DUS 1756-2:2017

DRAFT UGANDA STANDARD

First Edition
2017-mm-dd

Commercial blasting explosives — Specification — Part 2: Ammonium Nitrate Fuel Oil explosives

Reference number
DUS 1756-2: 2017

Compliance with this standard does not, of itself confer immunity from legal obligations

A Uganda Standard does not purport to include all necessary provisions of a contract. Users are responsible for its correct application

The Executive Director
Uganda National Bureau of Standards
P.O. Box 6329
Kampala
Uganda
Tel: +256 414 333 250/1/2/3
Fax: +256 414 286 123
E-mail: info@unbs.go.ug
Web: www.unbs.go.ug

Contents

Page

Foreword

Uganda National Bureau of Standards (UNBS) is a parastatal under the Ministry of Trade, Industry and Cooperatives established under Cap 327, of the Laws of Uganda, as amended. UNBS is mandated to co-ordinate the elaboration of standards and is

(a) a member of International Organisation for Standardisation (ISO) and

(b) a contact point for the WHO/FAO Codex Alimentarius Commission on Food Standards, and

(c) the National Enquiry Point on TBT Agreement of the World Trade Organisation (WTO).

The work of preparing Uganda Standards is carried out through Technical Committees. A Technical Committee is established to deliberate on standards in a given field or area and consists of key stakeholders including government, academia, consumer groups, private sector and other interested parties.

Draft Uganda Standards adopted by the Technical Committee are widely circulated to stakeholders and the general public for comments. The committee reviews the comments before recommending the draft standards for approval and declaration as Uganda Standards by the National Standards Council.

The committee responsible for this document is Technical Committee UNBS/TC 5, *Chemicals and environment]*

US 1780 consists of the following parts, under the general title *Commercial blasting explosives — Specification*:

- *— Part 1: Emulsion explosives*
- *— Part 2: Ammonium Nitrate - Fuel Oil explosives*
- *— Part 3: Ammonium Nitrate for explosives*
- *— Part 4: Sodium Nitrate for explosives*

Introduction

An explosive is a compound or a mixture of compounds, which when initiated by heat, impact, friction or shock undergoes a very rapid self-propagating exothermic reaction. This reaction produces more stable products, usually gases that exert tremendous pressure as they expand at high temperature.

Explosives can be classified into two broad groups, namely, the industrial explosive and the military explosives. Industrial explosives are also known as commercial explosives and include dynamites, slurries, emulsions and blasting powders. Military explosives are mainly used as ammunition in small arms as well as field guns and rockets. • Slurries consist of saturated aqueous solution of ammonium nitrate and other nitrates which also contain additional amounts of undissolved nitrates in suspension. Fuels are added to the composition in order to take up the excess oxygen of nitrates. Sensitizer in slurries can be monomethylamine nitrate, dispersed air bubbles, aluminium powder, etc.

Commercial blasting explosives — Specification — Part 2: Ammonium Nitrate Fuel Oil explosives

1 Scope

This Draft Uganda Standard specifies requirements, methods of test and sampling of Ammonium Nitrate Fuel Oil explosives

NOTE 1 The requirements of this standard should be read in conjunction with the Act of 1964 cap 309 and/or other applicable regulations

NOTE 2 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use

2 Normative references

The following referenced documents referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

DUS 1776:2017; light metal in hazardous location at mines — Guidelines for use

DUS 1757: 2017; Commercial blasting explosives — Terminology

US ISO 7010: 2011; Graphical symbols — Safety colours and safety signs — Registered safety signs

3 Terms and definitions

For the purposes of this document, the terms and definitions given in DUS 1757 and the following apply.

3.1
fuel oil
any liquid fuel that is burned in a furnace or boiler for the generation of heat or used in an engine for the generation of power

4. Requirements

4.1.1 General requirements

The permitted explosive shall be of a granular material, which is loose and free-flowing containing 94% (by weight) ammonium nitrate and 6% (by weight) fuel oil and shall be capable of initiation by a permitted detonator.

4.1.2 Density

The density of the explosive shall be within ± 0.05 g/cm^3 of that claimed by the manufacturer and fall within a range of 0.65-0.9 g/cm^3

4.1.3 Shelf life

An explosive shall have maximum shelf life of two (2) months from time of manufacture dependent on temperature and humidity conditions during storage under conditions specified in the relevant national legislation and approved by the competent authority

4.1.4 Sleep Time

The explosive shall have a sleep time of up to six (6) weeks from the time of manufacture under normal conditions in dry and stemmed blast holes.

NOTE The sleep time may be limited to the recommended sleep time of the initiating system.

4.2 Blast performance requirements

All permitted ANFO explosives manufactured for commercial use, in addition to meeting the general requirements stipulated is clause 4.1 above, shall comply with blast performance requirements as specified in the table 1 below.

Table 1 —Blast performance requirements

Test	Units	Expected Result	Test Method
Oxygen balance	%(m/m)	+ 0.5	Annex A
Capacity for Work	ml	≥ 260	Annex B
Detonation Velocity[1]	ms^{-1}	2500 – 4800	Annex C
Energy	MJ/kg	3.7	Annex D
Relative Weight Strength (RWS)	%	100	Annex E
Relative Bulk Strength(RBS)	%	100 - 115	Annex F
[1] The actual VOD depends on the conditions of use including the diameter of the hole and the degree of confinement			

5 Inspection and sampling

5.1 General

Owing to the dangerous nature of explosives, extreme care and caution shall be exercised during the inspection, sampling and testing of explosives. All safety precautions and procedures laid down in the relevant national legislations and those in DUS 1776: 2017 shall be strictly followed.

The sampling procedure given in annex G shall be applied in determining whether a lot complies with the appropriate requirements of this standard.

5.2 Inspection

Inspect the explosives for compliance with the requirements of clause 4

5.3 Sampling

In a single consignment of the material all the containers of the same, type and size and drawn from the same batch of manufacture shall constitute a lot. If a consignment is known to consist of different batches of manufacture or of different types and sizes of containers, the containers belonging to the same batch type and size shall be grouped together and each such group shall constitute a separate lot.

The number of containers to be selected at random from lots of different sizes shall be in accordance with Table 2.

Table 2 — Sample sizes to be considered

Lot size	Sample size
Up to 15	3
16 to 25	4
26 to50	5
51 to100	7
101 and above	10

6 Packaging and labelling

6.1 Packaging

Explosives shall be packed in water tight polyethylene lined bags of not less than 0.05 mm thick or in such other containers. The polyethylene bags shall be such that no leakage of the explosive occurs under normal conditions of transportation, handling and storage. Explosive plastic bags shall be packed in accordance with the relevant national legislation

6.2 Labeling

6.2.1 Each package shall also be marked with appropriate explosive symbol as specified in US IS0 7010.

6.2.2 Each package shall be legibly and indelibly marked with the following information:

a) indication of the source of manufacture;

b) name of the explosives;

c) batch / lot number;

d) expiry and manufacture date;

e) country of origin;

f) gross and net weight; and

g) manufacture or trade mark.

In addition to the above, the following cautionary note shall also appear on the label in red ink: "HIGHLY EXPLOSIVE. HANDLE WITH UTMOST CARE. DO NOT DROP OR SUBJECT TO HEAT. FRICTION OR SHOCK. DO NOT BRING ANY SPARK OR FLAME NEAR THE PACKAGE. DO NOT STORE OR STOCK AND TRANSORT WITH THE DETONATORS"

Annex A
(normative)

Oxygen balance test

A.1 Description

The oxygen balance is an expression that is used to indicate the degree to which an explosive can be oxidized.

If an explosive molecule contains just enough oxygen to convert all of its carbon to carbon dioxide, all of its hydrogen to water, and all of its metal to metal oxide with no excess, the molecule is said to have a zero oxygen balance. The molecule is said to have a positive oxygen balance if it contains more oxygen than is needed and a negative oxygen balance if it contains less oxygen than is needed.

A.2 Procedure

A.2.1 Obtain 100 grams of the explosive material

A.2.2 Determine the number of gram atoms of oxygen that are excess or deficient for 100 grams of a compound

A.2.3 Calculate the empirical formula of a compound in percentage of oxygen required for complete conversion of carbon to carbon dioxide, hydrogen to water, and metal to metal oxide.

A.3 Calculations

$$OB = \frac{1600\left(2x + \frac{y}{2} - z\right)}{M} \qquad 1$$

where

M is the number of atoms of metal (metallic oxide produced);

x is the number of carbon atoms;

y is the number of hydrogen atoms;

z is the number of oxygen atoms.

Annex B
(normative)

Capacity to work test

B.1 Trauzl lead block test

Is a test used to measure the strength of explosive materials and the capacity to work

B.2 Procedure

B.2.1 A cylindrical block of lead, 20 centimetres high and 20 centimetres in diameter is used.

B.2.2 A hole is drilled in the centre of the flat face that is 2.5 centimetres in diameter and 12.5 centimetres deep.

B.2.3 Into the hole, place 10 grams of the test explosive, and a standard number 8 blasting cap.

B.2.3 Fill the hole with fine sand (tamped), and set off the explosive.

B.2.3 The hole in the lead block expands due to the explosion.

B.2.3 pour water into the cavity left after the explosion.

B.2.3 Pour the water into a graduated cylinder to measure the volume.

B.2.3 The original volume of the hole shall be subtracted to get the volume of the expansion. Some part of the expansion is due to the blasting cap, and this is subtracted from the total as well (as determined by setting off the blasting cap with a non-explosive 10 grams of dummy material in a similar block).

NOTE Some part of the explosive energy goes into heating the lead block and the sand. Some part goes into blowing away the sand. Some part escapes as the heat of the gases after they leave the block. So what the test measures is not the total energy of the explosive, but the work it does on the lead block (Capacity for work)

Annex C
(normative)

Detonation velocity

C.1 Dautriche Method

The detonation velocity is a measure, in meters per second or feet per second of the speed at which the detonation wave travels through a column of explosives.

C.2 procedure

C.2.1 The sample of explosive under test is placed in a confinement tube which may or may not be surrounded by a steel sleeve.

C.2.2 The position of two blasting caps along the sample define the part for which the detonation velocity is to be measured.

C.2.3 The ends of the piece of detonating cord of known detonation velocity are connected to the blasting caps and the cord is passed across a lead plate as shown in figure C.1

C.2.4 The detonation wave in the test sample is initiated by a detonator or booster at the upstream end of the test tube and a steady detonation wave front starts to travel along the confinement tube.

C.2.5 As soon as the wave hits the first blasting cap (A) a second detonation wave is instantaneously initiated at the end of the detonation cord connected to the cap.

C.2.6 At the same time, the detonation wave in the test sample continues down the confinement tube, and eventually, it reaches the second blasting cap (B) positioned at a distance (m)

C.2.7 This then initiates a third detonation wave in the other end of the detonating cord, Eventually, the two detonation wave front in the cord travelling at equal speeds but in opposite directions, collide and produce a notch in the lead plate at the point of collision. Clearly, the time required for the two opposite detonation waves to travel from the first blasting cap to the collision point at the lead plate is the same

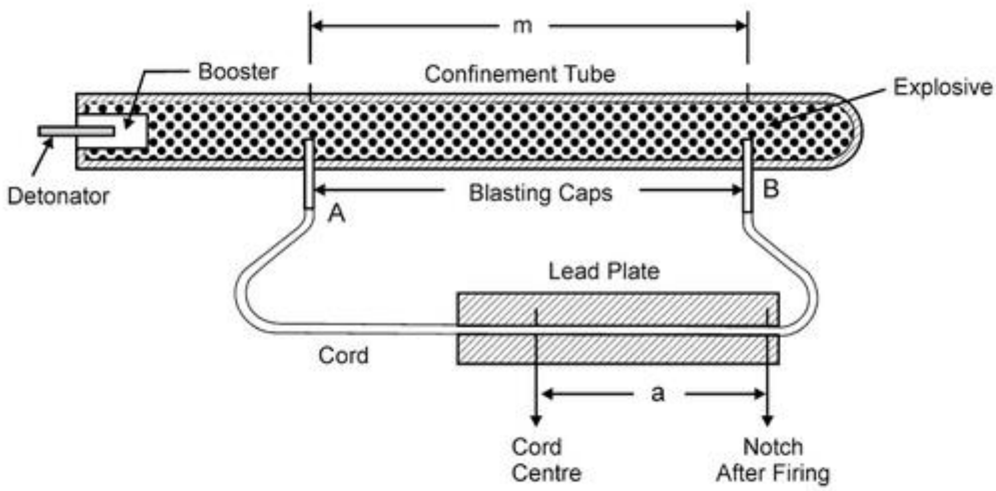

Figure C.1 — Dautriche Method of velocity of detonation

C.3 Calculation

For the wave going directly into the detonating cord of total length of cord (L) the approximate velocity of the explosive shall be given by;

$$D_{sample} = D_{cord} \times \left(\frac{m}{2a}\right) \qquad 2$$

where

D_{sample} is the sample is velocity of sample explosive;

D_{cord} is the cord is velocity of detonation of cord;

m is the distance between blasting cap A and B;

a is the distance between cord centre and notch after firing.

Annex D
(normative)

Explosive energy

D.1 Under water test method/ bubble test

Underwater blast (i.e. Bubble, Aquarium) test is widely used to measure explosive energy. This test is based on evaluation of parameters of pressure wave generated by underwater detonation.

D.1.1 Procedure

D.1.1.1 A specific mass of explosive is placed at sufficiently great depth in a large pond of clear water.

D.1.1.2 The explosive is detonated and a generated shock pressure pulse is measured by a suitable transducer by placing it at some distance away.

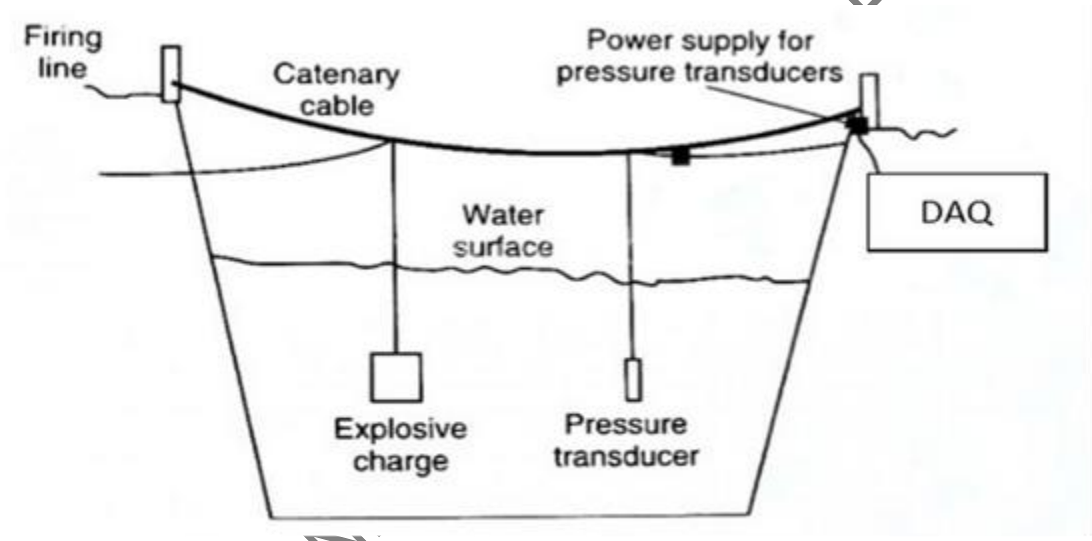

Figure D.1 — under water test Method of velocity of detonation

D.1.2 Calculation

Energy in the pressure pulse (energy output of explosive) is given by the following equation;

$$E_{explosive} = \frac{(12.5 * R)}{(D * C * W)} \int_0^t P(t)dt \qquad 3$$

where

R is the distance between the shot and the transducer;

W is the charge weight (Kg);

D is the density of water (g/cc).

C	is the velocity of sound in water (m/s)
P(t)	is the pressure as a function of time
t	is the time constant of the falling pressure pulse (s) and is calculated by dividing the peak pressure by e = 2.718 because up to one time constant, pressure fall exponentially.

D.2 Ballistic mortar test

D.2.1 Method of test

D.2.1.1 The system for test shall consist of a steel mortar, weighing about 360 Kg.

D.2.1.2 A measure of available energy per gram of explosive, suspended in an Aluminium frame of 3m height.

D.2.1.3 The mortar contains a firing chamber (295 cm^3) and a steel projectile weighing 18 kg (figure D.1). In the firing chamber 10gms of test explosive is detonated with a standard blasting cap and the projectile is ejected.

D.2.1.4 The recoil deflection of the ballistic pendulum is a measure of energy in the explosive; this is usually expressed relative to the standard explosive. Generally Blasting Gelatine (BG), a mixture of 92% NG and 8% Nitrocotton, is used as the standard explosive.

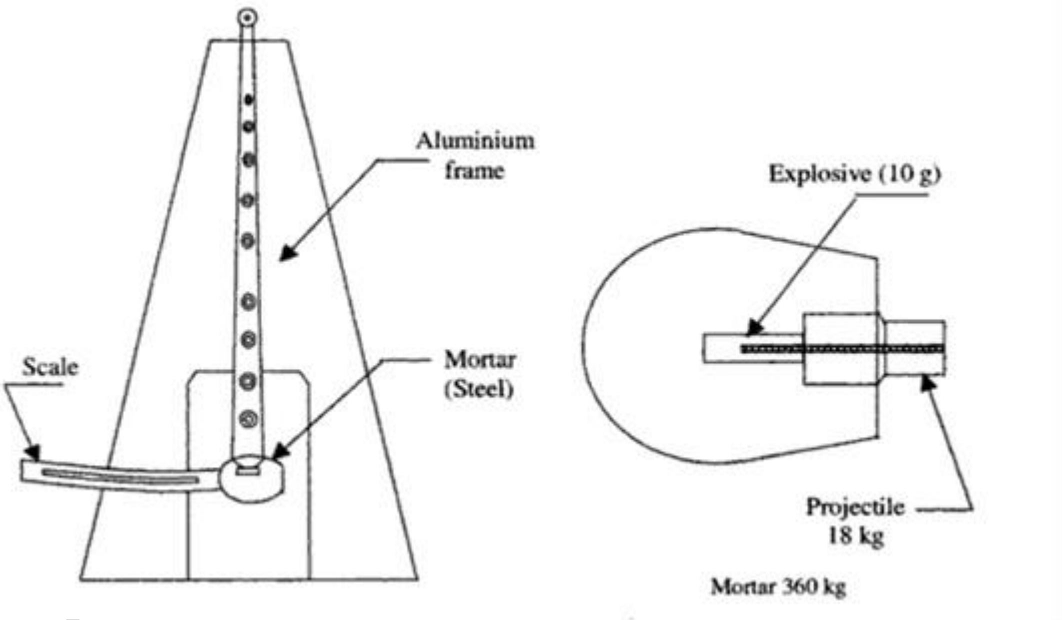

Figure D.1 — Dautriche Method of velocity of detonation

D.2.2 Calculation

Strength of the test explosive as a percent of Blasting Gelatine (BG) is given by the following equation

$$E_{explosive} = 100 \times \frac{(1-\cos A)}{(1-\cos B)} \qquad 4$$

where

$E_{explosive}$ is the energy of explosive;

A is the angle of deflection with the test explosive;

B is the angle of deflection with BG.

Annex E
(normative)

weight strength

E.1 Absolute weight strength (AWS)

The ratio of the energies available in a given volume of explosive compared to an equal mass of ANFO

Absolute weight strength is given by the following equation;

$$AWS = \frac{E_{\exp loosive}}{M_{ANFO}} \quad 6$$

Where;

$E_{explosive}$ = calculated energy of explosive (MJ)

M_{ANFO} = unit mass of ANFO (Kg)

E.2 Relative weight strength (RWS)

This is a measure of the energy available per weight of explosive as compared to an equal weight of ANFO. It is calculated by dividing the absolute weight strength (AWS) of the explosive by the AWS of ANFO and multiplying by 100.

Relative weight strength is given by the following equation;

$$RWS = \frac{(AWS \times 100)}{(AWS_{ANFO})} \quad 5$$

Where;

AWS = absolute weight strength of the explosive

AWS = absolute weight strength of the ANFO

Annex F
(normative)

Bulk Strength

F.1 Absolute Bulk Strength (ABS)

The energy available in a unit volume of explosive

$$ABS = AWS_{\exp losive} \times \rho_{\exp losive} \qquad 8$$

Where;

$AWS_{explosive}$ = absolute weight strength

P =density of the explosive (cc)

F.2 Relative Bulk Strength (RBS)

A measure of the energy available per unit volume of explosive as compared to an equal volume of ANFO at a density of 0.81 g/cm^3 ; it is calculated by dividing the bulk strength of an explosive by the bulk strength of ANFO and multiplying by 100.

$$RBS = \frac{ABS_{\exp losive} \times 100}{ABS_{ANFO}} \qquad 7$$

Where;

$ABS_{explosive}$ = absolute bulk strength of explosive

ABS_{ANFO} = absolute bulk strength of ANFO

Annex G
(normative)

Sampling and compliance with this standard

G.1 Sampling

G.1.1 Preservation

All samples shall be kept in water proof container/polythene cover till they are taken for testing to protect them from water and other atmospheric changes.

G.1.2 Lot

Samples of ANFO-based blasting explosives shall be drawn from each lot separately for deciding the conformity of the lot to the requirements of the specification.

G.2 Compliance with this standard

The lot shall be deemed to comply with the requirements of this standard, if taken in accordance with G.1, after inspection (see clause 5) and testing of the samples, for compliance with the requirements in clause 4, no defective is found.

Bibliography

[1] Drilling and Blasting of Rocks By E. Lopez Jimeno, C. Lopez Jimino, Ayala Carcedo (1995-01-01)

[2] IS 4668 -1985 Ammonium nitrate for explosives

[3] Rock Blasting: Effects and Operations By Pijush Pal Roy (2005)

[4] Rotary Drilling and Blasting in Large Surface Mines 1st Edition By Bhalchandra V. Gokhale

Certification marking

Products that conform to Uganda standards may be marked with Uganda National Bureau of Standards (UNBS) Certification Mark shown in the figure below.

The use of the UNBS Certification Mark is governed by the Standards Act, and the Regulations made thereunder. This mark can be used only by those licensed under the certification mark scheme operated by the Uganda National Bureau of Standards and in conjunction with the relevant Uganda Standard. The presence of this mark on a product or in relation to a product is an assurance that the goods comply with the requirements of that standard under a system of supervision, control and testing in accordance with the certification mark scheme of the Uganda National Bureau of Standards. UNBS marked products are continually checked by UNBS for conformity to that standard.

Further particulars of the terms and conditions of licensing may be obtained from the Director, Uganda National Bureau of Standards.

ICS nn.nnn.nn

Price based on nn pages