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MILITARY STANDARD

ESCAPE SYSTEM TESTING: GROUND, TRACK, AND FLIGHT TEST

FSC 1680

DEPARTMENT OF THE AIR FORCE

Escape System Testing: Ground, Track, and Flight Test

MIL-STD-846C(USAF)

1. This Military Standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Recommended corrections, additions, or deletions should be addressed to the 4950th Test Wing (TZSA), Wright-Patterson Air Force Base, Ohio 45433.

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1. SCOPE

1.1 This standard prescribes uniform test procedures to be used as the basis for system design approval of crew emergency escape systems.

1.2 This standard is applicable to crew module, ejection seat, and tractor rocket extraction seat escape systems. It covers the following types of system tests:

a. Integration tests

b. Static tests

c. Track tests

d. Flight tests.

1.3 The tests covered by this standard shall be conducted after completion of the applicable component and subsystem performance tests, analytical verification of system performance, and system development tests.

1.4 The tests specified in this standard are applicable to the following subsystems of each escape system:

a. Canopy

b. Hatch

c. Recovery

d. Environmental control

e. Seating and restraint

f. Impact and flotation

g. Stabilization

h. Sequencing

i. Propulsion

j. Survival equipment

k. Parent vehicle.

2. REFERENCED DOCUMENTS

2.1 This section is not applicable to this standard.

3. DEFINITIONS

3.1 System integration tests. System integration tests, as specified in table I, are those tests conducted on the complete escape system to demonstrate that all subsystems and components will function properly and in the correct sequence when integrated with the aircraft. These tests include the functioning and operation of those subsystems and components which are utilized in the normal or nonemergency mode of the aircraft.

3.2 System static tests. System static tests, as specified in table I, are those tests conducted to demonstrate proper operation, structural integrity, and function of the complete escape system and interrelated vehicle components and systems from the initiation of the escape sequence to ground recovery. These tests are conducted from the aircraft or from a suitable jig or test vehicle which simulates the structure and duplicates the dimensions of the aircraft.

3.3 System track tests. System track tests, as specified in table I, are those tests conducted to demonstrate the proper functioning of canopy jettisoning, ejection and separation, stabilization, recovery, and impact and flotation subsystems and components at velocities representing the complete dynamic pressure range of the aircraft or escape system design.

3.4 System flight tests. System flight tests, as specified in table I, are those tests conducted to demonstrate and functionally verify ejection and separation, stability, flight characteristics, recovery, and impact and flotation subsystems and components at velocities and altitudes representing the complete performance envelope of the aircraft or escape system design. The tests are conducted from an aircraft, subject to approval by the procuring activity.

3.5 Classification of tests

3.5.1 Successful tests. A successful test is a test in which all the required data are obtained and all escape system functional and sequencing requirements are met. The data must indicate that a crewmember would have ejected and landed on the earth's surface without exceeding the human tolerance specified in the performance specification.

3.5.2 No test. A test shall be declared a "no test" if:

a. The test vehicle speed was not within the acceptable speed range (a maximum of ±10 percent of target speed) for the test run from the time that the escape sequence was initiated until the time that escape system/sled separation occurred.

Table I. Summary of System Tests Requirements

Requirements / Program Type	System Integration Tests Paragraph Reference	System Static Tests Paragraph Reference	System Track Tests Paragraph Reference	System Flight Tests Paragraph Reference
Ejection or Extraction Seat Development Program	Required (5.1.1)	Two ejections (5.2.1) One canopy or hatch static test (5.2.3)	Twenty tests from minimum to maximum design speed. Canopies or hatches on all tests. (5.3.1)	Not required
Crew Module Development Program	Required (5.1.2)	Two ejections (5.2.2) Two hatch static tests (5.2.3)	Six tests from minimum to maximum flight (5.3.2)	Eight tests under various critical flight conditions. (5.4)
Compatibility Test Program (For Previously Developed and Qualified Escape System)	Required (5.1.1)	Not required	Eight tests from minimum to maximum design speed. Canopies or hatches on all tests (5.5.3)	Not required

b. The escape system fails to operate as a result of a non-escape system (i.e., sled, test initiated system) malfunction.

c. A failure occurs in either the data collection system or the photographic coverage resulting in insufficient data or coverage to permit adequate and satisfactory analysis of the test, and there is no other evidence of an obvious failure.

4. GENERAL REQUIREMENTS

4.1 Test facilities

4.1.1 Apparatus. The apparatus used in conducting tests shall be capable of meeting the conditions required by the tests specified herein.

4.1.2 Flight test. The locale selected for flight tests shall be adequate in area to insure recovery of all test items within its confines. Consideration shall be given to the protection of the personnel and property in the test area and surrounding vicinity.

4.2 Instrumentation. Measurements shall be made with instruments whose accuracy has been verified to the satisfaction of the procuring activity. Complete data and information describing the performance characteristics of the data collection system including transducers, signal conditioning, filtering, recording and playback equipment shall be prepared and included in the test plan and the test report. Also, instrumentation methodology including calibration procedures shall be included in the test plan and test report.

4.2.1 Electronic instrumentation. Electronic instrumentation shall be provided to sense, transmit, and record, as a minimum, the following types of data for all tests specified in this standard which will subject the escape system crewmember to accelerations during the process of pre-escape positioning, escape from the parent vehicle, entry into the air-stream, retardation and recovery, and land or water impact. Additional electronic instrumentation may be specified and required at the option of the procuring activity.

4.2.1.1 Structure-mounted instruments. Data shall be taken from instruments mounted on the primary structure of the escape system. The positions of the instruments shall be described in the test plan and test report in terms of an X, Y, Z coordinate system established with respect to the seat reference point and the plane of the compressed seat back as defined in the performance specification.

4.2.1.1.1 Crew module, ejection seat, and extraction seat. The following data shall be taken:

a. Vertical acceleration at or near the seat pan (G_z).

b. Lateral acceleration at or near the seat pan (G_y).

c. Longitudinal acceleration at or near the seat pan (G_x).

d. Pitch acceleration ($\dot{R}_y$).

e. Roll acceleration (R_x).

f. Yaw acceleration (R_z).

Angular acceleration data shall be corrected to eliminate the translational acceleration component of the measurement.

4.2.1.1.2 Crew module. The following additional data shall be taken:

a. Vertical acceleration of cg (G_z).

b. Lateral acceleration of cg (G_y).

c. Longitudinal acceleration of cg (G_x).

4.2.1.2 Crewmember-mounted instruments. For ejection and extraction seat escape systems, the following data shall be taken from instruments mounted on the simulated crewmembers:

a. Vertical acceleration of chest (G_z)

b. Lateral acceleration of chest (G_y)

c. Longitudinal acceleration of chest (G_x).

4.2.1.2.1 Extraction system crewmember instrumentation. For extraction escape systems the personnel restraint/parachute harness shall be instrumented to measure extraction forces in the lifting pendants at the attachments to the crewmember and the acceleration input to the crewmember at the harness/crewmember interface in the area of the buttocks.

4.2.1.3 Recording data. The following methods shall be used in recording data obtained in the tests to determine the capability of the escape system or its components to meet prescribed physiological acceleration tolerances:

a. The translational accelerometers used to measure the escape system acceleration environment shall have a frequency response which is flat, within ±5 percent, from DC to at least 100 Hertz. The angular accelerometers shall have a frequency response which is flat, within ±5 percent, from 1 to 100 Hertz.

b. The accelerometers used to determine maximum limits shall be fixed to the rigid portion of the escape system structure to approximate, as closely as possible, the measurements of the acceleration at the center of gravity of the crewmember escape system.

c. Data transmission and recording equipment shall have a frequency response which is flat, within ±5 percent, and in excess of 2.5 times the rolloff frequency of the accelerometer.

4.2.2 Photographic instrumentation. Photographic instrumentation shall be provided for all tests specified in this standard for the measurement of position, velocity, acceleration, and attitude of the emergency escape system and the crewmember. Photographic data of the crewmember extremities will be obtained and will be used to determine if gross abnormal positions and velocities are imparted or if there was impact of the crewmember with the aircraft or escape system structures. In addition, documentary and special event cameras shall be provided to record the complete test sequence and the behavior of pertinent or critical components or events of the emergency escape system during pre-ejection, separation, and free-flight sequences. Additional photographic instrumentation may be specified and required at the option of the procuring activity.

4.2.2.1 The following subparagraphs present types of photographic instrumentation, typical film sizes, and camera frame speeds. Metric, tracking, and 70 mm event coverage shall be black and white; all other coverage shall be in color. Still photographic coverage shall be provided to document test article installation and post-test condition. Particular attention shall be given to components suspected to have malfunctioned or failed.

a. Sledborne, 16 mm, frame speeds of 16 to 8,000 frames per second

b. Documentary, 16 mm, frame speeds of 8 to 64 frames per second

c. Hand pan, 16 to 70 mm, frame speeds of 5 to 400 frames per second

d. Metric, 16, 35, and 70 mm, frame speeds of 5 to 2,500 frames per second

e. Trackside, 16 mm, frame speeds of 500 to 3,000 frames per second

f. Event, 16, 35, and 70 mm, frame speeds of 10 to 2,500 frames per second

g. Airborne, 16 and 35 mm, frame speeds of 16 to 400 frames per second

h. Tracking, 35 mm, frame speeds of 4 to 20 frames per second.

4.2.3 Timing correlation. Master timing systems shall be utilized for data reduction and analysis. The master timing shall be a single timing source for both the photographic coverage as well as electronic data recording systems. Visual event initiation signals shall be incorporated on both the test vehicle and the escape system.

4.3 Test plan. Before starting any tests under this standard, the contractor should prepare a complete test plan outlining all proposed test procedures and the proposed test schedule. The test plan should include test objectives, description of each test, equipment and facilities to be used, and data to be recorded. The contractor shall not proceed with the test program until written approval has been received from the procuring activity. The test plan will be specified on the Contractor Data Requirements List of the contract (DD Form 1423).

4.4 Reports of tests. Reports of tests will be specified on the Contractor Data Requirements List of the contract (DD Form 1423).

4.5 Test conditions

4.5.1 Ejected weight. The weight of the ejected (or separated) portion of the escape system shall be determined by the testing activity. The weight shall be representative of that planned for use under service conditions and shall include the weight of the items of personal equipment specified, the weight of the crewmember(s), and the test weight.

4.5.2 Configuration. All static, track, and flight tests shall be conducted with final production configuration hardware for the complete escape system. Changes after the start of the qualification tests shall be held to a minimum, and when changes must be made, the reason for the change shall be submitted in writing for approval of the procuring activity prior to resuming the test program.

4.5.3 Track test vehicle. The track test vehicle shall be identical, insofar as practical, to the external configuration of the actual aircraft in the area of the canopy, hatch, or ejected crew module. The crew module test vehicle shall contain the actual method and structure of separation. The test vehicle shall be contoured in such a manner that the aerodynamic flow pattern over the test section shall be equal to that of the actual aircraft. The cockpit of the ejection seat or extraction seat test vehicle shall also duplicate the crew station configuration of the actual aircraft as far as representing critical ejection clearances. The test vehicle shall be capable of being propelled along a test track at the required speeds and shall be high enough above the track to minimize ground and rocket blast effects. The test vehicle design shall be approved by the procuring activity.

4.5.4 Simulated crewmember. The crew member shall be simulated by use of a dummy whose center of gravity under static load is representative of the crewmember's center of gravity under static load. Crew module, ejection seat, and extraction seat system tests shall be conducted using 5th and 95th percentile dummies. The dummies shall be used to demonstrate safe ejection under critical center of gravity variations and critical cockpit clearances. The dummies limbs shall be articulated to simulate the human limbs. Limb joints shall be set at 1g, barely restraining the weight of the limb when extended horizontally. Leg joints shall be adjusted with the torso in the supine position. Articulated head, neck, and torso joints shall not move at a horizontal acceleration load of 1g, in the test position, but shall move at a horizontal acceleration load of 2g. The dummy shall be configured with the personal equipment and clothing as required for the aircraft's operational use. The dummy shall be secured to the seat by means of the restraining harnesses normally used and the seat adjusted to that position considered to be most critical insofar as safe ejection is concerned.

4.5.4.1 Tethering of dummy limbs. Breakaway tethering of the dummy's hands to the ejection controls shall be used to simulate the grip strength of the

ejectee. Each hand shall be tied separately to the ejection control handle by a single break cord. The cord breaking force shall be 135 ±10 pounds for each ejection control handle. Tethering or restraining of the legs shall be provided only when such devices are an integral part of the system design.

4.5.5 Center of gravity variations. Crew module and ejection seat system static, track, and flight tests shall be conducted under those simulated service weight conditions which have been determined to be most critical for center of gravity/rocket thrust alignment. The contractor shall tabulate the proposed most critical center of gravity variations giving reasons for each selection. The procuring activity, however, will make the final decision on the configuration to be tested.

5. DETAIL REQUIREMENTS

5.1 System integration tests

5.1.1 Ejection and extraction seat system integration tests. The system integration test shall validate operational compatibility of the crewmember equipped with survival kit, parachute, and the associated restraint system and personal leads with composite disconnect interfaces. These tests shall be as follows:

a. Ejection control linkage tests. Demonstrate the functioning and operation of the mechanical linkage from the ejection control to the actuation of system-sequenced, propellant-actuated devices. Verify the proper sequencing of multiplace escape systems if included in the vehicle.

b. Adequacy of component performance. Demonstrate and individually determine the adequacy of all system components to perform as specified herein (e.g., demonstrate the adequacy of the restraint system to properly restrain the crewmember in the ejection position, etc).

c. Functioning of the manual egress handle. Evaluate positive functioning of the ejection or extraction seat's emergency egress handle to automatically release of the man from the seat for ground emergency conditions.

d. Tripper mechanism. Verify proper functioning of escape system tripper mechanisms as the seat is raised up the rails.

e. Services disconnect. Demonstrate adequacy of the seat services disconnect adapters while the seat is being raised and verify positive actuation of the emergency bailout oxygen supply.

f. Ejection distress signal. Demonstrate adequacy of the mechanical system that actuates the emergency bailout distress signal and actuated, if installed, the chaff dispersal system.

g. Seat/man separation. Evaluate the functioning and time sequencing of the restraint system release and seat/man separation.

h. Parachute actuation. Demonstrate adequacy of parachute deployment actuation.

5.1.2 Crew module system integration tests. The following demonstrations shall be completed to show that the escape system is compatible with the aircraft design:

a. Demonstration of all system manual operations. This demonstration shall include all crewmember operations required for preflight, flight, post-flight, and escape and survival. The complete sequence of functions shall be completed with 12 different crewmembers using the final configuration of the production hardware. The demonstration shall include all equipment to be worn or used by the crewmember during flight, escape, and survival.

b. Demonstration of compatibility of the escape system with other subsystems and surrounding structures. This test shall demonstrate that subsystems and components of the escape system which only assume their true configuration and function upon assembly of the complete aircraft will provide the required performance after that integration when using production hardware. A minimum of 10 simulated operational tests shall be accomplished on each item covered by the preceding description.

5.2 System static tests

5.2.1 Ejection and extraction seat system static tests. Ground firing of the escape system shall be accomplished for each crew station equipped with an ejection or extraction seat. This test shall be accomplished at least once with the canopy or hatch removed and at least once through the canopy. The tests may be accomplished either from the aircraft or from a suitable jig simulating the aircraft structure. On those aircraft where ejection through the canopy is not feasible due to the type of canopy construction, the seat system shall be fired in such a manner as to demonstrate that the seat will not eject until the canopy has been jettisoned.

5.2.1.1 Procedure. The seat system shall be fired by utilizing the ejection control on the seat. Modifications to the mechanism which do not affect the operation shall be permissible.

5.2.2 Crew module static tests. Two tests shall be conducted from a suitable jig or test vehicle at zero speed. These two tests shall demonstrate that the system is capable of providing a successful escape at zero speed and zero altitude.

5.2.3 Canopy and hatch static tests. Acceptable ground jettisoning of the canopy or escape hatch shall be conducted from a suitable jig simulating the aircraft structure to which the canopy or hatch is attached. The canopy or hatch shall be fired from the fully locked position only and shall be jettisoned by means of the jettison control normally employed by the crewmember. Modifications to the mechanism which do not affect the operation shall be permissible.

5.2.3.1 Ejection and extraction seat canopy or hatch jettison tests. One jettison test shall be conducted for each crew station.

5.2.3.2 Crew module hatch jettison tests. Two jettison tests shall be conducted for each hatch to demonstrate the emergency ground egress capability of the crew module.

5.3 System track tests

5.3.1 Ejection and extraction seat track tests. The escape system shall be tested as follows utilizing the test vehicle:

a. Zero speed tests. In addition to the tests of 5.2.1, two tests shall be conducted from the test vehicle at zero speed. These tests shall demonstrate that the system is capable of providing successful escape at zero speed and zero altitude.

b. Single crew station test. For aircraft with only one crewmember, a minimum of 18 tests shall be conducted. Four tests each shall be conducted at minimum and maximum speed. The remaining ten tests shall be conducted at intermediate speed conditions which shall provide maximum data on escape system performance.

c. Multicrew station tests. The tests required by 5.3.1(a) and (b) shall be accomplished for each added crew station. The sequence of tests between crew stations is to be proposed by the contractor but will require approval of the procuring activity.

d. Blast protection. For the tandem configuration and the side-by-side configuration, the tests of 5.3.1(c) shall demonstrate that ejection of the first crewmember will not injure the other crewmember. One test shall be at minimum flight speed and the other at maximum speed for each configuration.

5.3.1.1 Procedure. The seat system shall be fired by direct actuation of the firing mechanism or by operation of the normal ejection firing control. Provisions shall be made for automatic operation of the post-ejection equipment normally provided for the crewmember.

5.3.1.2 Canopy and hatch jettison tests. Canopy and hatch jettison tests shall be conducted in conjunction with all the escape system tests in 5.3.1.

5.3.2 Crew module system track tests. In addition to the two zero speed tests of 5.2.2, six track tests shall be conducted utilizing the test vehicle. Two track tests shall be conducted at minimum flight speed, two at maximum speed (V_L), and two at intermediate speed with regard to dynamic pressure.

5.4 Crew module flight tests. The contractor shall prepare a proposed flight test program, of a minimum of eight tests to demonstrate that the system will operate successfully under altitude, air density, mach number, etc, variations. These tests shall demonstrate that the system meets the minimum allowable escape system performance requirements when subjected to the above variables. Where feasible, the contractor's flight test program shall provide a test vehicle that is aerodynamically equal to the weapon system that is to use the escape system. The flight test program will require the approval of the procuring activity, especially with regard to test points in the critical corners of the performance envelope for the weapon system.

5.5 Reliability

5.5.1 Ejection or extraction seat system reliability. The seat system shall have demonstrated a minimum reliability of 90 percent at the 90 percent lower confidence limit after successful completion of the 22 consecutive total seat system tests in accordance with 5.2.1 and 5.3.1 for each separate crew station-escape system configuration. The failure of any one test shall require the rerun of the series from the beginning to demonstrate the reliability of the complete system. A failure of the instrumentation shall not be construed as requiring rerun of the tests.

5.5.2 Crew module system reliability. The requirements of 5.2.2 and 5.3.2 call for eight tests of the complete escape system under various test conditions. These eight tests must be consecutively successful, and the failure of any one test shall require the rerun of the series to demonstrate a minimum reliability of integration with the weapon system of 75 percent at the 90 percent lower confidence limit for the complete system. A failure of the instrumentation shall not be construed as requiring rerun of the tests.

5.5.3 Previously qualified ejection or extraction seats. Escape systems previously qualified to MIL-STD-846 shall be subjected to an additional eight consecutively successful tests as the minimum for each crew station in the weapon system. These compatibility tests shall demonstrate a minimum reliability of integration with the weapon system of 75 percent at the 90 percent lower confidence limit. The escape system program shall be in accordance with those requirements specified for the initial seat qualification test program with the exception that a minimum of eight system tests shall be accomplished in lieu of 22 system tests. The eight system track tests shall be in accordance with 5.3.1, 5.3.1.1, and 5.3.1.2. The two zero speed tests in 5.3.1(a) shall include one through-the-canopy ejection if permitted by the aircraft canopy design. In 5.3.1(b), six track tests (two each at low speed, intermediate speed, and high speed) shall be conducted.

5.6 Summary of test requirements. A summary of the minimum escape system test requirements is given in table I.

Custodian:
Air Force - 11

Review activities:
Air Force - 82, 84

Preparing activity:
Air Force - 11

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