NORTH ATLANTIC TREATY ORGANIZATION
ORGANISATION DU TRAITE DE L'ATLANTIQUE NORD

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19 February 2001

See CNAD AC/310 STANAG distribution

STANAG 4490 (EDITION 1) - EXPLOSIVES, ELECTROSTATIC DISCHARGE SENSITIVITY TEST(S)

Reference:
AC/310-D/155, dated 23rd February 1998.

1. The enclosed NATO Standardization Agreement which has been ratified by nations as reflected in page iii is promulgated herewith.

2. The reference listed above is to be destroyed in accordance with local document destruction procedures.

3. AAP-4 should be amended to reflect the latest status of the STANAG.

ACTION BY NATIONAL STAFFS

4. National staffs are requested to examine page iii of the STANAG and, if they have not already done so, advise the Defence Support Division through their national delegation as appropriate of their intention regarding its ratification and implementation.

Jan H ERIKSEN
Rear Admiral, NONA
Chairman, MAS

Enclosure:
STANAG 4490 (Edition 1)

STANAG No. 4490
(Edition 1)

NORTH ATLANTIC TREATY ORGANIZATION
(NATO)

MILITARY AGENCY FOR STANDARDIZATION
(MAS)

STANDARDIZATION AGREEMENT
(STANAG)

SUBJECT: EXPLOSIVES, ELECTROSTATIC DISCHARGE SENSITIVITY TEST(S)

Promulgated on 19 February 2001

Jan H ERIKSEN
Rear Admiral, NONA
Chairman, MAS

RECORD OF AMENDMENTS

No.	Reference/date of amendment	Date entered	Signature

EXPLANATORY NOTES

AGREEMENT

1. This NATO Standardization Agreement (STANAG) is promulgated by the Chairman MAS under the authority vested in him by the NATO Military Committee.

2. No departure may be made from the agreement without consultation with the tasking authority. Nations may propose changes at any time to the tasking authority where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

DEFINITIONS

4. Ratification is "In NATO Standardization, the fulfilment by which a member nation formally accepts, with or without reservation, the content of a Standardization Agreement" (AAP-6).

5. Implementation is "In NATO Standardization, the fulfilment by a member nation of its obligations as specified in a Standardization Agreement" (AAP-6).

6. Reservation is "In NATO Standardization, the stated qualification by a member nation that describes the part of a Standardization Agreement that it will not implement or will implement only with limitations" (AAP-6).

RATIFICATION, IMPLEMENTATION AND RESERVATIONS

7. Page (iii) gives the details of ratification and implementation of this agreement. If no details are shown it signifies that the nation has not yet notified the tasking authority of its intentions. Page (iv) (and subsequent) gives details of reservations and proprietary rights that have been stated.

FEEDBACK

8. Any comments concerning this publication should be directed to NATO/MAS - Bvd Leopold III 1110 Brussels - BE

STANAG 4490
(Edition 1)

NAVY/ARMY/AIR

NATO STANDARDIZATION AGREEMENT (STANAG)

EXPLOSIVES, ELECTROSTATIC DISCHARGE SENSITIVITY TEST (S)

Annexes:

A - Explosives, Small Scale Electrostatic Discharge Sensitivity Test
B - Explosives Large Scale Electrostatic Discharge Sensitivity Test

Related documents: None

AIM

1. The aim of this agreement is to standardise the test procedure to provide information on the electrostatic discharge sensitivity of explosive materials.

AGREEMENT

2. Participating nations agree to distinguish spark tests and large scale electrostatic discharge test, for determining the electrostatic discharge sensitivity of explosive materials.

3. Spark Tests. Participating nations who have ratified this STANAG agree on the following:

a. The test data obtained from these tests are specific and dependent on the test apparatus and environment,

b. Historically, the data produced in each country performing such tests are satisfactory and in-so-far as possible simulate the electrostatic energy that can be produced by humans, so there is no need to standardize the equipment.

c. Such data are required for qualification and will have to be provided by using the data exchange formats described in Annex A, as well as reference data.

4. The Large Scale Test for Sensitivity to Capacitive Discharge. Participating nation agree to accept one test as standard procedure and to use the data exchange formats as provided in Annex B. Such data is required for qualification of explosive materials at ambient temperature and, if relevant, in temperature conditions corresponding to use in operation (Note: the sensitivity of explosive materials is known to increase when temperature is decreased).

GENERAL

BACKGROUND INFORMATION

5. Most of ESD (electrostatic discharge) tests used at this time are "spark tests" that use small quantities of material and simulate the discharge through such material by charged humans or metallic pieces. Such tests do not provide the information required to explain accidents such as:

a. accidental ignition of missiles during their handling due for instance to electrostatic sensitivity of the energetic material at low temperature,

b. accidental ignition of rocket motor loadings during the production process (handling, mandrel extraction).

6. Such accidents are the result of charging of surfaces made from poorly conducting materials (plastics) in contact with explosive substances. These explosive substances may then be charged to a potential where breakdown occurs. This can lead to arcing and catastrophic accidental ignition.

7. This illustrates the fact that the "spark tests" performed with about 100 mg samples are not useful regarding this issue, and the need to adopt a "large scale ESD test", which must be standardized.

IMPLEMENTATION OF THE AGREEMENT

8. This STANAG is implemented when a nation has issued the necessary orders/instructions putting the contents of this agreement into effect.

EXPLOSIVES, SMALL SCALE ELECTROSTATIC DISCHARGE SENSITIVITY TEST

As indicated in paragraph 2, concerning the agreement, there is no standardised equiment for this test. Each participating nation will use its national test described in AOP-7.

NATO STANAG 4490 DATA SHEET Report Reference Number: (Unique Reference Number) Page __ of __Page(s)	
TEST SITE INFORMATION	**TEST CONDITIONS**
Laboratory: (Name of Laboratory) Date: (Date that form was completed) Test Procedure used: Title: AOP 7 Number: National references: Date Tested: (Date of test period) POC: (Point of contact)	Temperature (°C): Relative humidity (% HR): Upper electrode: Lower electrode: Distance between electrodes: Sample holder (confinement): Voltage: Capacitance: Line resistance: Other conditions:
SPECIMEN INFORMATION Identification of Explosive: (Trade name and/or Identity code) Manufacturer: (Name of Manufacturer) Lot, Batch or Consignment Number: Date of Manufacture or Receipt:	**RESULTS** Results of explosive tested:
SAMPLE STATE AND PREPARATION Physical state: Particles size: Density: Temperature and humidity conditioning: Moisture content:	Results with comparison explosives: Tetryl: RDX: PETN:

EXPLOSIVES, LARGE SCALE ELECTROSTATIC DISCHARGE SENSITIVITY TEST

1. SCOPE

This method may be used for the characterization of electrostatic discharge sensitivity of energetic materials such as non conductive high explosives, rocket motor and gun propellants. It is not applicable to primary explosives and pyrotechnics. If required it can be used to evaluate the influence of temperature on this sensitivity (generally the sensitivity is increased at low temperature).

2. PRINCIPLE

An unconfined sample of explosive material is submitted to a sequence of capacitive discharges with energy 15,6 Joules. The explosive material is sandwiched between a conical positive electrode and a negative plane electrode. A schematic of the apparatus is presented in figure 1. After each discharge the explosive material behavior is noted. Consecutive discharges are then repeated up to explosive reaction, or up to 30 discharges.

3. APPARATUS

3.1 High voltage supply

The high voltage is supplied to the positive electrode by a system of switched capacitors with the following features:

- high voltage power supply unit (PSU): 30 kV;
- maximum current intensity: 2mA (obtained with a greater than 15 MΩ resistance);
- capacity: 34.7nF (for instance three capacitors: 4.7, 10 and 20 nF, with independant coupling);
- maximum energy delivered by the capacitors: 15,6 Joules.

This system is operated using a two position switch (see schematic in figure 2).

3.2 Sample

With compact explosive materials (rocket motor propellants, PBX's) the sample is a cylinder with diameter 90 ± 0.5 mm and length 100 ± 0.5 mm.

With granular materials (granular high explosives, gun propellants) the sample is in a PMMA cylindrical container with O.D. 100 mm, I.D. 90 mm and length 125 mm. The material shall completly fill the container without being compacted.

Three samples are needed for a test.

3.3 Electrodes (figure 3)

The negative electrode is a brass disk, with diameter 88 or 110 mm according to the type material, thickness 5 mm, with a brass rod brazed on bottom for connection to earthing cable.

The positive electrode is a brass rod, with diameter 10 mm and length 210 mm. One end is conical (60° angle).

This positive electrode is connected to the high voltage supply with a high voltage copper cable (section 1.34 mm², characteristic impedance 72Ω). The maximum length of the cable is 10 meters.

4. SAMPLE PREPARATION

4.1 With compact materials

- the negative electrode with diameter 110 mm is glued in the bottom of a PMMA box with ID 127 mm (see figure 4), with a silicone resin;
- the sample is painted on one face with a sprayed conductive silver lacquer, (for instance: E-Kote 40 silver conductive paint from Allied Products Corp.);
- the sample is put in the PMMA box, the painted face in contact with the negative electrode;
- a dessicating substance (silicagel or other if not compatible) is dispersed around the sample, with a height of no more than 10 mm;
- a PVC cover with a hole in its center is then put on the PMMA box;
- the box is then conditioned during 15 to 20 hours at 20 ± 2°C, or at another temperature if specified (Relative Humidity is not necessarily controlled).

Note: Pressed samples should be tested at the density that will be used in service.

4.2 With granular materials

- the negative electrode with diameter 88 mm is glued in the bottom of a PMMA box with ID 90 mm (see figure 4);
- the sample (approximatly 636 cm3) is put in the PMMA box, at its bulk density;
- the PVC cover with a hole in its center is then put on the PMMA box;
- the box is then conditionned during 15 to 20 hours at 20 ±2°C, or at another temperature if specified. Relative Humidity is controlled if required for the type of material tested.

5. TEST PROCEDURE

After conditioning, the PMMA box with negative electrode and sample is put on a holder. The negative electrode is earthed. The positive electrode is put in contact with the sample. The high voltage generation is switched "on" (switch ❶ and ❷ "on") (figure 2) as well as the three capacitors (switch A, B and C "on"). The voltage is gradually increased to 30 kV; the discharge is effected after 5 seconds (switch ❸ "on" during 2 seconds). The more violent event is noted, among the types of reaction described hereafter. In case of reaction F, C or E the test is stopped. Otherwise, discharges are repeated every 5 seconds until a F, C or E result, or up to 30 discharges, in case of no such reactions.

This sequence is repeated with three different samples.

Note: The 5 seconds delay corresponds to five times the time constant τ (τ = RC where R is the resistance behind the transformer and C is the total capacitance; for R = 30 MΩ and C = 34.7 nF then $\tau \approx 1$ second).

This delay may be different according to the resistance R needed for ensuring Imax = 2 mA, according to B 3.1. requirements.

6. TYPES OF REACTION

The sample behavior is noted according to the following:

- no reaction: noted N;
- rising of the cover without flash: noted S;
- rising of the cover with light flash: noted L;
- block fragmentation: noted F;
- combustion: noted C;
- explosion: noted E.

7. REPORTING RESULTS - DATA SHEET

The standard data sheet under which all test information is reported is provided in figure 5.

If after 30 repeated discharges on all the three blocks only type N, no reactions, are observed, then the material is labeled insensitive to electrostatic discharge. For all other types of reactions as listed in section B6, the material is labeled sensitive to electrostatic discharge.

8. TYPICAL RESULTS

- HTPB Propellant (65 - 70 % AP, 18-20 % Al): Sensitive (Type of reaction: C).
- Double base propellant: Not sensitive (Type of reaction: N).
- Cross linked double base propellants: Not sensitive (Type of reaction: N).
- TNT: Not sensitive (Type of reaction: N).

SCHEMATIC OF THE TEST

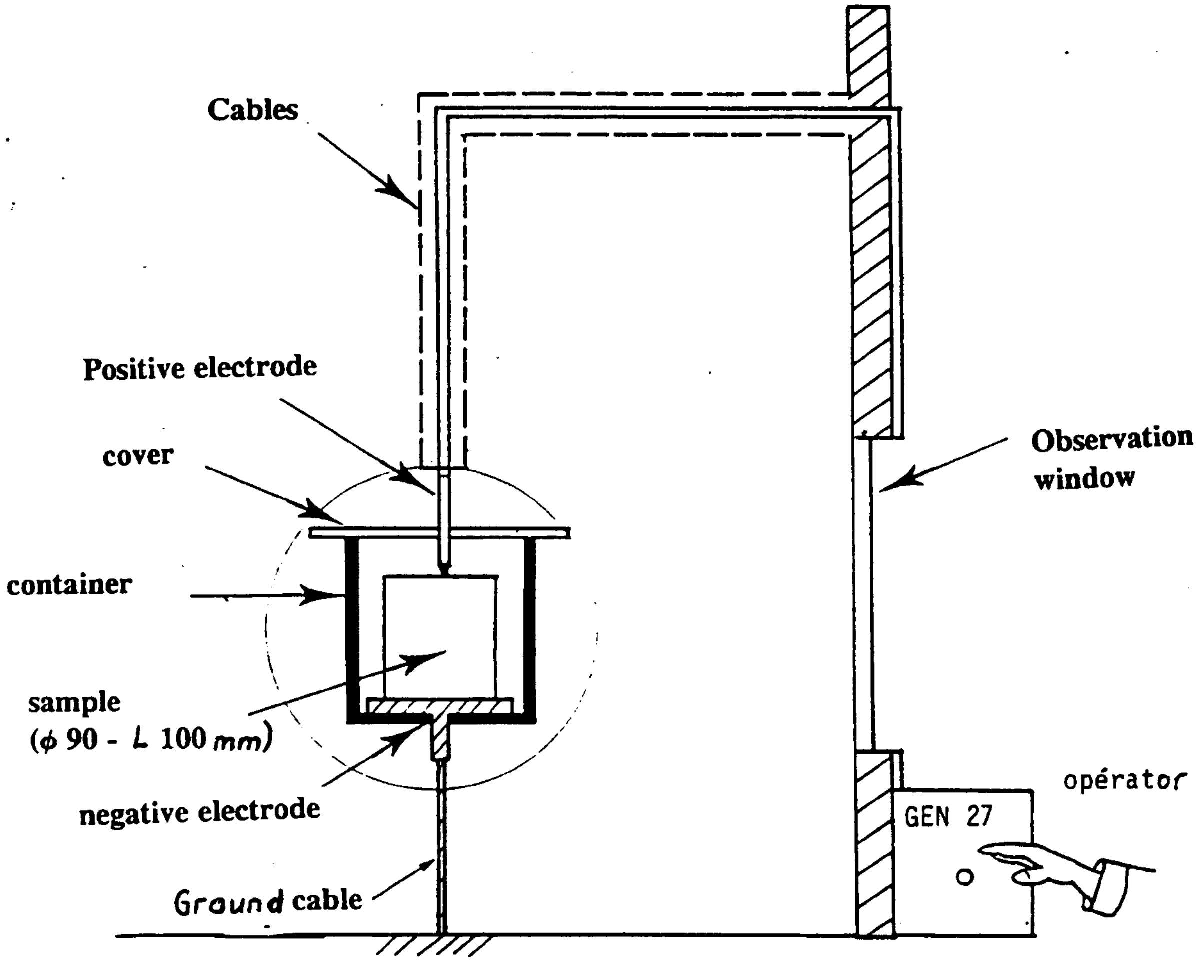

Figure 1

SCHEMATIC OF HIGH VOLTAGE AND DISCHARGE SUPPLY

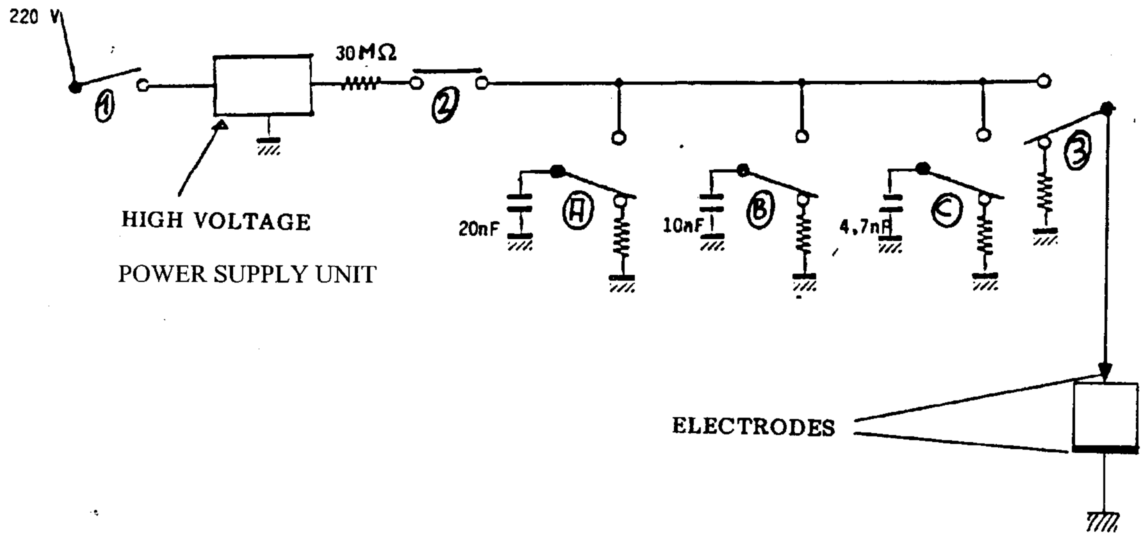

Figure 2

SCHEMATIC OF ELECTRODES

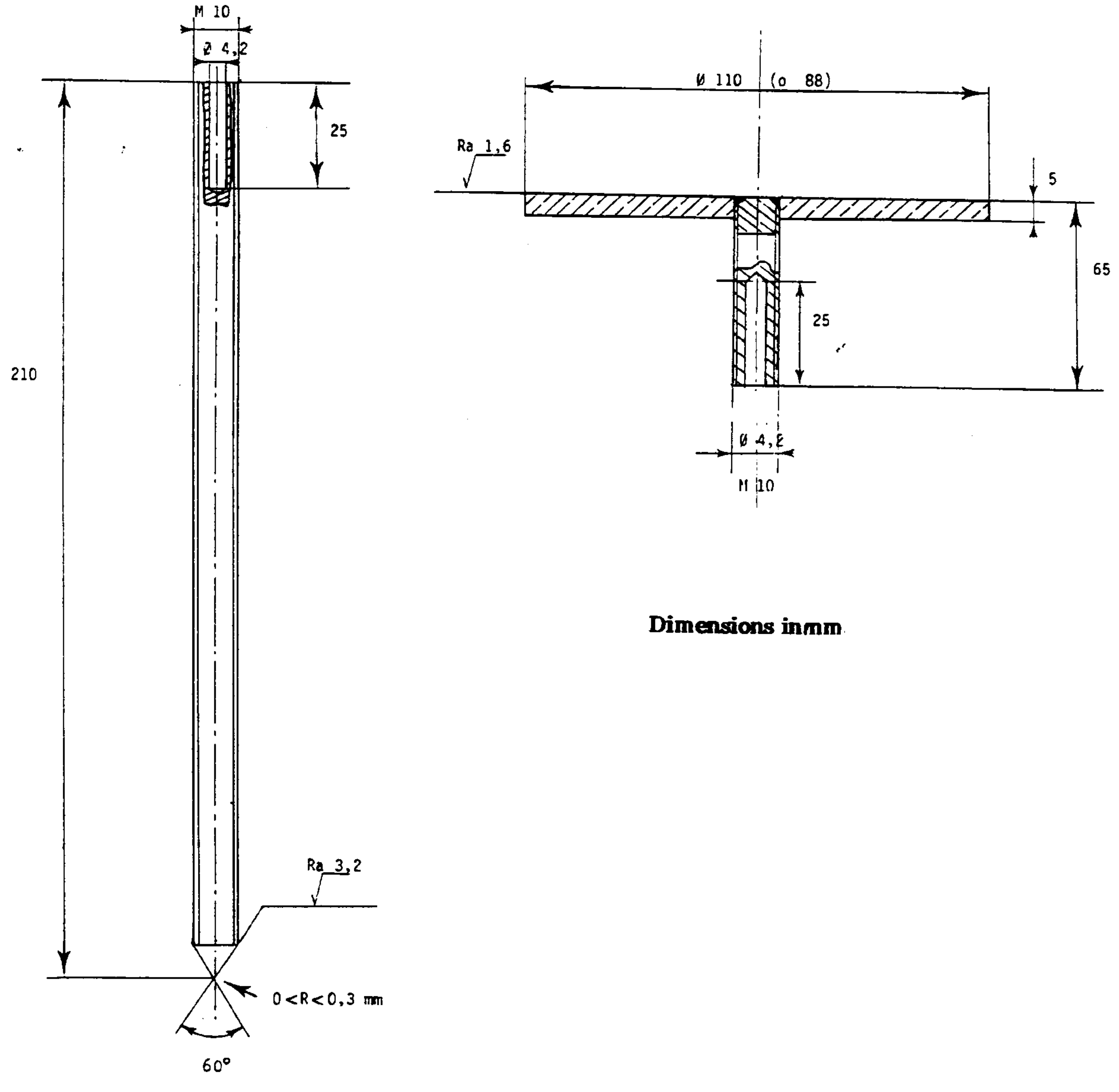

Figure 3

PMMA SAMPLE CONTAINERS

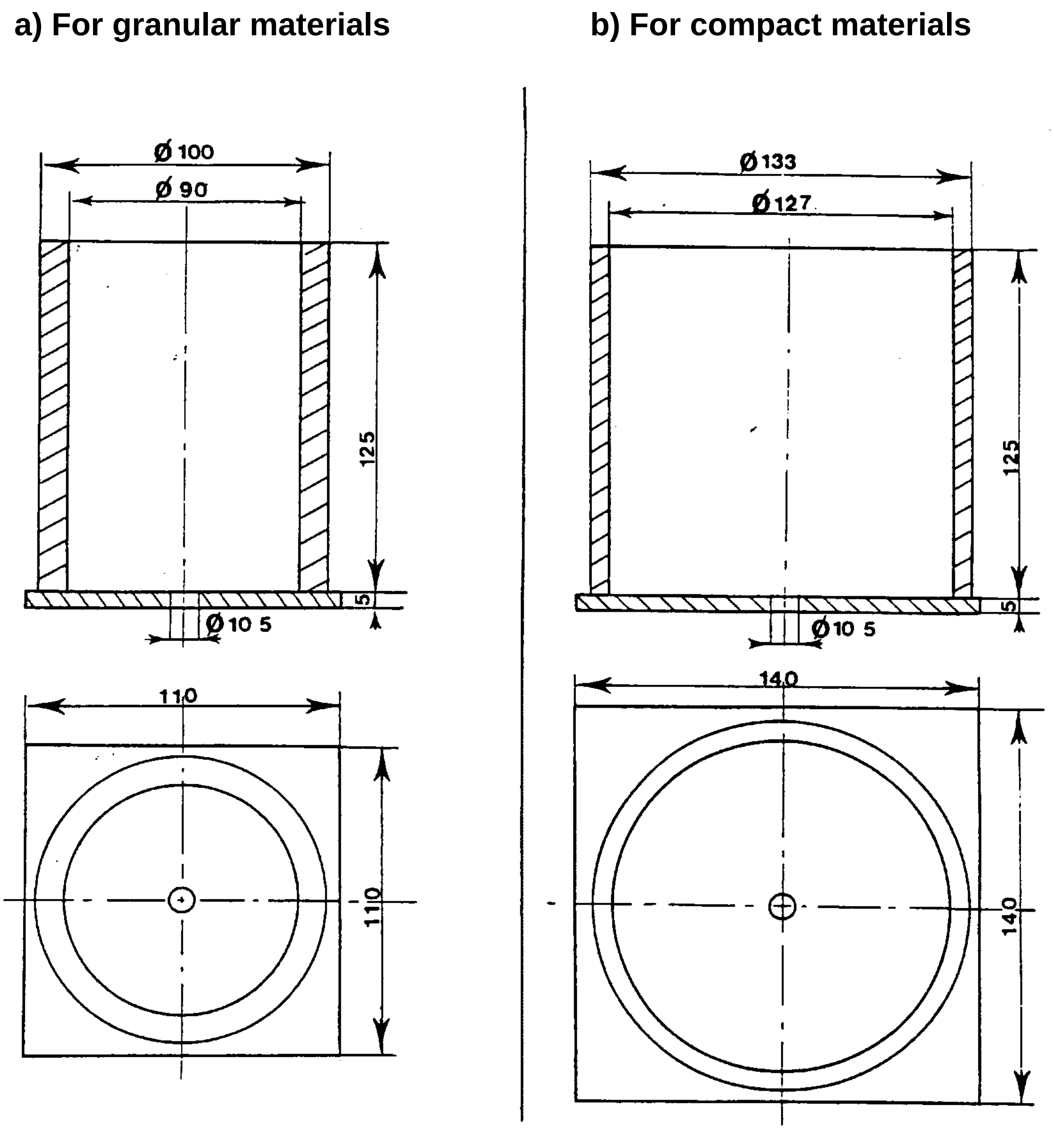

Figure 4

NATO STANAG 4490 DATA SHEET (side A)

Report Reference Number:
(Unique Reference Number) Page __ of __Page(s)

TEST SITE INFORMATION	TEST CONDITIONS
Laboratory: (Name of Laboratory) Date: (Date that form was completed) Test Procedure used: Title: AOP 7 Number: National references: Date Tested: (Date of test period) POC: (Point of contact)	Temperature (°C): Relative humidity (% HR): **RESULTS** - Detailed resultats: (see on side B) . Sample physical state after test: - sample n° 1: - sample n° 2: - sample n° 3: . Discharge number leading to the first event: - sample n° 1: - sample n° 2: - sample n° 3: . Most violent event observed: - sample n° 1: - sample n° 2: - sample n° 3: FINAL RESULT: - sensitive or not sensitive: - most violent event out of the three tests:
SPECIMEN INFORMATION Identification of Explosive: (Trade name and/or Identity code) Manufacturer: (Name of Manufacturer) Lot, Batch or Consignment Number: Date of Manufacture or Receipt:	
SAMPLE STATE AND PREPARATION Physical state: Particles size: Density: Temperature and humidity conditioning: Moisture content:	

Figure 5

NATO STANAG 4490 DATA SHEET (side B)

Page __ of __Page(s)

DETAILED RESULTS

Discharge Number	Sample n° 1	Sample n° 2	Sample n° 3
1			
2			
3			
4			
5			
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