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13. ABSTRACT

Describes a method for evaluation of general materiel capability to withstand airdrop operations. Provides procedures for test preparation, initial inspection, operational performance, rigging, loading, simulated airdrop impact, airdrop, post impact evaluation, safety, and human factors test. Not applicable to toxic or hazardous items.

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U. S. ARMY TEST AND EVALUATION COMMAND
COMMON ENGINEERING TEST PROCEDURE

AIRDROP CAPABILITY OF MATERIEL (GENERAL)

1. OBJECTIVE

The objective of this Materiel Test Procedure is to describe the engineering procedures required to determine the ability of materiel to withstand the restraint, extraction, retardation, and ground impact forces developed in airdrop operations.

2. BACKGROUND

Airdrop of materiel provides a rapid and efficient method of supplying tactical forces with the weapons, ammunition, vehicles, fuel, food, shelter and other items required to support operational missions. This capability is particularly important today because of the emphasis on mobility of military forces and the need for quick response by deployment (and resupply) of personnel and materiel anywhere on earth.

Airdrops are made by small Army aircraft or helicopters for close-in support missions. For large scale operation and global support missions, the greater capacity USAF military transport aircraft (C-130, C-141, and C-5) are used. Airdrops are usually conducted at 1100 to 2500 feet, but can be made at higher or lower altitudes if required. Tests have been conducted at minimum deployment altitudes, and also Low Altitude Parachute Extraction System (LAPES), where the load is extracted at extremely low levels (8-20 feet) and free falls to the ground.

Heavy cargo loads are safely extracted from aircraft using a system of extraction parachutes and control devices (activation control lines and pyrotechnique timing units) to snatch and extract the load from the aircraft. Utilizing single or clustered parachutes and energy-dissipating materiel to absorb ground impact forces, the load is delivered to the ground with a high probability that the load will not be operationally impaired. Lighter loads are dropped manually from the aircraft employing a single parachute and platform (or energy-dissipating materiel) to support the load. In each case, the manner of rigging the load is extremely important to the survival of the load. Upon impact, a cargo parachute release device separates the parachute and load to avoid the possibility of dragging the load along the ground.

This engineering MTP is concerned with testing under controlled conditions, the technical performance and safety characteristics of general Army materiel (except for explosive toxic or other inherently hazardous items) as pertains to material capability of withstanding airdrop operations in accordance with their design requirements as stated in the Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR) or Materiel Need (MN). Materiel within the scope of this MTP includes automotive equipment (and components) weapons, inert ammunition, missile support equipment, electronic equipment, and the various items of Quartermaster materiel (including rations, clothing, etc.).

3. REQUIRED EQUIPMENT

a. Supporting Aircraft and suitable airport facilities
b. Test Item and Maintenance Package
c. Drop Zone and Supporting Equipment
d. Support Vehicles (Emergency and Radio)
e. Load Recovery Vehicles (trucks, lifts, etc.)
f. Meteorological Support
g. Photographic Equipment (still and movie)
h. Cinetheodolites
i. Communications (Aircraft-to-Ground and Ground-to-Ground)
j. Telemetry Package and Supporting Ground Station
k. Airdrop Components (decelerators, platforms, extraction and restraint systems)

4. REFERENCES

A. Army Regulation 70-10, Research and Development; Test and Evaluation During Development and Acquisition of Materiel.
B. Army Regulation 70-38, Research and Development; Research Development, Test and Evaluation of Materiel for Extreme Climatic Conditions.
C. Army Regulation 70-39, Research and Development; Criteria for Air Transport and Airdrop of Materiel.
D. TECOM Regulation 70-23, Equipment Performance Report.
E. TECOM Regulation 385-6, Verification of Safety of Materiel During Testing.
F. AMC Regulation 385-12, Verification of Safety of Materiel from Development Through Testing, Production and Supply to Disposition.
G. Army Materiel Command Pamphlet 706-130, Engineering Design Handbook; Design for Air Transport and Airdrop of Materiel.
H. MIL-STD-669B, Loading Environment and Related Requirements for Platform Rigged Airdrop Materiel.
I. MIL-STD-814B, Requirements for Tiedown, Suspension and Extraction Provisions on Military Materiel for Airdrop.
J. MIL-STD-8591D, Airborne Stores and Associated Suspension Equipment; General Design Criteria For.
K. MIL-H-9884, Honeycomb Material, Cushioning, Paper.
L. Technical Manual 10-500 Series, Airdrop of Supplies and Equipment.
M. U. S. Air Force T.O. 1C-130A-9, Technical Manual, Loading Instructions.
N. Test Item, Safety Statement and Technical Manuals.
O. MTP 6-2-502, Human Factors Engineering.
P. MTP 7-2-100, Tiedown Cargo Aircraft.
Q. MTP 7-2-506, Airdrop Systems Safety.
R. MTP 7-2-510, Airdrop System Components.

5. SCOPE

5.1 SUMMARY

5.1.1 Preparation for Test

This section describes the preparation of facilities, rigging of the load, coordination of participating test activities and requirements for safety verification. It also outlines the requirement for personnel assignment, training, briefing of test and flight personnel, and the preparation of data recording instrumentation.

5.1.2 Test Conduct

The subtests are designed to determine the ability of materiel to withstand the forces imposed during airdrop operations. The materiels should be designed in accordance with applicable MIL-STD's such as MIL-STD 669-B and MIL-STD 814-B to withstand airdrop forces, assuming that the proper energy dissipating honeycomb configuration has been computed, the center of gravity of load/platform is accurate, the rigging including selection of parachutes is correct, and the environmental conditions are not excessive. The materiels which are tested should be operationally usable and reliable after impact in accordance with their performance criteria. The operational subtests below should verify that this is so, and quantify, where possible, the operability and durability of the materiel under test so that design improvements may be incorporated on future generations of these materiels. Those subtests which cross the interface between engineering and service tests, e.g., Human Factors Engineering and Safety, should be performed in conjunction with operational subtests, and to the extent feasible during the engineering testing. This data should be sent to the service test activity for use in planning their tests.

a. Pretest Inspection - The objective of this subtest is to verify that the materiel to be airdropped is in good physical condition, noting any damage or hazardous conditions which should be considered in the evaluation of the operational data.

b. Operational Test - The objective of this subtest is to verify that the materiel (and components) are operating properly prior to the airdrop test.

c. Rigging and Loading - The objective of this subtest is to ensure that the load is properly rigged and loaded in the aircraft.

d. Simulated Airdrop Impact Test - The objective of this subtest is to determine if the materiel can withstand an impact force equal to that expected in the airdrop. Proper rigging and placement of energy dissipating honeycomb are also verified during this subtest.

e. Airdrop - The objective of this subtest is to actually airdrop the materiel under field conditions and monitor its response to the physical forces involved, using telemetry, cinetheodolites, and cameras.

f. Post-Impact Evaluation - The objective of this subtest is to determine if the materiel was damaged or operationally degraded by the airdrop.

g. Safety - The objective of this subtest is to determine if the materiel is safe for airdrop operations, by monitoring the above subtests and noting any hazards to personnel, equipments, or the aircraft.

h. Human Factors Engineering - The objective of this subtest is to determine if there are any apparent Human Factors problems, by monitoring the above subtests and noting any difficulties during operation, handling, and maintenance of the test materiel.

5.1.3 Test Data

This section details the data to be collected. It includes two basic sets of data; physical, operation and test configuration data; and airdrop force data from the extraction, deceleration and impact phases of the test.

5.1.4 Data Reduction and Presentation

This section provides guidelines for analyzing and evaluating the reduced data from the subtests. The materiel performance evaluation is based on a qualitative assessment of the ability of the test materiel to withstand the airdrop forces.

5.2 LIMITATIONS

This MTP is limited to the testing of general materiels, excluding toxic or hazardous items.

Test procedures for determining the airdrop capability of explosive materiel are presented in MTP 4-2-509.

6. PROCEDURES

The procedures described herein need not be accomplished in the sequence they appear, but can be arranged to maximize the availability of test personnel, facilities, and when feasible, combined with other test procedures related to airdrop operations. Refer to MTP 7-2-100, 7-2-506, and 7-2-510 for possibility of integrating test procedures.

TECOM policy states that test areas with high risk of failure will be tested first.

6.1 PREPARATION FOR TEST

6.1.1 Planning the Operations

a. Review the QMR, SDP, or MN and determine what tests are required and what data must be taken to evaluate the ability of the test materiel to withstand airdrop operations.

b. Determine aircraft and U. S. Air Force support required; coordinate with all activities involved to ensure that support is available and that test schedules are acceptable.

c. Coordinate with Safety Officer in preparation for safety phase of Test Plan.

d. Review all prior engineering data, especially that data concerned with reliability, dependability, and environmental characteristics. Ensure that the test materiel can withstand airdrop environmental conditions, e.g., temperature, altitude, shock, and vibration.

6.1.2 Preparation of Checklists

a. Prepare specialized checklists to record information on areas of safety, human factors, and individual subtests which provide those questions that are critical to the evaluation of the test item. See Appendix A for a sample of a checklist.

b. Prepare comment sheets to accompany the checklists. These sheets could be used to enumerate the yes/no answers on the checklist.

6.1.3 Coordination of Test Personnel

a. Brief all test personnel on the basic test plan and specific objectives of each subtest. Explain what data is to be acquired and what test conditions must exist to ensure that data will be in usable form.

b. Instruct all test personnel on their specific responsibilities during pre-airdrop, airdrop, and post-airdrop test operations.

c. Explain the sequence of test procedures, relating what data is to be taken (checklists, telemetry, cinetheodolite, photography, etc.) and how the data is to be marked for proper identification.

6.1.4 Selection of Airdrop System Components

Determine the airdrop components required for the airdrop operations. Appendix B provides general information on airdrop components and illustrates how these components are selected, based on their performance characteristics. Additional information is available from references B, C, D, H, I, J, K, L, M, and N.

It should be noted that Army Regulation 70-39 states that materiel developed for airdrop must be designed to meet the requirements imposed by the characteristics and capabilities of the airdrop systems with which they will be used. (Air Force cargo aircraft, Army aircraft and helicopters). It is therefore conceivable that the test materiel(s) may be subjected to airdrops from several different types of aircraft. The selection of airdrop components will then be a matter of selecting those components required for each type of airdrop to which the materiel will be subjected.

6.1.5 Briefing of Flight Operations Personnel

a. Brief the pilot, co-pilot, cargo-master, and other flight personnel on the objective of the mission, the proposed flight plan, and sequence of drops.

b. Instruct the pilot to provide a time-countdown when approaching the Drop Zone, 3 minutes out, and 10 seconds from start of drop.

c. Brief the pilot on local terrain condition, alternate landing fields, etc., if he is unfamiliar with the airdrop area. If possible, have a senior member of the test team accompany the pilot on the flight and act as an advisor.

6.1.6 Prepare Airdrop Facilities and Drop Zone

a. Ensure that the telemetry receivers, cinetheodolites, cameras, etc., are checked, calibrated and ready to support the airdrop mission. This is usually done in accordance with manufacturer's operating instructions or Standing Operating Procedures (SOP) developed by the test activity.

b. Ensure that the Drop Zone has been established and recovery emergency crews are ready to support the airdrop. Utilize existing SOP's or the guidelines described in Appendix C to establish the Drop Zone.

6.1.7 Meteorological Recordings

a. Ensure the required meteorological instrumentation is available to record local weather conditions around the area of the Drop Zone.

b. Ensure the availability of hand-held anemometer for use at the Drop Zone to measure wind speed and direction.

6.1.8 Safety and Emergency Provisions

a. Secure the area around the Drop Zone, barricading access roads and placing "Restricted Area" signs at prominent locations as a warning to military and civilian personnel.

b. Patrol the Drop Zone to ensure the area is clear of personnel.

c. Strategically locate vehicles and helicopters to respond to any emergency. Ensure that each crew is aware of their duties in case of an emergency.

d. Review the test item safety statement and identify all possible hazards to personnel and the aircraft.

e. Prepare adequate safety precautions in accordance with the general safety evaluation methods described in MTP 7-2-506. Also, refer to the common safety MTP that relates to the materiel under test, e.g., automotive, electronic, missile, weapons or general equipments.

6.1.9 Select Rigging and Instrumentation

a. Review the rigging requirements provided in the training package and prepare the load for the Simulated Airdrop Impact Test. The rigging will be adjusted as a result of the simulated airdrop to provide optimum support to the load.

b. Review the rigging requirements provided in the training package and prepare for the actual airdrop. This will include the extraction chute, recovery parachute, static lines, release device, etc.

c. Determine what instrumentation (accelerometers, strain gages, telemetry) is required for the simulated and actual airdrop tests.

d. Conduct preliminary checks to ensure that all rigging equipments and instrumentation components are functioning satisfactorily and are safe to handle.

6.2 TEST CONDUCT

During the following subtests the materiel under test should be subjected to those conditions and forces normally associated with airdrop operations. It is important that these conditions and forces be accurately identified so in case of materiel damage (or operational degradation) the cause of damage can be determined. The analyst can then evaluate what design improvements are required in the materiel to make it suitable for airdrop operations.

6.2.1 Pretest Inspection

a. Examine the materiel for completeness and freedom from shipping damage. Photograph any damaged areas. Submit an Equipment Performance Report (EPR) for each noted shortage or discrepancy in accordance with applicable procedures of TECOM Regulation 70-23. This will include a detail technical inspection.

b. Record all nameplate identifying data.

c. Examine all manuals and drawings for adequacy.

6.2.2 Operational Test

Prior to either the simulated or actual airdrop test the materiel should be operationally tested to ensure it is functioning properly. These tests should be repeated again after the airdrop in exactly the same manner as before to determine if the airdrop had produced any degradation in operation or performance of the test materiel. Since this MTP deals with a variety of materiels, i.e., automotive, weapons, inert ammunition, missile support equipment, and quartermaster material, the operational tests will vary in type and extent of testing required. Specific test methods and procedures should be obtained from applicable manufacturers or technical operating manuals. Some general guidelines for operational testing are presented in Appendix D.

a. Adjust and operate all equipments in accordance with appropriate manufacturers or technical manuals.

b. Determine and note any deficiencies in operation.

c. Perform any adjustments or repairs required to bring the equipment within the normal operational conditions.

d. For non-operational items such as rations, select a small sample and use in accordance with normal procedures to ensure there is nothing unusual about the items to be airdropped.

6.2.3 Rigging and Loading

The test materiel should be rigged in accordance with developer furnished draft procedures. All work should be done by a qualified rigger under the supervision of the airdrop/project officer.

a. Rig the load either for a Simulated Airdrop Impact Test or actual Airdrop depending upon which test is to be conducted.

If a simulated impact test is conducted, ensure that there is sufficient energy-dissipating materiel under the load to prevent damage during the initial drops (when the optimum placement of the honeycomb is being determined). Refer to Appendix B for calculation of honeycomb.

b. Verify that there are sufficient tiedown points provided on the test materiel and these tiedown points meet the strength requirements contained in the QMR (or MIL-STD).

c. Inspect the rigged load just prior to transporting it to the test area. Photograph the load from several angles to best illustrate the final configuration.

d. Transport the rigged load to the control drop area (for simulated test) or the aircraft. Photograph the methods used in loading, unloading, and transfer to the aircraft. Note any unusual events that should be considered in the analysis, e.g., shock, vibration, unusual environmental conditions.

e. Attach the load to the crane (for simulated test) or place in the aircraft.

f. Inspect and photograph the load, rigging and tiedown.

g. Identify any safety hazards noted in handling, transport, and emplacement of the load.

6.2.4 Simulated Airdrop Impact Test

This subtest is usually conducted prior to an actual airdrop to ensure that the test materiel can withstand the impact forces. It is an inexpensive way of verifying that the test materiel will probably withstand airdrop forces and is used extensively for those test materiels which have no prior airdrop history. This subtest will be conducted at a Static Airdrop Test Facility as described in Appendix E.

a. Calculate the required drop height. (See Appendix E.) The initial drop height should provide a vertical velocity less than the design velocity requirements, e.g., if the design velocity is 28.5 fps, the initial drop may be made at 19 fps.

b. Attach appropriate sensors (accelerometers) to the load to record the impact forces. They should be placed at strategic points around the load.

c. Attach strain gage patches to the harness straps to sense strain levels at major supporting points.

d. Connect the sensors to the telemetry transmitter package mounted on the load. Signals may be hard wired to the telemetry receiving/recording station or transmitted (radiated) in the normal manner between the load and telemetry station.

e. Make several calibration transmissions to ensure transmitting equipment is functional and to calibrate receiving station recording equipments.

f. Load and check the movie and still cameras. Place movie cameras (high speed cameras) at strategic locations to photograph the drop.

g. Attach the rigged load to the release device and cable of the crane. Ensure that all safety precautions are in effect and personnel are clear of the drop area. Lift the load to the effective drop height (distance from bottom of platform to ground).

h. Photograph the load and configuration from several angles.

i. Synchronize the events of the drop by providing a count-down to the telemetry station, photographers, and test crew. Use range time to correlate the data.

j. Upon signal from the project officer, start recorders, activate the release device, and monitor drop until the load impacts and comes to rest on the reinforced concrete pad.

k. Photograph the load after impact and note any obvious damage to the load or rigging.

l. Determine if rigging and honeycomb should be rearranged to better support the load.

m. Adjust rigging and honeycomb if required. Calculate the effective drop height to provide a vertical velocity equal to the design velocity. Repeat the above test at the new drop height.

n. Conduct a Post Impact Evaluation (on-site and off-site) as described in paragraph 6.2.6 and note any damage or operational difficulties as a result of the Simulated Airdrop Impact Test.

6.2.5 Airdrop

The airdrop should be conducted under controlled conditions relative to those to which the materiel will be subjected in a field operation. It is assumed that the rigging method is correct. All of the forces imposed by extraction, retardation, and impact will be closely monitored by telemetry and photographs. The responses of the load will be recorded by cinetheodolite instrumentation and drop zone cameras.

a. Recheck the rigging prior to tie-down of the load.

b. Install the telemetry transmitter package and connect all sensors. Connect batteries and run a calibration check to ensure proper operation. Disconnect power until the load is to be dropped.

c. Check all communications (ground, air, and voice recording of pilot and airdrop crew). A check list may be used to ensure that all equipments have been checked and are operating correctly.

d. Make final ground preparations at the Drop Zone including:

1) Marking and targeting the area where drop is to be made.
2) Ready smoke grenades. Suitable containers (trash barrels) may be used to concentrate and billow the smoke.
3) Placement of emergency and recovery vehicles.
4) Emplacement and check of ground cameras.

See Drop Zone Illustration in Appendix E.

e. In the aircraft, tie down the loads and photograph this configuration. (Refer to U. S. Air Force T.O. 1C-130A-9, Technical Manual, Loading Instructions.)

f. Check the cameras in the aircraft and ready them to photograph the extraction phase of the airdrop.

g. Check and make ready the telemetry station, cinetheodolites and movie cameras (35 mm cameras).

h. If a chase plane is used, prepare the cameras and check the communications with ground control and the cargo aircraft.

i. The safety officer should check all safety provisions prior to the takeoff of the cargo aircraft.

j. Advise all test personnel of the number of drops to be made and how the aircraft will make its approach.

k. Measure the velocity and wind direction at the Drop Zone and advise if conditions are suitable for the airdrop.

Airdrop with the current systems is usually restricted to wind speeds below 15 knots. Other factors must also be considered, e.g., wind gusting and vertical air drafts. (See Appendix B - Standard Airdrop System Limitations.)

l. With all stations alerted, the aircraft takes off and heads for the Drop Zone. When the aircraft is 10 minutes from the Drop Zone the pilot will alert the flight crew. The crew puts on parachutes and starts to prepare for the drop. The flight crew will maintain positions forward of the load and take all other safety precautions to ensure the safety of crew and aircraft.

The pilot shall alert all stations when the aircraft is 3 minutes from the Drop Zone. He will also state at this time if this is to be a practice run or "wet run", where loads will be dropped. The pilot will usually want to make at least one practice run prior to dropping the loads.

m. When the aircraft is 3 minutes out from the Drop Zone a smoke grenade will be activated to show the pilot the direction of the wind. At this time communication should be verified between all ground and airborne units.

n. During this time the telemetry transmitter packages should be activated and transmit a calibration signal to the ground station.

o. On the approach leg of the flight path the cargo doors will be opened, the cargo readied for drop and the pilot starts a countdown 10 seconds from release of cargo (pushed out or extracted).

All stations (cinetheodolites, cameras, telemetry, chase plane cameras) start recording events from start of 10 second count. The cameras inside the aircraft should be running at this time.

p. Release and drop the load(s) over the Drop Zone as close to the target as possible. Loads may be dropped individually or in combination, depending on the mission and equipment available.

If the load fails to extract, start emergency procedures described in the Standing Operating Procedures. These procedures require the load to be secured, the line to the extraction chute cut, and the load relocated to its original CG point, and tie-downs connected.

q. At the Drop Zone, note all conditions of the drop and ground impact that would be of value in the analysis of data.

r. At the completion of the drop the flight crew should retrieve the static lines, close the cargo doors, and return to the airfield. The pilot should advise the test crew of any conditions of the airdrop he noted that would be of value in the analysis of data.

6.2.6 Post-Impact Evaluation

The Post-Impact Evaluation should be based on a careful inspection of the test materiel after the airdrop. All component equipments should be operationally tested to indicate their suitability for proceeding to EST (expanded source test). The type of materiel tested will primarily dictate the extent of the inspection and operational testing. Other factors such as the statistical airdrop history of similar materiels should also be considered in this evaluation.

a. Inspect the airdropped materiel for physical damage (on-site). Photograph the impact position of the load and note any obvious damage, including broken rigging, broken pallets, jammed mechanisms, etc.

b. Release the materiel from its rigging and perform a close inspection again noting and photographing any damage.

c. Assemble (if required) and operate the equipments in accordance with applicable field or technical manuals. Attempt to simulate tactical conditions when possible. For example (after driver maintenance check) a vehicle should be combat loaded and run over various terrain for at least 200 miles. During these runs the vehicle should be stopped and started a number of times to simulate tactical operations.

d. Note any operational difficulties but do not repair or adjust any equipments at this time.

e. Select a sample of the airdropped materiels and .ansport to an off-site facility where a detailed inspection can be performed. Do the same for those equipments which failed the on-site operational tests.

f. Disassemble and carefully inspect all component equipments. X-ray may be used where it is impractical to disassemble the test materiel. Note any equipment damage which could seriously affect the operation of the equipment. Particular attention should be given to weapons where the operation of critical parts, such as the loading and extraction mechanism, requires testing in different firing modes and at various firing rates in order to determine any degradation in equipment performance.

6.2.7 Safety

a. Throughout each of the subtest operations (inspection, rigging, loading, tiedown, aircraft, Drop Zone, recovery and operational tests) note any safety hazards, the cause of the hazards, and what steps were taken to alleviate the hazard. Integrate the safety requirements of MTP 7-2-506, Air-Drop Systems Safety, whenever possible to more completely define the safety hazards of airdrop components.

b. Note all deviations from the general precautions specified in AMC Regulation 385-12 and TECOM Regulation 385-6.

6.2.8 Human Factors Engineering

a. Throughout each of the subtest operations observe the test personnel as they perform the assigned tasks. Note any difficulties in handling, operating, or maintaining the test materiel. Determine if any of these difficulties are caused by Human Factors design problems.

b. Note all deviations from the general Human Factors Engineering considerations described in MTP 6-2-502.

This subtest is not intended to be as complete or comprehensive as the Human Factors Engineering Test which will be conducted during Service Testing, but should provide valuable supplementary information to the Service Test evaluation.

6.3 TEST DATA

6.3.1 Preparation for Test

6.3.1.1 Selection of Airdrop System Components

Record the following:

a. Aircraft (internal) components selected
b. Retardation (external) components selected

6.3.1.2 Preparation of Airdrop Facilities and Drop Zone

a. Provide a description of the test facilities, location of telemetry, cinetheodolites, cameras, etc.

b. Describe the Drop Zone, its location, placement of ground cameras, safety provisions, and placement of vehicles.

6.3.1.3 Meteorological Recording

Record the following data just prior to the airdrop:

a. Temperature, dew point, and humidity
b. Wind speed and direction
c. Sky cover, visibility and soil temperature
d. Solar radiation, net radiation, and total radiation
e. Atmospheric pressure, air density and density altitude
f. Wind profile, temperature profile, and ozone

6.3.2 Test Conduct

6.3.2.1 Pretest Inspection

a. Describe the physical condition of the materiel including any defects noted.

b. Annotate any photographs taken with nameplate, date, time, and location information.

c. Describe any deficiencies noted in examination of manuals and drawings.

6.3.2.2 Operational Test

Record the following:

a. Operational tests conducted
b. Deficiencies noted
c. Adjustments made to bring to optimum operational condition
d. Size of sample selected (if appropriate)

6.3.2.3 Preparation of Loads (Rigging and Instruments)

Record the following:

a. Type of rigging used
b. Placement of sensors on load
c. Type of telemetry package used
d. Location of telemetry package

6.3.2.4 Simulated Airdrop Impact Test

a. Describe the Static Drop Test Facility used for the Simulated Impact Test.

b. Record specific trajectory and event data including release altitude, time of release, and angle of impact slope (if not horizontal).

c. Record the physical force data (acceleration, strain, and deceleration) on magnetic tape, for reduction to oscillograph records.

d. Photograph the drop using high speed cameras (16mm, 250 to 8000 FPS), with associated control equipment to assure coverage during the precise interval required by the test project.

e. Annotate the still photographs taken before and after the drop with the drop number and time and date.

6.3.2.5 Airdrop

a. Extraction Phase - Record the physical forces (velocity, acceleration, strain) using on-board cameras and telemetry recorders.

1) Extraction force
2) Fore and aft acceleration of platform
3) Stresses and deflections of platform
4) Forces in parachute and rigging
5) Sequence of times

b. Extraction Phase - Record the attitude and oscillations of the load using cinetheodolite cameras, ground cameras, and chase plane cameras.

c. Recovery Phase (descent) - Record trajectory data using cinetheodolites and cameras.

1) Rotation of load
2) Orientation of platform during descent
3) Equilibrium rate of descent
4) Attitude of platform prior to descent
5) Oscillation prior to impact
6) Horizontal displacement of rigged load

d. Recovery Phase - Record the parachute opening and drag forces using telemetry instrumentation.

e. Impact Phase - Record the physical forces in the load and suspension lines using telemetry instrumentation.

1) Impact accelerations at selected points on load
2) Impact strains at selected points on load
3) Load's force in suspension lines
4) Load's force in lashings during rebound

f. Impact Phase - Photograph ground approach and impact using cameras at several opposing angles.

6.3.2.6 Post-Impact Evaluation

a. Record the extent of any physical damage discovered on-site.

b. Annotate all photographs with test number and time and date.

c. Record the results of operational tests conducted on-site. Record data in the same manner and format that was used in former engineering tests of the item so data may be easily correlated.

d. Describe the results of inspection tests conducted off-site (at special test facilities or laboratories).

e. Record the results of operational tests conducted off-site. Use the same data formats as described in c. above.

6.3.2.7 Safety

Record the following:

a. Deviations from specified safety precautions in AMC and TECOM Regulations or in MTP 7-2-506.

b. Conditions under which hazards were observed.

c. Actions taken to alleviate hazards.

6.3.2.8 Human Factors Engineering

a. Describe any operational problems which were incurred as a result of poor Human Factors Engineering Design, in accordance with the general considerations in MTP 6-2-502.

b. Describe what action was taken to resolve these Human Factors Problems.

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 Data Reduction

a. Inspection and Operational Data - Prepare a summary of those problems noted in the pre- and post-drop inspection and operational data. If a number of problems are noted, a matrix will help graphically display the data.

b. Cinetheodolite Data - Develop the photographic film and prepare it for display on film reader and processor. Process the angular space position data from the cinetheodolite stations (usually 3 stations), and prepare a computer printout. The printout data should contain position data in azimuth and elevation coordinates, time correlated, with vertical and slant velocities computed. The vertical and slant velocities (trajectory) should be corrected by meteorological data.

c. Photographs - Enlarge and annotate those photographs that show important or unexpected events. Test personnel should review these photographs and add any additional information they can from their observations of the airdrop.

d. Written descriptions from test personnel - Organize and format written descriptions of test events for ease of review. Sort all similar data together, and attach to photographic or other data.

6.4.2 Data Presentation

The reduced data should be reviewed and evaluated by a Project Engineer. The techniques used by the Project Engineer may vary somewhat between test activities but the results of the evaluation will indicate if the tested materiel meets the requirements of airdrop systems. The Project Engineer should document the evaluation in a report (or reports) that will verify the materiel design characteristics, and supply needed information to service and environmental test facilities.

6.4.2.1 Airdrop Test Summary Report

This report should contain specific information on:

a. The conditions and events of the airdrop. A typical data sheet for recording this information is shown in Appendix F.

b. The ability of the materiel tested to withstand the physical forces of the airdrop operation. A qualitative assessment should be presented to show whether the materiel tested is well within the design requirements and provides the high reliability and dependability characteristics desired for airdrop, or if the materiel performance is marginal and some design improvements are recommended.

c. Whether the airdrop test conditions described in this report are representative of tactical airdrop operations.

Item c. is most important if the evaluation is to critically establish that the materiel tested is suitable for airdrop operations from various aircraft and helicopters. To ensure this, the materiel should have been subjected to the maximum airspeed, deceleration force, and impact force in accordance with current design values.

6.4.2.2 Safety Report

A Safety Release Recommendation should be submitted in accordance with TECOM Regulation 385-6, based on the data collected during airdrop and operational tests. This report should specify if the TECOM Safety Release, or Interim Safety Release identified all hazards or if additional safety information should be added prior to service testing. Safety hazards should be identified in accordance with the general classifications stated in MTP 7-2-506, e.g., negligible, marginal, critical, or catastrophic.

6.4.2.3 Human Factors Engineering Report

This report should contain specific information on:

a. The Human Factors design features of test materiel, including suitability for handling and moving, operation under field conditions, and ease of maintenance.

b. Any problems noted during airdrop phases, and if there is a need for redesign or modification based on observations of test and flight personnel.

c. The need for special tests during service or environmental testing to resolve any questionable areas.

GLOSSARY OF COMMON AIRDROP TERMS

1. Accelerometer: An instrument for determining the acceleration of the system with which it moves.

2. Airborne Operation: An operation involving the movement by air of combat forces and their logistical support and delivery by airlanding or airdrop into an objective area.

3. Aircraft Loading Table: A data sheet used by the ground force unit commander containing information as to the load that actually goes into each aircraft. It is an annex to the Unit Operation Order.

4. Airdrop: A method of unloading personnel, supplies and equipment from aircraft in flight.

5. Airdrop Types:

   a. Free Drop - is delivery from aircraft in flight certain non-fragile items of supply, without the use of parachutes.

   b. Low Velocity Airdrop - is the delivery from an aircraft in flight of the various items of supply and equipment by the use of cargo parachutes. Such loads are especially prepared for airdrop delivery by either packing the items in air delivery containers or by lashing them to platforms. Cargo parachutes are then attached to the load to retard descent of the load and to ensure minimum landing shock. The nominal terminal velocity is 28.5 feet per second.

   c. High Velocity Airdrop - is delivery of certain items of supply especially rigged with an energy dissipator attached to the underside of the load with a stability device, such as a ringslot parachute attached to the top of the load to maintain it in an upright position. The stabilizing device is designed to minimize oscillation of the load and to create just enough drag to hold the load upright during descent so that it will land on the energy dissipator. Terminal velocity is 70 to 90 feet per second.

   d. Controlled Airdrop Cargo System - is an electronically guided cargo-airdrop system that is composed of a parawing which retards the descent, a control subsystem, a cargo container and a ground based transmitter. Still in the experimental phase, this system offers a new concept in air delivery that can deliver critical materiels and supplies to troops in remote or hostile areas at any time of the day or night under all kinds of terrain conditions.

6. Airdrop Equipment: Special items of equipment, such as parachutes, air delivery containers, platforms, tie-downs, and related items used in air delivery of personnel, supplies and equipment.

7. Airspeed: The speed of an aircraft relative to the air.

   a. Indicated - airspeed recorded on airspeed indicator in aircraft.

   b. True - calibrated airspeed corrected for altitude and temperature deviations from standard.

8. Allowable Cargo Load: The amount of cargo determined by weight, cubic displacement, and distance to be flown, which may be transported by the aircraft.

9. Altitude:

   a. Absolute - altitude above the surface of the earth.

   b. Indicated - altitude recorded on altimeter after the corrected altimeter has been set in the barometric scale.

   c. True - calibrated altitude corrected for density. Also, altitude above sea level.

10. Bulk Loading: Stowage of supplies so as to utilize the entire carrying capacity of a vessel, disregarding segregation of cargoes either by class, service, or commodity.

11. Canopy Filling Time: In cinetheodolite analysis that time interval measured from the instant of full line stretch of the main parachute to the first full opening of the main parachute canopy.

12. Canopy-Parachute: The main supporting surface of a parachute.

13. Cargo Parachute: A parachute used to lower cargo discharged from an aircraft in flight. Classified as light, medium, heavy and auxiliary.

14. Cargo Tie-Down System: The system of fittings, devices, and provisions designed to prevent shifting of loads during air movement.

15. Chute: A term for those canopies which do not actually "defend against a fall", e.g., pilot chutes and extraction chutes.

16. Cluster: A group of two or more parachutes attached to a single load and designed to open simultaneously.

17. Daisy Chain: The deployment of a parachute from a load by a static line attached to a second load, the parachute of which is already deployed. Two or more parachutes may be connected to a daisy chain.

18. Deployment: The withdrawal of the canopy and suspension lines from the pack.

19. Deployment Bag: A type of pack used to hold packed parachutes and from which the suspension lines are deployed first, as in the T-10 troop-type or G-11A cargo parachutes.

20. Deployment Time: The deployment time is that interval of time between the parachute release and the instant of full line stretch. At full line stretch, it is assumed that the parachute canopy has not begun to fill but is in a stretched out uninflated configuration. In cinetheodolite analysis there are three deployment times:

a. Extracted Airdrop - that time interval measured from the instant the extraction chute force is transferred to the main parachute deployment bag from the stowed position on the platform, to full line stretch of the main parachute.

b. Gravity Airdrop-static Line Activated - that time interval measured from the instant the static line initiates the release of the main parachute from the deployment bag, i.e., instant of movement or visual distortion of the main parachute deployment bag from the stowed position on the load, to full stretch of the main parachute.

c. Gravity Airdrop-pilot Chute Activated - that time interval measured from the instant the pilot chute initiates release of the parachute from the deployment bag, i.e., instant of movement or visual distortion of the pilot chute, to full line stretch of the main parachute.

21. Development: The process of opening the canopy after deployment.

22. Development Time: The development time is that interval of time between the instant of full line stretch and the instant of full opening of the parachute. It is assumed that the parachute canopy begins to fill instantaneously from full line stretch. Development time is sometimes referred to as inflation or filling time. In cinetheodolite analysis, development time is that time interval measured from the instant of full line stretch of the parachute to the instant of first full opening of the parachute.

23. Downtime: In cinetheodolite analysis, that time interval measured from the instant that the platform or load is physically separated from the aircraft to the instant the platform or load impacts the ground or to the instant of canopy relaxation (for clusters, the instant for first canopy relaxation).

24. Drift: The horizontal displacement of a parachute-store system during descent as caused by crosswinds or by glide instability of the canopy.

25. Drop Zone: A specified area upon which airborne troops, equipment, and supplies are dropped by parachute or on which supplies and equipment may be delivered by free fall.

26. Drop Test, Static: Simulating an airdrop by dropping a test item from a fixed structure.

27. Energy-Dissipator: (See Honeycomb.)

28. Extraction: A technique used in air delivery in which the cargo is withdrawn from the cargo compartment by means of an extraction chute.

29. Extraction Time:

a. Extraction time is that interval of time between release of the extraction chute and the exit of the load from the aircraft. This interval includes the deployment time and filling time of the extraction chute as well as the time required to move the load from the aircraft.

b. In cinetheodolite analysis, that time interval measured from the instant of movement of the extraction bag from its stowed position in the aircraft to the instant of physical separation of the platform from the aircraft.

30. G-force: The measure or value of the gravitational pull of the earth as modified by the earth's rotation, equal to the acceleration of a freely moving body at the rate of 32.16 feet per second.

31. Gross Rigged Weight: The airdrop weight plus the weight of all airdrop rigging.

32. Honeycomb: A construction of thin sheet materiel, such as nonimpregnated paper for fabric which has been corrugated or bonded, to form a core materiel whose cross section is a series of mutually continuous cells similar to natural honeycomb. Most commonly used size for airdrop operations is 3 inch thickness with 0.5 inch cell size. (See MIL-H-9884.)

33. Outsized Cargo: Items that are transportable but require special instructions regarding loading procedures, lashing and tiedown, shoring, restricted locations in the aircraft, or may be partially disassembled.

34. Parachutes, Formed Gore: Medium porosity parachutes with drawn-in skirts more stable than flat parachutes. Because of its reliability and stability this parachute has established a record of only one landing injury per each 20,000 jumps.

35. Parachutes, Glide Surfaces: Medium to low porosity cloth characterized by a conical surface at the lower portion of the canopy. This surface serves to stabilize the canopy during descent. The stabilization type is used with mines, torpedoes, and bombs; the universal type is for missiles and capsule recovery; and the personnel type is used in the rescue of airmen.

36. Parachutes, Ribbon Type: Flat disc design, canopy constructed of ribbons. Porosity is similar to that of the ringslot; however, the individual units of the open area are smaller and the stability of the ribbon parachute is better than that of the ringslot.

37. Parachutes, Ringslot: Canopy constructed of rings. Flat disc design and has considerably higher porosity. They are more stable than any medium porosity types which are widely used in the extraction of heavy loads from cargo aircraft.

38. Parachutes, Rotating: Has large slots which are so shaped and arranged that escaping air causes the parachute to rotate. The combination of gore shape and rotation is said to give added lift to the parachute.

39. Parachutes, Solid Flat: Either circular disc, triangle or square designs with medium porosity. Unstable in that they either oscillate, glide or perform a combined motion.

40. Pathfinders: Teams dropped at an objective to establish and operate signal devices for the purpose of guiding aircraft to drop and landing zones.

41. Phototheodolite (Cinetheodolite): A spindle-mounted metrical camera capable of horizontal and vertical circles whereby the camera axis may be read directly.

42. Pilot Parachute: An auxiliary parachute attached to a large parachute, usually at the apex to function as an anchor and to assist the larger parachute in deployment and development.

43. Pitchover: Turning of a platform during extraction into a position wherein the forward end of the platform is rotating downward.

44. Platform: A base of metal or wood which serves as the support to which equipment may be lashed for air delivery.

45. Rate of Descent: Vertical component of the resultant velocity of an air delivery system as it moves along its trajectory.

46. Reefing: A method of constraining the canopy so as to delay its full development, which decreases the opening shock, decreases the drag area, and enhances stability.

47. Restraint Factor: The amount of restraint expressed in units of gravity, or "g's", to prevent movement of cargo in a specified direction.

48. Retardation System: A system used to retard and stabilize the descent of an airdropped item.

49. Rigging: Method of preparing a particular piece of equipment or load of supplies for air delivery.

50. Specific Loads: Loads which, due to their physical characteristics, must be classified as outsized cargo.

51. Standard Loads: All loads for which technical manuals (Army) and/or technical orders (Air Force) have been established.

51.a. Loadspreader: Wood glued to the top of the energy dissipator of sufficient area and thickness to assure full crushing of the dissipator over its entire area. Load spreaders are used in loads having irregular undercarriages.

52. Static Line: A line of webbing used to open parachute pack and release canopy, one end of the line being fastened to parachute and the other end to the aircraft.

53. Strain Gages: A resistive element used to measure tension of compression forces. Used to measure airdrop forces, e.g., snatch, deployment, and shock forces.

54. Telemetering: The technique of recording data by transmitting signals from the cargo load to a ground receiving station. Signals are calibrated so physical parameters can be accurately interpreted on oscillograph records or digitized and processed by computer.

55. Terminal Velocity: Hypothetical maximum speed of an air delivery system could attain along a specified straight flight path under given conditions of weight and drag if falling an unlimited distance in air or a specified uniform density.

56. Tie-down:

a. A webbing strap with D-ring used to lash load to heavy drop platform.

b. A chain and binder assembly used to lash cargo to tie-down rings in aircraft.

57. Unitized Load: A single item or number of items packaged in a specified manner and capable of being handled as a unit. Unitization may be accomplished by placing the item in a container, or by bonding them securely together. A unitized load, when placed on a pallet and fastened thereto, may be referred to as a palletized load.

58. Wind, Relative: The velocity of the air with reference to a body in it. It is usually determined from measurements made at such a distance from the body that the disturbing effect of the body upon the air is negligible.

APPENDIX A

SAMPLE CHECKLIST

PROJECT ENGINEERS AIR DROP SAFETY CHECK LIST

OPERATION TITLE: Cargo Air Drop DATE: ____________

DROP ZONE: ____________ PROJECT ENGINEER: ____________

CHECK POINTS	YES	NO	N/A
1. BEFORE OPERATION			
a. Brief Airborne Operations on pertinent aspects of load, i.e., weight, size, explosive or flammable hazards, etc. Refer to Safety Statement if applicable.			
b. Ensure that Airborne Operations has in possession a complete and correct Air Drop Test Request.			
c. Assist Airborne Operations with completion of Cargo Manifest.			
d. Read and understand appropriate Air Drop SOP's.			
e. Ensure that appropriate SOP's are available for reference during test.			
f. Brief DZ controller of safety aspects of load.			
g. Inform DZ controller of waiting periods required after impact, if applicable, and of who may approach load (EOD, Rigger personnel, etc.).			
h. Brief DZ controller of security aspects of load and provide him with an access list if appropriate.			
i. Brief chase aircraft pilot of pertinent aspects of load as above.			
j. Check adequacy of load/platform/container restraint.			

Project Engineers Air Drop Safety Check List (Continued)

CHECK POINTS	YES	NO	N/A
k. Check extraction system components for correct installation.			
l. Ensure that adequate fire fighting personnel and equipment are on hand when loading aircraft with explosives or flammables.			
m. Ensure that aircraft is electrically grounded when loading explosives or flammables aboard.			
n. Ensure that appropriate fire symbols, explosive signs and warning signs are prominently displayed as required.			
o. Inspect load after loaded in aircraft.			
p. Check ground releases, if applicable.			
q. Check dual rail restraint against AF manual where appropriate.			
r. Ensure that flight crew is briefed on safety aspects of load and on flight requirements.			
s. Ensure that hazardous loads are properly marked according to TM 38-2501 and AFM 71-4.			
t. Establish communication with DZ controller.			
u. Ensure that necessary personnel are present at DZ prior to drop.			
2. DURING OPERATION			
a. Inform DZ controller when wet run is authorized.			
b. Brief casual personnel of safety/security aspects of load.			
c. Direct DZ controller to abort drop if unsafe conditions are observed.			
d. Report any malfunctions to Airborne Operations.			

Project Engineers Air Drop Safety Check List (Continued)

CHECK POINTS	YES	NO	N/A
e. Ensure that all personnel are a safe distance from the predicted impact point on the DZ			
f. Ensure that all access roads to the DZ are barricaded.			
3. AFTER OPERATION			
a. Inspect every load for damage, rigging adequacy, safety and security aspects.			
b. In cases where explosive or flammable hazards exist after the drop, remain in control of the DZ until declared clear by EOD or other responsible activity.			
c. In cases where security is involved after the drop remain in control of the DZ until relieved by responsible authority.			
d. Ensure that DZ recovery crew is briefed on safety/security aspects of load.			
e. Brief Recovery crew on recovery requirements.			

APPENDIX B

AIRDROP SYSTEM COMPONENTS

1. General

Airdrop system components are classified in two groups, those components internal to the aircraft (e.g., winch, conveyor, tiedowns, side-rails, indicators, and communications); and components which support the load during the drop (e.g., extraction chute, parachute, reefer, platform, energy dissipator, harness, hardware, and release mechanism).

These components are discussed in paragraphs 2 and 3 below, and their general characteristics are illustrated in the associated charts and figures. Standard airdrop system limitations are discussed in paragraph 4. This information should be verified by researching the latest edition of those documents referenced in this MTP.

2. Internal Components

The selection of internal components is based on the type of aircraft used and the size, weight, and configuration of the load to be airdropped. The components described below relate mainly to large cargo aircraft of the type used by the Air Force. Smaller aircraft and helicopters use simpler forms of these components because of the size and weight restrictions.

a. Roller Conveyors - are assembled from sections of skate-wheel conveyors either 8 or 10 feet long and 1 foot wide. Two or three sections are normally bolted side by side to form a double or triple section.

b. Dual Rail Cargo Handling System - is essentially a roller conveyor which encompasses locking and release mechanism for securing and/or releasing pallets and modular platforms. It consists of conveyor frame assemblies and extension rails. The conveyor frame is mounted on both outboard sides of the airplane cargo floor and ramp. The extension rails are mounted on the cargo floor and bridge the cargo floor conveyor frame assemblies to the ramp conveyors. The intermediate conveyors are mounted on the cargo floor and ramp, and are centered between the conveyor frame assemblies.

c. Buffer Boards - constructed of wood or metal are mounted on each side of the cargo floor aft end and have fittings to attach them to mating fittings on the airplane. The buffer boards prevent the load from getting caught on its way out of the airplane.

d. Forward Buffer Assemblies - are L-shaped brackets, brace or clamps which are bolted to the conveyors just forward of the load to prevent forward movement of the cargo after all other restraints have been removed.

e. Tiedown Devices - The airplane is equipped with a number of chain and tension assemblies (tiedowns) to apply restraint to the cargo. Each tiedown is rated to withstand a specific load or force, e.g.:

1) D-1 Tiedown is rated at 25,000 pounds capacity. On one end of the tiedown a fitting attaches to the cargo floor tiedown fitting. On the other end is a slot into which any chain link may be inserted. The chain is drawn tight by adjusting the turnbuckle.
2) MB-2 Tiedown is rated at 25,000 pounds and is similar to the D-1 except for a hook instead of jaws to attach to the tiedown fitting, and a quick release which permits detachment from the load regardless of chain tension.
3) C-2 tiedown has a 10,000 pound rated capacity, and is similar in operation to the D-1, but is smaller and lighter.
4) MB-1 Tiedown has a rated capacity of 10,000 pounds and is similar to the MB-2. They are used for all restraint in which 10,000 pound capacity fittings can be used to restrain airdrop loads.
5) A-1A Tiedown is rated at 1,250 pounds and consists of a strap on which there are one stationary hook and one movable hook. The stationary hook attaches to the cargo floor tiedown fitting. The strap is passed around a part of the load and the hook on the other side of the strap is attached to another tiedown fitting.
6) MC-1 Tiedown is rated at 5,000 pounds and is similar to A-1A except it has a pretension lever to aid in tightening the strap.
7) Type CGU-1/B Tiedown is a 20 foot long nylon web strap assembly rated at 5,000 pounds. It is equipped with a rachet hook at one end with a handle that rotates 60 degrees per ratchet, and moves 120 degrees to release the spool for letting out webbing.
8) A-2 Cargo Net is rated at 10,000 pounds. It is used to secure small items of cargo, such as crates or boxes that do not have attachment points to which tiedown hooks can be applied. The ring sides of the net are secured to the cargo area floor or to platforms by passing a tiedown through the rings.

The computations to determine tiedown components, and descriptions of tiedowns and methods of securing the loads are described in AMCP 706-130.

f. Static Line Anchor Cable System - provides for attaching and restraining the static lines during an airdrop. The system includes static line anchor cables which are held in place by means of forward, center, and aft supports. Retriever cable assemblies pull the extracted static lines back into the airplane after an airdrop.

g. Static Line Retrievers - consist of a winch, forward retriever cable assembly, and aft retriever cable assembly for both right and left sides of the airplane. The forward switches control both wind and unwind operations of the winches; the aft switches control only the rewind.

3. External Components

The type and number of external components required for the airdrop depends on the weight of the load and the impact velocity desired. As an example, in tests conducted at the Yuma Proving Ground on various containers the airdrops impact ranged from 19.43 fps for an 8-foot platform to 37.42 fps for A-21 containers.

The nominal terminal velocity of the low velocity airdrop is 28.5 fps. High velocity airdrop ranges between 70 to 90 fps.

a. Energy Dissipator Configuration - Ground impact provides the most severe environment to which a dropped load is subjected. The energy dissipator system (see honeycomb in Glossary of Terms) must reduce the severity of that environment to a level acceptable to the item being dropped.

Each item of military equipment which is to be airdropped should be designed to be compatible with current energy dissipator systems, and should be able to survive the deceleration shock of ground impact. The deceleration shock level can be described as:

$$D = W(G + 1)$$
$$28.5 \text{ to } 0 \text{ fps} = W(18.5g + 1)$$
$$28.5 \text{ to } 0 \text{ fps} = W(19.5g)$$

where D = deceleration shock level (28.5 to 0 fps)
W = weight of test item
G = number of g's deceleration

As shown, the item must withstand a deceleration force of 19.5 times its airdrop weight W(G + 1) (decelerated from 28.5 feet per second to zero feet per second on ground impact.

The deceleration force of G + 1 or 19.5 times the item airdrop weight is met by using 3.25 square feet of paper honeycomb crushing area for each 1000 pounds of item airdrop weight. The 12 inch thickness of paper honeycomb is composed of four layers of 3 inch thick panels with a dynamic crushing stress of 6000 pounds per square foot. The standard thickness for the energy dissipator is twelve inches for all drops where the deceleration required is from 28.5 feet to zero feet per second.

The effective area vs load for various crushing stresses (G=18.5) is shown in Figure B-2.

A sample set of calculations is shown on page B-6 for a 20,000 pound load at 8g and 18.5g deceleration levels.

b. Recovery Parachutes and Disconnect - The recovery parachutes must be capable of producing the proper rate of descent. Cargo parachutes may be used singly or in clusters to obtain similar rates of descent for a large range of airdrop item weights. The characteristics of standard cargo recovery parachutes are shown in Figure B-3.

A disconnect mechanism is provided between the recovery parachute and the load to prevent overturning or dragging the load during high wind conditions. The disconnect is accomplished upon ground contact when the vertical stress force is relieved.

c. Extraction Parachutes - The extraction parachute must pull the load from the aircraft in a manner that will not cause tipping and subsequent oscillations of the load. Extraction parachute load requirements are shown in Figure B-4.

4. Standard Airdrop System Limitations - The following limitations apply to current standard airdrop systems. Research being conducted to extend airdrop capability will cause frequent revision of these limitations as new methods and materiels are developed.

a. The current standard airdrop systems are designed to function properly at airdrop speeds up to 150 knots. Present airdrop operations, however, are limited to lower airdrop speeds, the highest being 130 knots.

b. A standard airdrop altitude of 1100 feet above the highest terrain on the Drop Zone is presently being used. The advantages of low-altitude airdrop are prompting the development of new systems for this use.

c. Airdrop with the current system is normally restricted to wind speeds below 15 knots.

d. The maximum rate of descent specified for current systems is 28.5 feet per second. This rate of descent is based on 100°F at an altitude of 5000 feet. Some items, such as ammunition, are adaptable to high-velocity container drops at 70 to 90 feet per second.

e. Heavy equipment drops can be made with unit load weights of from 2500 to 35,000 pounds. Single- and multiple-platform airdrops can be made up to the design limits of the aircraft.

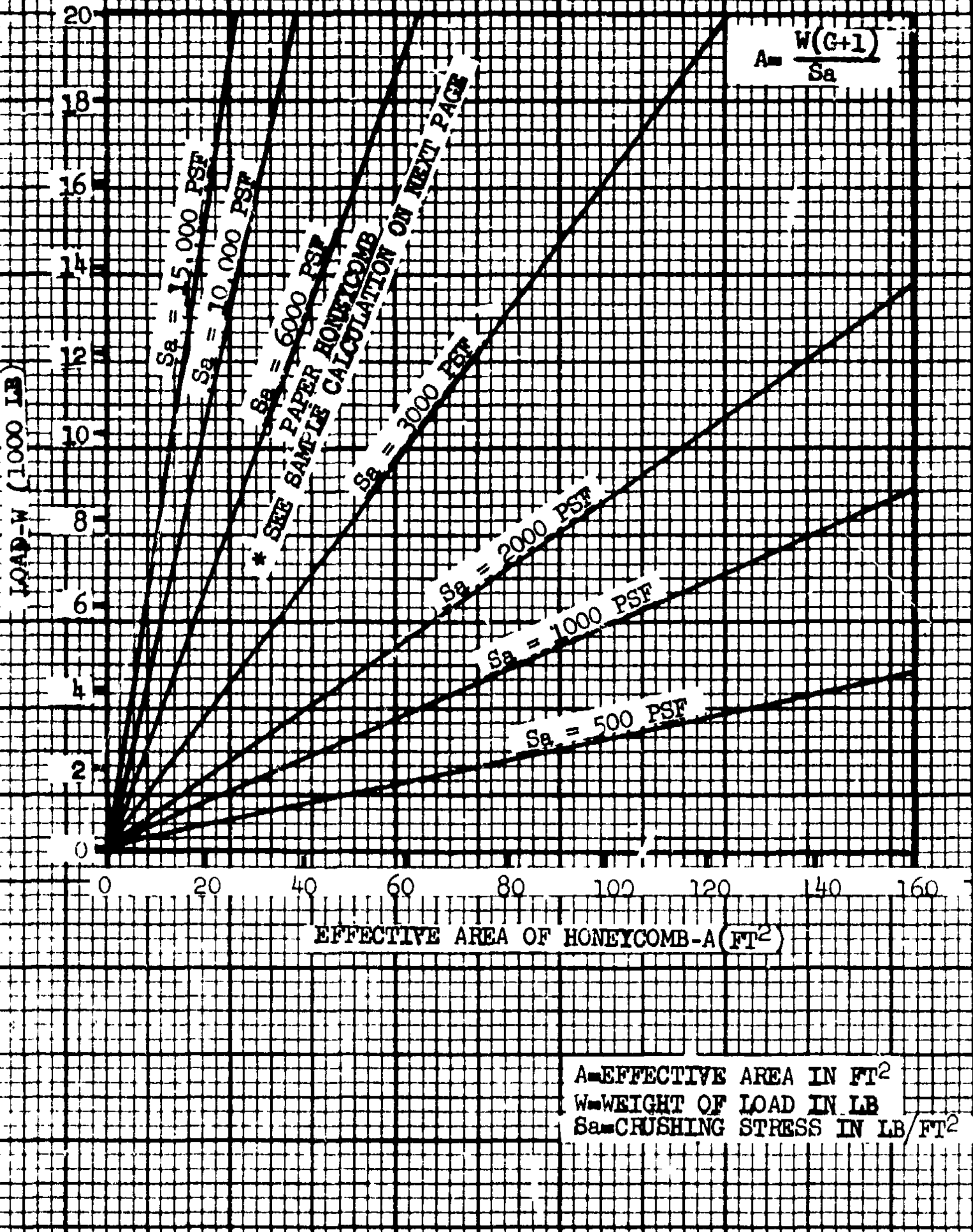

FIGURE B-2

EFFECTIVE AREA VS LOAD FOR VARIOUS CRUSHING STRESSES (G=18.5)

*Sample Calculation for Paper Honeycomb

Assume that a 20,000 pound load is to be test dropped and the deceleration level selected for the initial drop is 8 g's (a value of 7 to 10 g's is reasonable for initial test drops of most Army equipment). The area of paper honeycomb required can be calculated by:

$$A = \frac{W(G+1)}{Sa}$$

where W = rigged weight of load = 20,000 lb
G = 8
Sa = average dynamic crushing stress of paper honeycomb

$$A = \frac{20,000(8+1)}{6000}$$

$$A = 30 \text{ sq ft}$$

The total area of paper honeycomb to be distributed under the load is 30 square feet. The dissipation area should be apportioned beneath the item according to the weight, distribution and maximum strength areas of the item. A trial and error method may be used (during simulated airdrop) so that, by the time the final configuration is reached, all honeycomb stacks are crushing uniformly.

If the same load (20,000 pound load) is to be test dropped at a deceleration level of 18.5 g's, the area of paper honeycomb required is:

$$A = \frac{W(G+1)}{Sa}$$

$$A = \frac{20,000(18.5+1)}{6000}$$

$$A = 65 \text{ sq ft.}$$

CHARACTERISTICS OF STANDARD CARGO RECOVERY PARACHUTES

ABBREVIATED NOMENCLATURE	* WEIGHT (LB)	MAXIMUM LOAD LIMIT (LB)	METHOD OF DEPLOYMENT	CANOPY		SUSPENSION LINES		DEPLOYMENT BAG &/OR PACK
				TYPE	NOMINAL DIAMETER (FT)	NUMBER	LENGTH (FT. & IN.)	
G-1 & G-1A	25	300	STATIC LINE	FLAT CIRCULAR	24	24	15 FT 0 IN	PACK
T-7A CONVERTED	20	300	STATIC LINE	FLAT CIRCULAR	24	24	16 FT 10 IN	PACK
T-7 CONVERTED	25	500	STATIC LINE	FLAT CIRCULAR	28	28	22 FT 10 IN	PACK
G-13	45	500	STATIC LINE	PARABOLIC SHAPED-GORE	NOMINAL 32.4 SKIRT 24.25	20	30 FT 0 IN	PACK
G-12C	128	2200	PILOT CHUTE	FLAT CIRCULAR	64	64	51 FT 0 IN	PACK
G-12D	128	2200	PILOT CHUTE OR EXTRACTION PARACHUTE	FLAT CIRCULAR	64	64	51 FT 0 IN	DEPLOYMENT BAG
G-11	250	3500	EXTRACTION PARACHUTE	FLAT CIRCULAR	100	120	60 FT 0 IN	DEPLOYMENT BAG
G-11A	250	3500	EXTRACTION PARACHUTE	FLAT CIRCULAR	100	120	35 FT 0 IN	DEPLOYMENT BAG

* Approximate packed weight of entire parachute assembly

FIGURE B-3

EXTRACTION PARACHUTE LOAD REQUIREMENTS

EXTRACTION PARACHUTE SIZE & TYPE	EXTRACTION LOAD RANGE (LB)		EXTRACTION LINE
	SKATE WHEEL SYSTEM	DUAL-RAIL SYSTEM	
15-foot reefed ring-slot (148-inch reefing line)	1,750 to 3,500	---	2-loop Type X Nylon
15-foot reefed ring-slot (260-inch reefing line)	3,500 to 7,000	2,520 to 5,070	2-loop Type X Nylon
15-foot ring slot (unreefed)	5,600 to 11,200	3,730 to 8,000	2-loop Type X Nylon
22-foot ring-slot (unreefed)	11,200 to 21,500	8,000 to 17,000	3-loop Type X Nylon
28-foot ring-slot (unreefed)	---	13,000 to 25,000	4-loop Type X Nylon
Two 28-foot ring-slots (unreefed)	---	25,000 to 35,000	5 loop Type XXVI Nylon

FIGURE B-4

APPENDIX C

GUIDELINES FOR ESTABLISHING THE DROP ZONE

1. Select a Drop Zone location which can best support the recovery of airdropped materiels and affords maximum safety features:

   a. Minimum number of obstacles in the area.
   b. Access to the area by recovery and emergency vehicles.
   c. Availability of adequate aircraft approach and departure routes.

2. Compute the required length of the Drop Zone:

$$D = RT$$

where D = zone length in meters
R = ground speed (rate) of aircraft in meters/sec
T = time required for aircraft to release its cargo

correcting R = aircraft indicated airspeed ± prevailing winds over the Drop Zone

3. Determine how much load can be released during each pass.

4. Set out a ground target indicating the desired point of impact. Target can be cross or circular in shape, at least 10' x 10' area. Drop Zone may also be designated by a code letter to identify a specific DZ where multiple drops are being made.

5. Emplace recovery and emergency vehicles around the perimeter of the Drop Zone in position to move into Drop Zone rapidly.

6. Take airspeed and direction measurements at ground level. A hand-held windmeter is usually accurate enough for these measurements.

7. Establish communications between the Drop Zone radio operator/recovery NCO, the aircraft, and all recovery and emergency vehicles and established radio frequencies.

8. As aircraft approaches Drop Zone activate a smoke grenade and place in a can or barrel to generate billows of smoke, to indicate wind direction to the aircraft. Smoke should stop prior to actual drop so the drop will not be obscured.

9. During the airdrops, the airdrop officer/cargo master should be advised of changes in windspeed and direction, and the need to correct jump or release points.

APPENDIX D

GENERAL GUIDELINES FOR OPERATION AND INSPECTION OF MATERIELS

1. Automotive Equipment (and Components)

Automotive equipments may be subjected to two levels of operational testing. The first level of testing is simply to operate the equipment in a normal environment and observe its general performance. For example, a vehicle could be driven several miles over improved and secondary roads, and if it moved, turned, and stopped without difficulty its performance could be assumed to be satisfactory. The second level of testing would require that the vehicle be subjected to specific engineering tests where its performance would be evaluated under maximum load (and tow) conditions while the vehicle is driven over test course. The vehicle could also be dismantled to determine if there are any cracks, bent shafts, misalignments, etc., that would impair its operation during a tactical mission. The latter type of operation and inspection has the obvious advantage of being a more complete test and provides the analyst with qualitative data on the condition of the test materiel. It is, however, a more expensive method of testing, requiring more test time, facilities, and special test equipment. Often a practical solution to operational testing can be found between the two levels of testing described above where sufficient performance data is taken to ensure that, within a reasonable confidence level, the data truly reflects the operational condition of the automotive equipment.

2. Weapons

Weapons can best be operationally verified by performing normal prefiring tests, including alignment checks as required. Weapons may also be fired on a test range to ensure that the accuracy of the weapon is within stated performance limits. If the weapons are fired, the same control ammunition should be used for post airdrop operational test firing of these weapons.

3. Inert Ammunition

The casing of the ammunition can be inspected for physical damage or deformation. The ammunition may also be subjected to non-destructive techniques to determine whether there is any internal damage, e.g., X-ray or sonic testing. If the ammunition can be fired, i.e., the warhead is inert but the propellent is not, samples of ammunition may be fired before and after the airdrop to verify the operability of the ammunition.

4. **Missile Support Equipment**

A number of items may be classed as missile support equipment, including loaders, transporters, erection platforms, electronic vans, communication vans, etc. The most appropriate operational test would be in its normal operational configuration connected to other support equipment, as it would be during a tactical situation.

Some extensive operational tests would be expected in the case of an electronic or communications van, but in most cases the physical damage observed would determine how extensive the operational and performance tests should be.

5. **Electronic Equipment**

Electronic equipment is often damaged by airdrop, even with the shock mounting and cushioning provided. Something as simple as a loose connector or cracked circuit board can cause the failure of a major piece of electronic equipment. It is therefore important to subject these equipments to a thorough operational inspection prior to and after the airdrop. If the equipment has several modes of operation, each should be tested under normal operational conditions, connected to other equipments as it would be in tactical conditions.

6. **Quartermaster Materiel**

Quartermaster materiels require only a simple operational test in the case of rations, or a visual inspection in the case of clothing, etc. These materiels, because of their bulk and elasticity, usually are not severely damaged by airdrop. Acceptance criteria for these materiels may be stated in gross terms, i.e., it is either usable or not usable.

APPENDIX E

STATIC AIRDROP TEST FACILITY AND AIRDROP TEST ZONE

1. STATIC AIRDROP TEST FACILITY

This facility usually consists of a crane (or hoist), a release mechanism, instrumentation sensors (on the load), telemetry station (portable or fixed), and an impact/control area. As shown in Figure E-1, the load is hoisted by a crane fitted with a helicopter release hook on the hoist cable.

The facility is utilized to conduct static (free fall) drop tests on load configurations prior to airdropping them from an aircraft. In conduct of static drop tests the rate of descent for specific impact velocities is carefully controlled, as are the air delivery load platform configuration and system impact attitude. The maximum capacity for these drops is about 35,000 pounds from a maximum height of 70 feet, which provides impact velocities up to 69.7 feet per second. The static drop tests normally involve impact velocities up to 30 feet per second which is obtained with a drop height of 14 feet.

In addition to horizontal impact surfaces, a 15 degree and 45 degree angle impact slope of concrete may be provided for controlled resultant impact environment.

Initial drop tests should be made with deceleration force levels less than the G+1 level specified in the system design, while retaining the design thickness of cushioning materiel. For example, if the design level specified is 28.5 feet per second the first drop could be made at a lower velocity, or 19 feet per second. The equivalent drop height for 19 ft/sec would be calculated as:

$$h = \frac{V^2}{2g}$$

where

V = impact velocity = 19 ft/sec
g = acceleration due to gravity = 32.2 ft/sec^2

$$h = \frac{(19)^2}{2(32.2)}$$

$$h = 5.6 \text{ ft}$$

The drop height is measured from the bottom of the skid or platform to the impact surface (5.6 feet).

The instrumentation systems for this type of drop consist basically of physical force data recording units and high speed photography. The data are transmitted from the transducers on the drop load to recording instrumentation either directly by hard wire or by employing the telemetry transmitter packages which are ultimately used on the load during actual airdrop. The photographic equipment normally consists of two or more 16-mm high speed cameras. Still cameras are used before and after the drop to record effects on the test materiel or airdrop system.

2. AIRDROP TEST ZONE

Airdrop test zones are used during the actual (dynamic) airdrops. These zones are usually segregated for the airdrop of personnel, general materiel or for ammunition/explosive/toxic materiel.

Types of data usually acquired for airdrop test projects are space position data for reduction to velocity and acceleration, retardation system snatch and opening force shock, impact shock, strain and vibration. These types of data are usually obtained by means of accelerometers on the test materiel and/or on the load platform, strain patches on the test load and strain links in the load rigging and parachute webbing systems.

This information is usually obtained by utilization of one or more telemetry packages, mounted on the load, transmitting to ground telemetry receivers. (See Figure E-2.)

Performance of the loads during extraction from the aircraft is evaluated from both high-speed motion picture coverage in the aircraft and velocity measuring devices to determine the extraction rate relative to the aircraft.

During airdrop, sequence of the load, space position, velocity, and associated data are obtained by use of cinetheodolite instrumentation utilizing instrument positions strategically located to provide coverage on all the drop zone. Cinetheodolite trajectory data are connected to zero wind conditions from which dynamic pressures are computed by application of meteorological data.

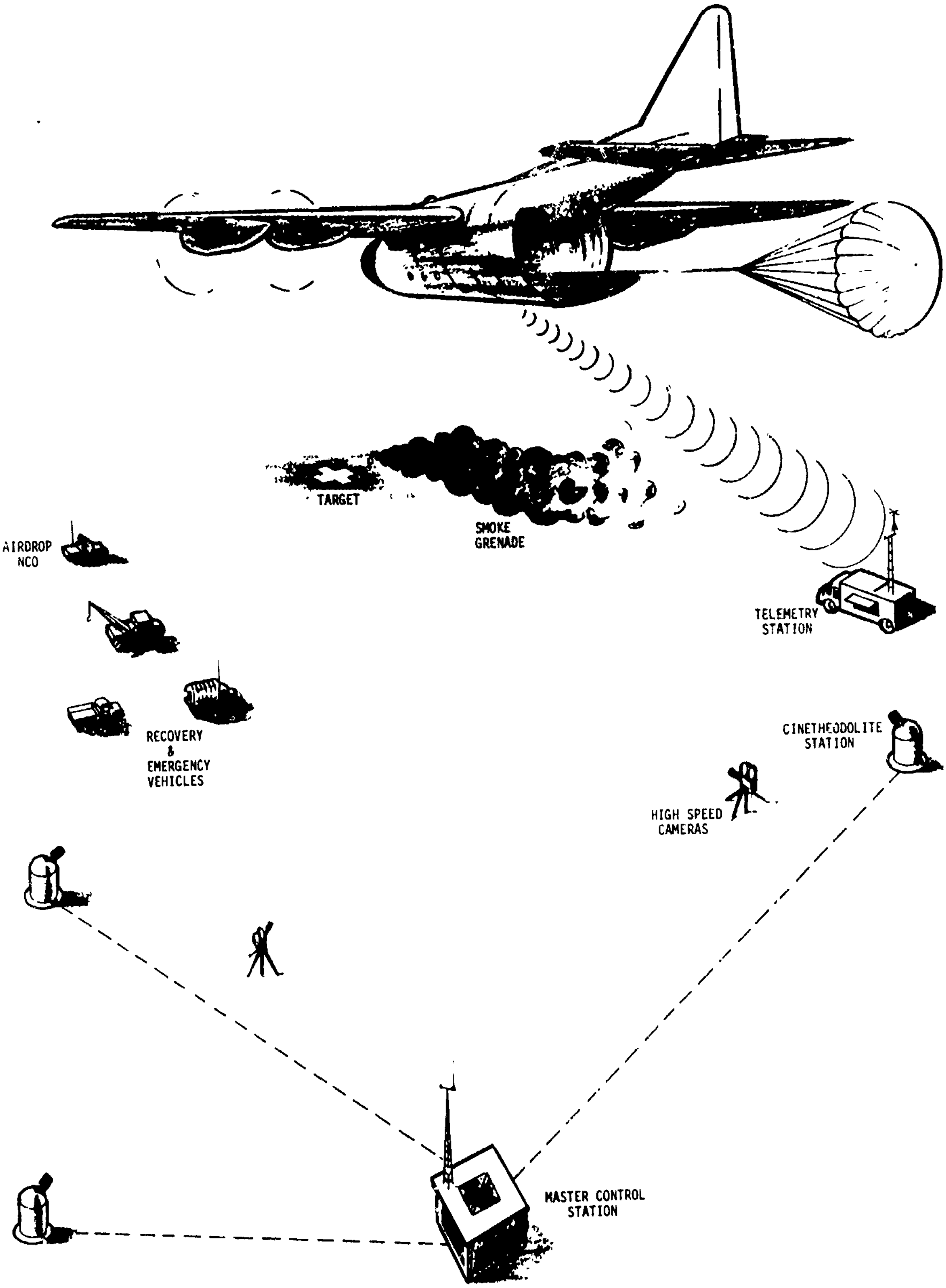

FIGURE E-2 AIRDROP TEST ZONE

APPENDIX F

SAMPLE AIR DROP TEST SUMMARY FORM

Test Type ___Rated load___

Test Condition 2/1 --- 1500 ft abs (2000 ft MSL), 300 lb, 150 KIAS

Test No. 2/1-2 (ATD 25) Date ________

Parachute S/N ___2___ Modification No. __--__, Use No. ______
Deployment Bag Type ___flat___
Aircraft Type ___C-130___

Trajectory and Event Data

Aircraft

Release Velocity	268	ft/sec
Release Altitude	1504	ft (abs)

Parachute

Deployment Time	1.2	sec
Dynamic Pressure (at _____ sec time)	*	lb/ft^2
Filling Time	1.4	sec
Opening Time	2.6	sec
Stabilization Time	4.6	sec
Altitude Loss to Stabilization Time	175	ft
Down Time	52.6	sec
Equilibrium Rate of Descent (Actual)	30	ft/sec
Equilibrium Rate of Descent (ICAO Corrected)	*	ft/sec
Impact Velocity (Vertical Component)	30	ft/sec
Impact Velocity (Resultant)	41	ft/sec
Parachute Snatch Force	*	lb (pk)
Parachute Opening Force	*	lb (pk)

Meteorological Data

Surface (132 m MSL)

Air Temperature	12.8	°C
Relative Humidity	49%	%
Pressure	990.6	mbs
Density Altitude	192	m
Absolute Air Density	1.2032	Kg/M^3
Wind Velocity	1.8	mps

Altitude (500 m MSL)

Relative Humidity	87	%
Pressure	936	mbs
Temperature	6.9	°C
Wind Velocity	4.2	mps

* Not Available

Remarks

Performance satisfactory.