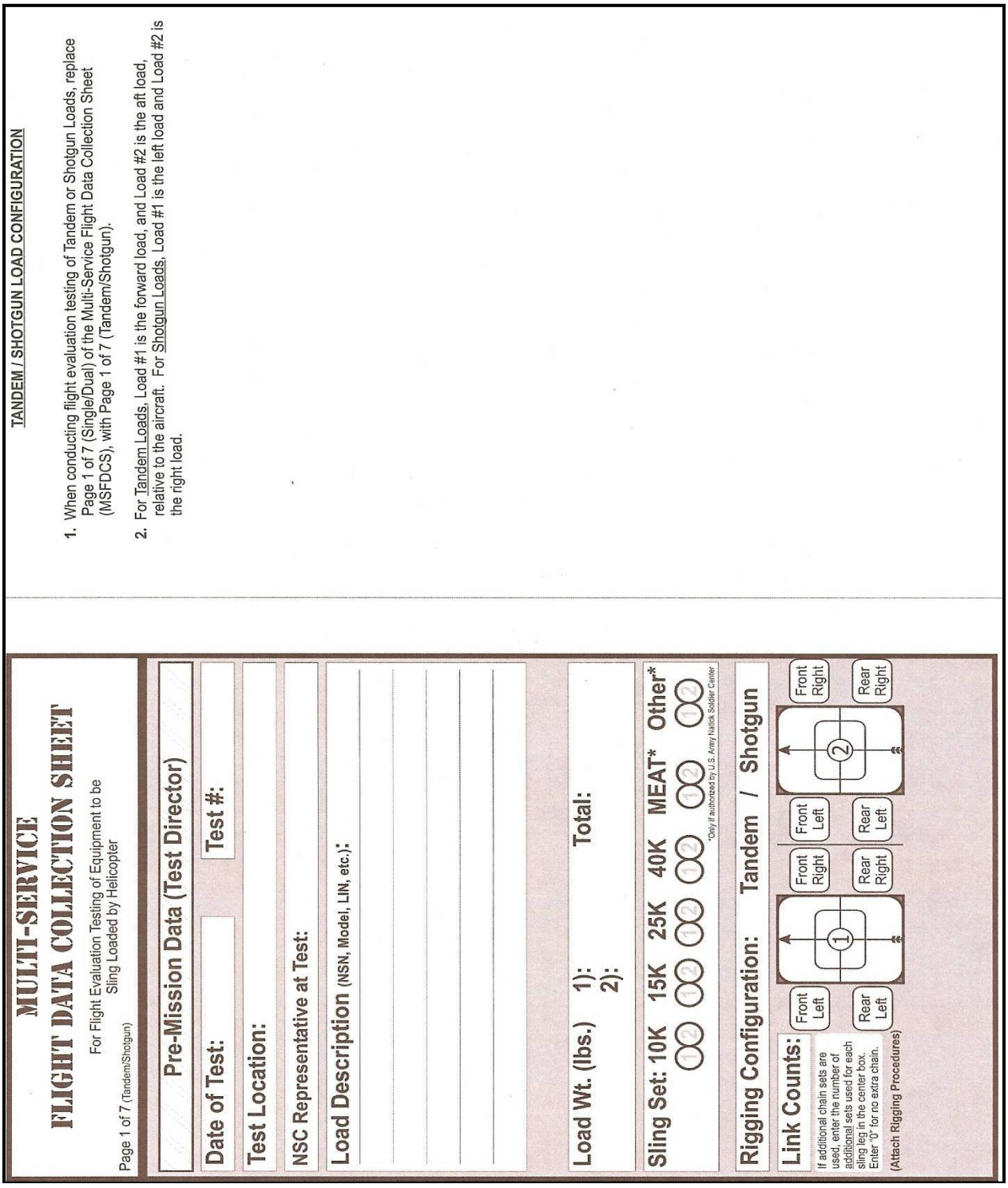
C. Fair Load Stability: Load may oscillate, rotate and/or weathervane during most maneuvers. Directional orientation is not stable throughout maneuvers. However the load remains stable in its rotational state, the rotation does not continue to wind up the sling legs, and the load does not pose a threat to the aircraft.

D. Poor Load Stability: Load oscillates, rotates, or weathervanes during all maneuvers. Directional instability may become severe and require immediate action by the flight crew to prevent damage to the load and/or aircraft, or danger to personnel.

F. Unacceptable Load Stability: Load is uncontrollable for most or all of the maneuvers. Directional instability is unpredictable and dangerous. Transport of the load at the prescribed airspeed is not recommended.

Figure E-1. MSFDCS and rating criteria (cont'd).

APPENDIX E. EXTERNAL AIR TRANSPORTABILITY MULTI-SERVICE FLIGHT DATA COLLECTION SHEET (MSFDCS) AND RATING CRITERIA.



MULTI-SERVICE
FLIGHT DATA COLLECTION SHEET

For Flight Evaluation Testing of Equipment to be Sling Loaded by Helicopter

Page 1 of 7 (Tandem/Shotgun)

Pre-Mission Data (Test Director)

Date of Test: **Test #:**

Test Location:

NSC Representative at Test:

Load Description (NSN, Model, LIN, etc.):

Load Wt. (lbs.) 1): 2): **Total:**

Sling Set: 10K 15K 25K 40K MEAT* Other*

*Only if authorized by U.S. Army Natick Soldier Center

Rigging Configuration: Tandem / Shotgun

Link Counts:

If additional chain sets are used, enter the number of additional sets used for each sling leg in the center box. Enter "0" for no extra chain.

(Attach Rigging Procedures)

Front Left | Front Right | Front Left | Front Right

1 | 2

Rear Left | Rear Right | Rear Left | Rear Right

TANDEM / SHOTGUN LOAD CONFIGURATION

1. When conducting flight evaluation testing of Tandem or Shotgun Loads, replace Page 1 of 7 (Single/Dual) of the Multi-Service Flight Data Collection Sheet (MSFDCS), with Page 1 of 7 (Tandem/Shotgun).
2. For Tandem Loads, Load #1 is the forward load, and Load #2 is the aft load, relative to the aircraft. For Shotgun Loads, Load #1 is the left load and Load #2 is the right load.

Figure E-1. MSFDCS and rating criteria (cont'd).

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APPENDIX F. ACRONYMS.

AAR	Association of American Railroads
ACC	Air Combat Command
ACL	allowable cabin load
AFB	Air Force Base
AFSOC	Air Force Special Operations Command
AGL	above ground level
AMC	Air Mobility Command
AMCP	Air Mobility Command publication
ANSI	American National Standards Institute
AR	Army Regulation
ASC	Aeronautical Systems Center
ASFS	Army Standard Family of Shelters
ASTM	American Society of Testing and Materials
ATTLA	Air Force Air Transportability Test Loading Activity
BII	basic issue items
C	Celsius
CFR	Code of Federal Regulations
CLA	Cargo Loading Adaptability
cm	centimeter
CRAF	Civil Reserve Air Fleet
DOD	Department of Defense
DODI	Department of Defense Instruction
DOT	Department of Transportation
DTS	Defense Transportation System
EAT	external air transport
F	Fahrenheit
ft	feet
ft/sec	feet per second
FM	Field Manual
FMVSS	Federal Motor Vehicle Safety Standard
FR	France
GAWR	gross axle weight rating
GCWR	gross combination weight rating
GE	Germany
GSW	gross shipping weight
GVWR	gross vehicle weight rating
GWR	gross weight rating

APPENDIX F. ACRONYMS.

HSL	helicopter sling load
IAT	internal air transport
in.	inch
ISO	International Organization for Standardization
ITOP	International Test Operations Procedure
JAI	Joint Aircraft Inspection
kg	kilogram
km/hr	kilometers per hour
kN	kilonewton
kPa	kilopascal
LAPE	Low Altitude Parachute Extraction
LASH	Lighter Aboard Ship
lb	pound
lbf	pounds force
LOLO	lift on/lift off
LOTS	Logistics-Over-the-Shore
LVAD	Low Velocity Air Drop
m	meter
m/sec	meters per second
MCM	Mine Counter Measure
MHE	material handling equipment
MIL-HDBK	Military Handbook
MIL-STD	Military Standard
mph	miles per hour
MSFDCS	Multi-Service Flight Data Collection Sheet
NATO	North Atlantic Treaty Organization
NATOPS	Naval Air Training and Operating Procedures Standardization
NAVAIR	Naval Air Systems Command
NHTSA	National Highway Traffic Safety Administration
NSRDEC	Natick Soldier Research, Development and Engineering Center
OVE	On-Vehicle Equipment
psi	pounds per square inch
psig	pounds per square inch gauge
PTP	Proposed Test Plan

APPENDIX F. ACRONYMS.

RORO	roll on/roll off
SAIT	Simulated Airdrop Impact Test
SDDCTEA	Military Surface Deployment and Distribution Command Transportation Engineering Agency
SEABEE	Sea Barge
SOP	Standing Operating Procedure
STRACNET	Strategic Rail Corridor Network
TEA	Transportation Engineering Agency
TM	Technical Manual
TOP	Test Operations Procedure
TSARC	Test Schedule and Review Committee
UK	United Kingdom of Great Britain and Northern Ireland
US	United States
USAF	US Air Force
USMC	US Marine Corps
USN	US Navy
V/STOL	Vertical/Short Take-Off and Landing

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APPENDIX H. APPROVAL AUTHORITY.

CSTE-TM 25 April 2013

MEMORANDUM FOR

Commanders, All Test Centers
Technical Directors, All Test Centers
Directors, US Army Evaluation Center
US Army Operational Test Command

SUBJECT: Test Operations Procedure (TOP) 01-2-500A Transportability, Approved for Publication

1. TOP 01-2-500A Transportability, has been reviewed by the US Army Test and Evaluation Command (ATEC) Test Centers, the US Army Operational Test Command, and the US Army Evaluation Center. All comments received during the formal coordination period have been adjudicated by the preparing agency. The scope of the document is as follows:

This TOP provides guidance for preparing test plans and conducting test programs to evaluate the transportability characteristics of military equipment whether towed, self-propelled, or moved by carrier over highway, off-road terrain, railway, waterway, or by air.

2. This document is approved for publication and has been posted to the Reference Library of the ATEC Vision Digital Library System (VDLS). The VDLS website can be accessed at https://vdls.atc.army.mil/.

3. Comments, suggestions, or questions on this document should be addressed to US Army Test and Evaluation Command (CSTE-TM), 2202 Aberdeen Boulevard-Third Floor, Aberdeen Proving Ground, MD 21005-5001; or e-mailed to usarmy.apg.atec.mbx.atec-standards@mail.mil.

FONTAINE.RAYMOND.G.1228612770

MICHAEL J. ZWIEBEL
Director, Test Management Directorate (G9)

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Forward comments, recommended changes, or any pertinent data which may be of use in improving this publication to the following address: Range Infrastructure Division (CSTE-TM), US Army Test and Evaluation Command, 2202 Aberdeen Boulevard, Aberdeen Proving Ground, MD 21005-5001. Technical information may be obtained from the preparing activity: Support Equipment Division (TEDT-AT-WFE), US Army Aberdeen Test Center, 400 Colleran Road, Aberdeen Proving Ground, MD 21005-5059. Additional copies can be requested through the following website: http://itops.dtc.army.mil/RequestForDocuments.aspx, or through the Defense Technical Information Center, 8725 John J. Kingman Rd., STE 0944, Fort Belvoir, VA 22060-6218. This document is identified by the accession number (AD No.) printed on the first page.