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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Provides a method of evaluating the safety of mines and demolitions during development testing. Covers inspections and tests for adequacy of safety features; confirmation of functioning loads; sensitivity to accidental detonation during emplacement, arming, disarming, and recovery; safety during transportation including secured cargo vibration, rough handling, and 12.2-meter drop; and effects of high- and low-temperature storage on functioning. Not applicable to chemical mines.

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

DRSTE-RP-702-103
*Test Operations Procedure 4-2-502 5 May 1978
AD No.

# SAFETY EVALUATION OF MINES AND DEMOLITIONS



1. SCOPE. This TOP provides general procedures for evaluating the safety of mines and demolitions during developmental testing. The procedures are not applicable to chemical mines.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

| ITEM | REQUIREMENTS |
|---|---|
| Detonation site | A site with suitable barricades and operational shields designated and located as prescribed by range control unit |
| Temperature chamber | To condition test items to temperatures ranging from 68.3° to -51.1° C (155° to -60° F) |
| Laboratory vibration exciter | As described in TOP 1-1-050 |
| Drop test facility | As described in TOP/MTP 4-2-601 |

*This TOP supersedes MTP 4-2-502, 8 September 1970.

| ITEM (Cont) | REQUIREMENTS (Cont) |
|---|---|
| Package tester | As described in TOP 4-2-602, appendix D |
| Industrial X-ray facility | For radiographic inspections of test items for conformance to specifications |
| Operating equipment | Recovery vehicles and equipment with remote controls for disarming and recovery of live test items |
| Electromagnetic radiation facilities | As described in TOP 1-2-511 |

2.2 Instrumentation.

| ITEM | MAXIMUM ERROR OF MEASUREMENT |
|---|---|
| Timing device | Arming delay time to +5 sec or 1% of the delay time, whichever is less |
| Electromagnetic radiation instrumentation | As described in TOP 1-2-511 |
| Meteorological equipment: | |
| Windspeed | 0 to 44.7 m/s ±0.8 m/s |
| Wind direction | 360° ± 3° |
| Ambient temperature | -35° to +50° C ±0.2° C |
| Relative humidity | 5% to 100% RH ±1% |

*Values may be assumed to represent ±2 standard deviations; thus the stated tolerances should not be exceeded in more than 1 measurement out of 20.

3. PREPARATION FOR TEST.

3.1 Planning.

a. Review the safety statement (provided in accordance with DARCOM-R 385-12 and TECOM Suppl 1) 1/ and all previous test reports of similar or related items.

b. Assemble information on the physical characteristics of the item (TOP/MTP 4-2-500) and its expected modes and areas of deployment.

1/ DARCOM-R 385-12 with TECOM Suppl 1, Life Cycle Verification of Materiel Safety.

c. Review all system safety analyses prepared by the developer or manufacturer (DARCOM-P 385-23, ch 6) [2] to determine whether any potential hazards have been identified which involve field employment of the item or which require special attention during testing. If a formal system safety analysis has not been accomplished, initiate one as required by applicable paragraphs of MIL-STD-882A [3]. The assembly information must include a complete description of the system and system operation. Special procedures for handling and operation must be identified. Preliminary safety tests of components such as fuzes (MIL-STD-331A) [4] and tests to determine the explosive hazard classification (TB-700-2) [5] must be completed.

d. Based on the information assembled above, plan a comprehensive testing program to demonstrate the safety of the test item or to identify any features or conditions of use that could cause injury to personnel or damage to materiel. The plan must include the following essential features:

(1) Preliminary examinations and limited tests necessary to certify, through a safety release in accordance with DARCOM-R 385-12, that the item is safe for further testing. Performance tests appropriate for this phase are described in paragraph 5.

(2) Selected physical performance and reliability tests to verify that the item under test satisfies minimum design and construction requirements for safe field deployment. Tests required are selected from TOP 4-2-505, Mines and Demolitions, based on the purpose and characteristics of the system under test, and an analysis of possible failure modes. They may include any or all of the following tests:

| | |
|---|---|
| High humidity | Sand and dust |
| Fungus resistance | Solar radiation |
| Salt spray (fog) | Immersion |
| Rain | Weathering |
| Bullet impact | Blast and sensitivity |
| External heat | Detonation propagation |
| Corrosion | Electrostatic discharge |
| Exudation and growth | Compatibility with standard materials |
| Determination of critical diameter | |

(3) Systematic observations and analyses of the test system throughout all phases of development testing to identify and investigate any actual or potential hazards to personnel and equipment that may result from storage or handling and employment of the item under field conditions. Record any specific information required to update the system safety analysis.

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2/ DARCOM-P 385-23, System Safety.

3/ MIL-STD-882A, System Safety Program for Systems and Associated Subsystems and Equipment, Requirements for.

4/ MIL-STD-331A, Fuse and Fuse Components, Environmental and Performance Tests for.

5/ TB 700-2, Explosives Hazard Classification Procedures, 19 May 1967.

e. Prepare a test operations checklist using the guide in the appendix but covering specifics for the test item and situation.

f. Prepare data collection sheets to collect the data required for the particular item under test.

3.1.1 Sample Size. The selection of an acceptable sample size for safety testing will depend on the characteristics of the test item and the experimental data available on its expected performance. The minimum sample size will be based on requirements and test item cost consideration. Further guidance on sample size selection for significant results is in TOP 3-1-002.

3.1.2 Extreme-Temperature Limits. Mines and demolitions are generally tested for safe handling and functioning at air temperatures up to 68.3° C or other temperature that may have been experimentally determined or which was specified. This is a hot soak temperature equivalent to the upper extreme that the item will experience in service. The assumption is made that mines and demolitions must be safe for handling and emplacement at the high air temperatures and direct sunlight occurring in hot-dry areas (AR 70-38) [6/] since most mines are now emplaced on the surface of the ground and are subject to the severest temperature and solar radiation conditions. The above temperature, 68.3° C, is an experimentally determined temperature for ammunition in general and may vary for specific types of mines.

Mines and demolitions intended for unrestricted worldwide application are tested down to an air temperature of -51.1° C. This temperature limit may be modified if requirements documents restrict the areas of intended deployment. For safety evaluation purposes, the test temperatures used when the requirement specifies the intermediate-cold or cold climates of AR 70-38 are those occurring in one climatic category colder than the specified category of deployment; i.e., -45.5° C for intermediate-cold areas and -51.1° C for cold areas.

3.2 Test Items.

a. Select test items and components manufactured as single lots.

b. Select inert or minimum charge items when they will not compromise the evaluation.

c. Inspect all test items and components for damage, deterioration, and obvious manufacturing defects prior to testing.

d. Examine and compare the physical dimensions of at least one item with drawing requirements. Check the fit of components, especially arming pins, clips, or other parts involved in performing the arming operation.

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6/ AR 70-38, Research, Development, Test, and Evaluation of Materiel for Extreme Climatic Conditions.

e. Number each test item and key the numbering system to any inspection records furnished by the manufacturer.

f Make operability checks of electrically initiated components that do not contain explosives.

g. X-ray all explosive-filled test items and examine for defects or deviations from specifications.

h. Record the following data for the test item and its ancillary equipment, as applicable:

(1) Nomenclature, model and serial numbers.

(2) Manufacturer.

(3) Accessories and tools supplied.

(4) Noted material discrepancies.

3.3 Personnel. Familiarize test personnel with the technical and operational characteristics of the test item, as described in the applicable technical manuals, requirements documents, or manufacturer's literature. Review any special warnings prepared by the developer and all safety SOP's before commencing the safety evaluation.

4. TEST CONTROLS.

a. Observe all range and facility safety SOP's throughout testing.

b. Conduct tests at ambient temperature (10° to 32° C) unless otherwise specified. When extreme-temperature conditioning is required, follow the temperature limitations of paragraph 3.1.2.

c. Ensure that the safety evaluation is planned, conducted, and reported by engineering personnel who are occupationally qualified in the safety of the specific commodity under test.

5. PERFORMANCE TESTS.

5.1 Adequacy of Safety Features. Test for effectiveness and reliability the method employed to render the test item safe for handling and emplacement. Procedures will vary depending on whether the method is mechanical in nature or involves a pneumatic, hydraulic, electrical, magnetic, or chemical principle. Common external devices include cotter pins, clips, keys, collars, and other locking arrangements that prevent movement of working parts. Safety is enhanced for some items by delay arming in which a timing mechanism or electrical device triggers the final arming action of the test item after a predetermined delay by removing a barrier place in front of the firing pin, repositioning an

out-of-line detonator, or completing an electrical circuit. Mass scatterable mines usually employ both sequential and delay arming features in which a particular sequence of operations or events must take place before delay arming is initiated.

5.1.1 Method.

5.1.1.1 Live and Inert Items With Live Armed Fuzes.

a. For items that are functioned by an external load, apply a load in excess of that required, with the safety device in place. The size of the overload will depend on the item; generally, the less the functioning load the greater the percentage overload.

b. In the case of items that employ multiple or sequential arming features, use a logical, step-by-step approach to ensure that all safety mechanisms, both internal and external, are performing properly.

c. Check delay arming features by attempting to function a sample of items immediately before the lower limit of the delay time tolerance is reached.

5.1.1.2 Live and Inert Items With Live Unarmed Fuzes. Check items designed to be initiated by influences other than mechanical load by exposing the unarmed fuze or initiator to the type of influence required (e.g., inertial force, acoustic signal, magnetic influence, seismic vibrations), at levels that would function the armed item 100 percent of the time.

5.1.1.3 Live Items Without Fuzes. Check safety features in the main body of a mine or demolition device by subjecting items without fuzes to the vibration, rough handling, and 12.2-meter drop tests described in paragraph [illegible].

5.1.2 Data Required. Record whether or not the safety feature can be overriden or whether the test item can be inadvertently detonated.

5.2 Confirmation of Functioning. Conduct functioning tests to ensure that the [illegible] activation employed will function the item within the ranges [illegible] specified.

5.2.1 Method.

a. Modify at least three test items to simulate a detonation by replacing explosive components with a harmless indicator such as a flashbulb.

b. For items that are functioned by an external load, place successively heavier weights in increments of approximately 1% of the

anticipated functioning load on each test item until an indication of functioning is obtained. For items that are functioned by influences other than external load (such as magnetic influence, acoustic signal, or seismic vibrations), expose the item to increasing levels of the required influence.

c. Repeat the procedure at least five times for each item.

d. Where temperature extremes may alter the functioning of a design significantly, obtain measurements at these extremes (para 3.1.2).

5.2.2 Data Required.

a. Weight or level at which each test item functions during each trial.

b. Air temperature at which each trial is performed.

5.3 Special Sensitivity Tests. Evaluate all new mines and demolitions for hazards to personnel during emplacement and, except for mass scatterable mines, recovery. Mass scatterable mines are not considered recoverable since they employ a self-destruct feature that detonates the mine after a predetermined time period. All test items are inherently dangerous, but they must not be hazardous before final arming or after either the first disarming operation or expiration of the self-destruct period, whichever is applicable. The possibility of an unwanted detonation during arming, disarming, or before the self-destruct period expires must also be considered.

5.3.1 Method.

a. Design and conduct simulated field trials on a sample of items to identify and investigate any hazardous conditions that may occur during the emplacement, arming, and recovery (when applicable) of the test item under all expected circumstances. If appropriate, identify all potential hazards through a fault-tree analysis as described by Hammer. 7/ Determine whether the item is initiated when tripped, bumped, dropped short distances, or otherwise disturbed while armed. Also evaluate hazards associated with the disarming and recovery of items that have been emplaced for an extended period of time. For these tests, as many components as possible should be inert.

b. Design and conduct special test phases to determine the severity of each possible accident that could result from the hazardous conditions identified. Estimate from test data the risk of each accident's occurring during normal accomplishment of these operations as well as during inadvertent mishandling.

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7/ Hammer, Willie, Handbook of System and Product Safety, Prentice-Hall, Englewood Cliffs, NJ, 1972.

c. Items containing electric initiators may be susceptible to spontaneous functioning because of electromagnetically generated current. The procedure for conducting an electromagnetic radiation hazards test is contained in TOP 1-2-511.

5.3.2 Data Required.

a. Ambient air temperature and relative humidity.

b. Type of soil.

c. Conditions of soil.

d. Functioning failure indications.

e. Functioning hazards during emplacement, arming, disarming, etc.

f. Susceptibility to detonation by transient electromagnetic signals.

5.4 Transportation Tests. Plan the tests for the safety of mines and demolitions during transportation according to the expected conditions of shipment and handling. Mines that are shipped separately from the fuzes require separate 12.2-meter drop tests and secured-cargo vibration tests for each component. Mines that may be transported on the back of a truck with the fuzes in place but unarmed are subjected to loose cargo tests in this condition. On the other hand, the safety evaluation of mines that are not assembled with fuzes until the mine is on the ground ready for burial should simulate this condition. Perform the following tests with locking or safety device oriented in the most severe load position.

5.4.1 Secured-Cargo Vibration. Conduct a secured cargo vibration test to simulate the transport of packaged items by rail, air, ship, truck, or trailer.

5.4.1.1 Method

a. Subject a portion of the items to be tested for safety to a laboratory vibration test simulating the mode of transportation that the test item is likely to encounter in use. Condition 20 test items to 68.3° C and 10 test items to -51.1° C (para 3.1.2). Securely fasten the test items in their shipping configuration to the vibrator and vibrate in two planes. Schedules of vibration rates and durations are in TOP 1-2-611. Laboratory vibration techniques are discussed in TOP 1-1-050.

b. Following vibration, inspect the items externally and by X-ray as appropriate and function them at the conditioned temperatures

5.4.1.2 Data Required.

a. Collect prefunctioning test data in accordance with TOP 1-2-601.

b. For functioning tests record the following as applicable:

(1) Date and time of functioning.

(2) Temperature of test item, air, and soil.

(3) Type and condition of soil.

(4) Any difficulty encountered in handling, assembling, emplacing, or arming the items.

5.4.2 Rough Handling. Conduct rough handling tests to simulate the severe shocks, bumps, and drops that an item may receive when thrown loosely on the bed of a truck, dropped from a tailgate, or dropped while being assembled or emplaced.

5.4.2.1 Method. Subject a sample of test items to a sequence of rough handling tests in accordance with TOP 4-2-602. These tests consist of packaged drops from 2.13 meters, a loose cargo test in the configuration(s) in which issued to troops, and unpackaged 1.5 or 2.1-meter drops. Inspect all items, assess any damage, and function the items considered acceptable.

5.4.2.2 Data Required. Collect data in accordance with TOP 4-2-602 and paragraph 5.4.1.2b.

5.4.3 12.2-Meter Drop. Test packaged explosive items for their ability to sustain a 12.2-meter drop (simulating an accidental drop during ship loading or unloading) without detonation or other hazard to personnel and facilities.

5.4.3.1 Method. Conduct 12.2-meter drop tests in accordance with TOP MTP 4-2-601. The test samples are not fired after these tests since the performance criterion is that the samples must be safe for handling and disposition after drops.

5.4.3.2 Data Required. Collect data in accordance with TOP MTP 4-2-601

5.5 Storage Tests.

5.5.1 Method. Store packaged and loose test items at temperatures that simulate the climatic environment of their intended deployment and then function the items to evaluate the effect of storage on item functioning. Conduct the desert storage phase following the 7-day, high temperature low-humidity cycle of TOP MTP 4-2-820. For cold temperature storage, soak the test items for 3 days at -51.1° C. A test sample size of five is normally exposed at each temperature extreme, but the number may vary depending on packaging configuration.

5.5.2 Data Required. Collect data in accordance with TOP/MTP 4-2-820 and paragraph 5.4.1.2b.

6. DATA REDUCTION AND PRESENTATION.

a. Tabulate all data and compare with performance and safety criteria for the specific product under test.

b. Based on data recorded during preliminary safety tests, prepare a safety release recommendation for submittal to TECOM.

c. Assemble and summarize all test results and safety information generated during the preliminary safety tests conducted in accordance with this TOP and the performance tests conducted as described in TOP 4-2-505. Assign the proper category of hazard level for each hazard identified. Report hazard level (MIL-STD-882) and classification (deficiency, shortcoming, etc.) in accordance with DARCOM R 700-38 (para 4f) and TECOM Supplement 1. 8/ Report the conditions of use under which each hazard was observed and describe any features that require further investigation, including any hazards that could occur or increase as a result of increased storage or emplacement times. Describe (narratively) all hazards identified and recommend actions required to eliminate or avoid each potential hazard.

d. Update the system safety analysis in accordance with DARCOM-P 385-23, if necessary.

Recommended changes to this publication should be forwarded to Commander, U. S. Army Test and Evaluation Command, ATTN: DRSTE-AD-M, Aberdeen Proving Ground, MD 21005. Technical information may be obtained from the preparing activity: Commander, U. S. Army Aberdeen Proving Ground, ATTN: STEAP-MT-M, Aberdeen Proving Ground, MD 21005. Additional copies are available from the Defense Documentation Center, Cameron Station, Alexandria, VA 22314. This document is identified by the accession number (AD No.) printed on the first page.

8/ DARCOM-R 700-38 with TECOM Suppl 1, Test and Evaluation - Incidents Disclosed During Materiel Testing.

## APPENDIX
## CHECKLIST GUIDE FOR SAFETY EVALUATION OF MINES AND DEMOLITIONS

| ITEM | YES | NO | NA |
|---|---|---|---|
| 1. All operating personnel briefed on test requirements, special procedures, hazards, and any unusual aspects of test. | | | |
| 2. Test items inspected, available, and numbered. | | | |
| 3. Electrically initiated components that do not contain explosives checked for operability. | | | |
| 4. All instrumentation calibrated, properly installed, and operational. | | | |
| 5. SOP* requirements satisfied. | | | |
| 6. Required data recorded. | | | |

*SOP 385-107 at APG

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