UK Health and Safety Executive Testing Memorandum TM 2 (TM 2)

About TM2

The UK Health and Safety Executive (HSE) *Testing Memorandum 2 (TM 2) for testing and approval of explosives for use in coal mines and other mines in which flammable gas may be a hazard* is attached.

The Explosives Inspectorate has obtained approval from the HSE to adopt the TM2 for attachment to their document, upload to their website and for use within Queensland. The TM2 is not available on the HSE website.

Notes and guidance on permitted explosives and the TM2

Permitted explosives form a special class of explosive authorised for use in underground coal mines. Explosives designed for use in underground coal mines must be tested as a permitted explosive against TM2. Within Australia, TM2 is the only accepted specification for explosives used in underground coal mines. TM2 groups explosives in relation to their intended use as follows:

- P1 – single, simultaneous or delay firing in shafts and drifts
- P3 – single, simultaneous firing undercut coal, rippings, dintings and scourings
- P4 – primarily for delay firing in undercut coal and rippings
- P5 – primarily for delay firing in solid coal.

Permitted explosives are authorised through a request to the Chief Inspector under section 13 of the Explosives Regulation. They are authorised as suitable for use in an underground coal mine only in relation to their intended use in P1–P5 applications.

Refer to Information Bulletin 10 – Authorisation of explosives and trials of unauthorised explosives

Further restrictions apply to the use of permitted explosives. The maximum charge limit for a P1 or P3 permitted explosive allowed in any one shot hole shall not exceed 800 grams. The quantity used in a single shot hole may be increased, subject to a site specific risk assessment, to a maximum of 1200 grams, provided that the shot hole is more than 1.8 metres in length with a minimum burden of 0.5 metres with at least 0.6 metres of stemming. For multiple shot holes, no more than 1600 grams. The maximum charge weight for a P5 permitted explosive allowed in one shot hole shall not exceed 1000 grams. Refer to the Mines Inspectorate and the manufacturer for further information.

Testing requirements

To conduct the testing of the permitted explosive (including import, possession, manufacturing, storage, transport and use), approval to trial an unauthorised explosive will be required. Once the trial is completed, the explosive can be authorised in Queensland.

Further information regarding trial and authorisation of an unauthorised explosive

Note that references to HSE and employees of HSE are not relevant in Queensland. The sections of TM2 that reference HSE may be directed to the Explosives Inspectorate.

The list of permitted explosives authorised in Queensland is available at the following link:

Information Bulletin no. 71 – List of Authorised Explosives

Authorised by **Chief Inspector of Explosives** | Noel Erichsen
Version 2, 18 May 2016
For more information visit: http://www.dnrm.qld.gov.au
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Test and approval of explosives for use in coal mines and other mines in which flammable gas may be a hazard

Testing Memorandum TM 2

(Revised April 1995)

Contents

Part 1 Introduction

1 Under mining legislation[1] only explosives which have been approved by the Health and Safety Executive (HSE) may be used in most coal and other safety lamp mines. Also certain blasting operations may be carried out only with explosives of types approved by HSE for those particular purposes. These explosives are termed 'permitted explosives', and are approved as being in one of the following groups:

Group P1	Single, simultaneous or delay firing in shafts and drifts.
Group P3	Single or simultaneous firing in undercut coal, rippings, dintings and scouring.
Group P4	Primarily for delay firing in undercut coal and rippings.
Group P5	Primarily for delay firing in solid coal.
Group P4/5	Delay firing in undercut coal and rippings and delay firing off-the-solid.

[1] Advice on the relevant statutory provisions may be obtained from the addresses in paragraph 3(a).

Note

P2 previously referred to sheathed explosives.

2 A list of 'permitted explosives' may be obtained on request from the HSE. It is normally revised annually.

Part 2 Procedure when applying for test and the conditions of approval

Requirements to be met before an explosive can be accepted for test

3 (a) Application on Form MD17 should be made in duplicate to HM Inspectorate of Mines, HSE, St Anne's House, University Road, Stanley Precinct, Bootle, Merseyside, L20 3RA and the Chief Testing Officer (Explosives), Health and Safety Laboratory, Harpur Hill, Buxton, Derbyshire SK17 9JN. The application must be accompanied by a certificate of continuity of detonation as defined in paragraph 33 of Appendix 1.

(b) The composition of the explosive must fall within the limits of one of the explosives on the HSE's List of Authorised Explosives or have passed the tests for being placed on that list.

(c) Both the explosive and the cartridge or combination in which it is proposed to issue it must be of such a character as not to be liable to deteriorate or to become dangerous under conditions of storage or practical use.

(d) Explosive will not normally be accepted for test if it is more than two months old on receipt at the Testing Station; at the discretion of Testing Officer it may be stored for up to 30 days before test. If it is found impossible to test the explosive before it is three months old the Testing Officer may require a new sample.

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Dispatch of samples of explosives for test

4 (a) If the Executive is prepared to accept the explosive for test, the Testing Officer will make arrangements with the applicant for the receipt of the explosive at the Testing Station.

(b) The quantity of explosive required for test and the manner in which it must be cartridged are given in Appendix 2.

(c) If an explosive fails the tests the manufacturers are required to collect any surplus explosive within 30 days of notification by HSE, failing this HSE will dispose of the explosives and a fee to cover disposal costs will be charged.

Attendance at testing station

5 By previous arrangement with Testing Officer, manufacturers and their representatives can attend at the Testing Station when their explosives are being officially tested or retested or when experimental shots with their explosives are being fired.

Nature of tests and approvals

6 (a) The tests which will ordinarily be made are detailed in Appendix 1. The tests may be varied in detail or other tests may be added at the discretion of HSE to afford additional information or to meet particular conditions in the use of the explosive. HSE also reserves the right to revise any of the standard tests.

(b) If an explosive fails to pass the tests, no second trial will be allowed without the special sanction of HSE.

(c) A report summarising the nature and results of the tests applied will be supplied to the applicant. If the explosive passes the tests and is otherwise acceptable, an approval will be issued by HSE. The approval will show the manufacturer's name of the explosive, such name or number as will identify the sample uniquely, the permitted composition, the name of the manufacturer and the factory at which it is to be made, the method of mixing, the information to be placed on the cartridge and on or in the packages; and the maximum charge in any one shothole.

(d) On completion of the tests the manufacturer will be advised of the test fees.

(e) HSE will conduct random testing to ensure that explosives in use in coal mines are satisfactory.

(f) Samples for testing will be either picked up at the manufacturer's depot by HSE with a minimum of advance warning, or requested through normal purchasing channels.

(g) If a manufacturer wishes to market an explosive the composition of which does not fall, in respect of each and every ingredient, within the limits allowed for an explosive already approved, the proposed explosive will be dealt with as a new explosive and not as an altered explosive and the HSE may require the explosive to be tested afresh.

Altered explosives

7 (a) If at any time after an explosive has been approved by HSE the manufacturer wishes:

(i) to make it at a different factory;

(ii) to mix it in a different type of machine;

(iii) to use materials from a different source or prepared in a different way;

(iv) to cartridge in a different wrapping

(b) HSE must be so informed and the manufacturers must give a written assurance that the product submitted appeared, on the basis of tests carried out, to be as safe as that originally sent to HSE for testing prior to approval being granted. The assurance is to be supported by the manufacturer's own test results for the explosive. Following changes in the source of supply of raw materials, as notified under (iii) above, random check tests will be made as deemed necessary.

Conditions of approval

8 (a) The composition and characteristics of the explosive must at all times conform, within the limits allowed, to those of the sample officially tested.

(b) HSE may at any time cause any approved explosive to be re-tested. Notice of such retest will be given to the manufacturer. If any explosive fails on re-test HSE may revoke the approval.

(c) HSE reserves the right to revoke any approval of an explosive which in practical use is found to cause ignitions of firedamp or to be otherwise dangerous or which proves to be of defective composition or bad manufacture or fails in any way to comply with the conditions of the approval. HSE also reserves the right to revoke the approval of any explosive which is not brought into use within two years from the

date of approval or which has ceased to be supplied for use in coal and other safety lamp mines.

(b) Application for 'experimental shots' should be made in the same manner as for all explosive for approval, see paragraph 3(a).

Experimental testing ('Experimental shots')

9 (a) Testing of an experimental nature may be undertaken to enable manufacturers to assess the likelihood of a new explosive passing the official test, or to assist them in developing improved explosives, or to measure the power of an explosive. The firing of each such charge is called an 'experimental shot'. A report upon the results of such tests will be supplied to the applicant but no approval will be issued. Such reports are not to be used for advertising purposes nor are they to be regarded as a substitute for an approval.

Comparability testing

10 Within a period of time to be mutually agreed, comparability tests will be carried out to cross-check the performance of the manufacturer's test apparatus with those at the Health and Safety Laboratory, Buxton. The manufacturers will be charged for the tests carried out at Buxton at the normal rate.

11 If the result of the comparability tests are significantly different, and if in discussions between manufacturers and HSL personnel it is agreed that it is necessary to visit the manufacturers' premises then these visits will be carried out at the manufacturers' expense.

Appendix 1 Official tests for permitted explosives

General conditions applicable to all groups

1 For all groups of explosives the complete test consists of:

(a) Firing charges into a mixture of methane and air except for a mixture of propane-air-nitrogen in Break Test Apparatus II for the test of a P4 explosive; and

(b) Additionally, for Groups P1, P3 and P5, firing charges into coal dust and for Group P5, firing charges in the deflagration cannon.

2 For each group some charges are fired when loaded in the bore of a cannon which discharges into a cylindrical steel gallery containing the gas mixture or the coal dust. For Group P4 explosives charges are also fired into a gas mixture contained in a steel assembly of prescribed shape and size, termed Break Test Apparatus No II and described in paragraph 10 of this Appendix.

3 The density and velocity of detonation are measured and recorded but do not affect the criterion of passing the test.

Methane-air and propane-air-nitrogen mixtures

4 For those tests for which methane-air or propane-air-nitrogen mixtures are specified the methane or propane shall be at least 95% pure. The mixture into which a test shot is fired shall contain combustibles equivalent to 9.0 ± 0.25% of methane in the case of methane-air mixtures and 3.60 ± 0.1 % propane in the case of propane-air-nitrogen mixtures. The water content of these gas mixtures must be 0.75% or less by volume.

Coal dust

5 For those tests for which coal dust is specified it shall contain approximately 33% of volatile matter (calculated on an ash-free, dry basis) and shall be ground to such a degree of fineness that 85% by weight will pass through a sieve of which the normal aperture size is 63 micrometres.

Dimensions

6 All dimensions for the cannons, galleries and break test apparatus are nominal. Currently used tolerances may be obtained from the Chief Testing Officer.

Cannons

7 The cannons used are of two types. Type 1 cannon is used for all shots fired into the cylindrical gallery. This cannon is a cylinder of special steel 450 mm or more in diameter and having an axial bore which when new is 55 mm in diameter and 1200 mm long.

8 Type 2 cannon is a cylinder of special steel 914 mm long and 152 mm in diameter; it has an axial bore of 55 mm which passes right through the cannon. Each end of the cannon is closed by a hinged end cap. One end cap is fitted with insulated terminals and the other can be fitted with steel discs having different sized central release holes. Type 2 cannons are used for deflagration tests.

Gallery

9 The gallery referred to in paragraph 2 of this Appendix is a horizontal steel shell 1524 mm in diameter. The portion which is filled with gas or a coal dust cloud is 5490 mm long and there may or may not be an extension beyond that length. The working portion is sealed at one end by a diaphragm of paper or plastic. The other end is fitted with a steel plate with a central hole of a size exceeding that of the cannon bore. In use, the cannon (after being charged with the explosive to be tested) is moved horizontally, on rails or otherwise, until it presses against the end of the gallery, to which it makes a gas-tight seal. The axes of the cannon bore and the gallery are in line.

Break Test Apparatus II

10 Break Test Apparatus II is an assembly of two stout steel plates each 1829 x 1829 mm with or without subsidiary steel plates of the same aggregate area, in a suitable enclosure. The plates are horizontal and are held apart at distances which may be varied at the discretion of the Testing Officer between 51 mm and 152 mm by stout pillars passing through both plates near their corners. If subsidiary plates are not used, the lower plate has cut in it, along a centre line, a semi-cylindrical groove 45 mm in diameter from one edge to within 152 mm of the opposite edge. If subsidiary plates are used a similar groove is cut in one of them, which then lies centrally on the lower plate. To either side of it flanking plates of equal thickness cover the residual area of the lower plate. The gap between the plates is closed along that side of the square on which the stopped end of the groove lies, and along one adjacent edge.

The enclosure has a capacity of about 5.7 m^3 and is capable of being filled with a methane-air mixture or a propane-air-nitrogen mixture; it completely surrounds the plates.

Cartridges

11 (a) Unless otherwise agreed by the testing officer, the cartridges for all the tests of all the groups must be as follows:

(i) Nitroglycerine sensitised explosives - the explosive will be in the form of 200 g commercial cartridges in the normal

diameter which is required to be tested, ie either 32 mm or 37 mm.

If a nitroglycerine sensitised explosive is submitted for test in 32 mm diameter cartridges and passes, it will only be approved for use in that diameter.

(ii) Non-nitroglycerine explosives - the explosives will be in the form of commercially produced cartridges which are not less than 200 g weight:

Unless otherwise agreed by HSE cartridges and their compositions submitted for test must be made by the intended method of manufacture and at the intended site of manufacture.

They should not be misshapen and should be filled to an approximately uniform density. The Testing Officer may, at his discretion, reject cartridges that do not fulfil these requirements, or may require that the explosive shall be re-cartridged by the manufacturer.

(b) The cartridge will be fired in the case, wrapper or covering in which the explosive is proposed to be employed.

Priming

12 In fitting the detonator, the cartridge will be pierced in one end without unfolding or otherwise opening any part of the latter. The detonator will be completely inserted until its top is flush with the cartridge surface. The leading wires will then be given a half-hitch round the cartridge.

Loading and stemming

13 (a) In loading cannon Type 1 for tests in the gallery a dry fireclay plug 25 mm in length is first inserted except that in the test defined in paragraph 27 Series (i) sufficient sand is first inserted to ensure that when loaded there shall be a space of only 51 mm between the outer end of the charge and the mouth of the cannon. When inverse initiation is specified, the primer cartridge is then inserted with the detonator to the back, and the charge made up with such other cartridges as are required. When direct initiation is specified, the primer cartridge is inserted last with the detonator to the front of the bore. When stemming is specified a single dry fireclay plug 25 mm in length and fitting the bore closely is pushed on to the charge, but not with such force as to distort the cartridges.

(b) For tests in Break Test Apparatus II the specified charge is laid in the groove with its centre coincident with the centre of the groove and with the detonator nearer to the stopped end of the groove.

(c) The deflagration test arrangement consists of two 57 g cartridges of explosive, a donor and a receptor, separated by a 100 mm long barrier of coal dust. The whole of the test arrangement is confined in the centre of a Type 2 cannon and detonation is initiated in the donor cartridge which is always placed nearest to the terminals.

Method of firing

14 Every test charge will be fired electrically, using a strength 8 instantaneous copper-cased low tension electric detonator, or at the discretion of the Testing Officer, with such other type of detonator as may be used in practice with the particular explosive being tested.

15 Before or during a test, the Testing Officer may, at his discretion, fire shots with permitted explosives, or take such steps as he considers necessary, in order to satisfy himself that standard conditions prevail. In particular, care will be taken to ensure that the cannon bore has not become so enlarged as to cause any appreciable reduction of the severity of the test. The Testing Officer may, at his discretion, suspend or discard a test, or any part of it, if he is not satisfied that the standard conditions exist, and the test would not be charged for.

The tests for P1 explosives

16 Series (i): Twenty-six shots each of 142 g inversely initiated and loaded as specified in paragraph 13(a) of this Appendix are fired without stemming from a Type 1 cannon into the specified gas mixture contained in the specified gallery.

17 Series (ii): Five shots, (for emulsion explosives substitute a temporary figure of 10 shots) each of 800 g directly initiated and loaded and stemmed as specified in para 13(a) of this Appendix are fired from a Type 1 cannon into the specified gas mixture contained in the specified gallery.

18 Series (iii): Five shots, each of 800 g directly initiated and loaded and stemmed as specified in paragraph 13(a) of this Appendix are fired from a Type 1 cannon into coal dust of the nature and fineness specified, disposed in the specified gallery as follows:

(a) A strong wooden platform is placed in the gallery with one end touching the end-plate through which the shot is fired. The platform is 305 mm wide and 3050 mm long and its top is 152 mm below the bore of the cannon.

(b) Prior the test 2268 g coal dust are scattered along the first 5490 mm of the gallery. For the first shot 1134 g of coal dust are laid along the

first 1829 mm of plank; for subsequent shots 570 g are used.

Criteria of passing the test

19 The explosive passes the test if:

(a) It has caused not more than 13 ignitions, (for emulsion explosives substitute a temporary figure of 6 ignitions) in series (i);

(b) It has caused no ignition in series (ii) and (iii);

(c) In the opinion of the Testing Officer it has detonated in a satisfactory manner throughout the tests.

The tests for P3 explosives

20 Series (i): Twenty-six shots each of 400 g inversely initiated and loaded as specified in paragraph 13(a) of this Appendix are fired without stemming from a Type 1 cannon into the specified gas mixture contained in the specified gallery.

21 Series (ii): Five shots, each of 1020 g directly initiated and loaded and stemmed as specified in paragraph 13(a) of this Appendix are fired from a Type 1 cannon into the specified gas mixture contained in the specified gallery.

22 Series (iii): Five shots, each of 570 g inversely initiated and loaded as specified in paragraph 13(a) of this Appendix are fired without stemming from a Type 1 cannon into a pre-formed coal-dust cloud prepared in the specified gallery as follows: two paper bags each containing 570 g coal dust of the nature and fineness specified and a strength 8 instantaneous copper-cased detonator are suspended near the top of the gallery 762 mm and 2134 mm respectively from the closed end. The detonators are connected in series with each other and with the detonator in the test charge, which is a strength 8 half-second delay detonator. On firing, the bag detonators disperse the dust and the charge fires half a second later. Before the beginning of the test 2268 g of coal dust are scattered along the first 5490 mm length of the gallery.

Criteria of passing the test

23 The explosive passes the test if:

(a) It has caused not more than 13 ignitions in the series (i);

(b) It has caused no ignition in series (ii) and (iii);

(c) In the opinion of the Testing Officer it has detonated in a satisfactory manner throughout the tests.

The tests for P4 explosives

24 Series (i): Twenty-six shots, each of 227 g, loaded as specified in paragraph 13(b) of this Appendix are fired in Break Test Apparatus II, specified in paragraph 10 of this Appendix in an atmosphere of propane-air-nitrogen. The gas mixture will be prepared by adding propane to air until the proportion of propane in the atmosphere is 4.00 ± 0.1 % and then by adding nitrogen to this mixture of propane and air until the proportion of propane in the mixture is 3.60 ± 0.1%.

25 Series (ii): Twenty-six shots, each of 400 g, inversely initiated and loaded as specified in paragraph 13(a) of this Appendix are fired without stemming from a Type 1 cannon into the specified gas mixture contained in the gallery detailed in paragraph 9 of this Appendix.

Criteria of passing the test

26 The explosive passes the test if:

(a) It has caused not more than 13 ignitions in series (i).

(b) It has given not more than 3 ignitions in the 26 shots of series (ii).

(c) For explosives that are submitted as Group P4/5 the series (ii) test above is not required.

(d) In the opinion of the Testing Officer it has detonated in a satisfactory manner throughout the tests.

The tests for P5 explosives

27 Series (i): Twenty shots, each of 570 g inversely initiated and loaded as specified in paragraph 13(a) of this Appendix so as to allow only a distance of 51 mm between the outer end of the charge and the mouth of the cannon are fired without stemming from a Type 1 cannon into the specified gas mixture contained in the specified gallery.

28 Series (ii): Five shots, each of 1020 g directly initiated and loaded and stemmed as specified in paragraph 13(a) of this Appendix are fired from a Type 1 cannon into the specified gas mixture contained in the specified gallery.

29 Series (iii): Five shots, each of 570 g inversely initiated and loaded as specified in paragraph 13(a) of this Appendix are fired without stemming from a Type 1 cannon into a pre-formed coal dust cloud prepared in the specified gallery as follows: two paper bags each contained 570 g of coal dust, of the nature and fineness specified and a strength 8 instantaneous copper-cased detonator are suspended near the top of the gallery 762 mm and 2134 mm respectively from the closed end. The detonators are connected in series with each other and with the detonator in the test charge which is a strength 8 half-second delay detonator. On firing, the

bag detonators disperse the dust and the charge fires half a second later. Before the beginning of the test 2268 g of coal dust are scattered along the first 5490 mm length of the gallery.

30 Series (iv): Twenty-six shots each as described in paragraph 13(c) are fired in a Type 2 cannon with a release hole 3.2 mm in diameter.

Criteria of passing the test

31 The explosive passes the test if:

(a) It has caused no ignition in series (i), (ii) and (iii);

(b) It has caused not more than 13 deflagrations of the receptor cartridges in series (iv);

(c) In the opinion of the Testing Officer it has detonated in a satisfactory manner throughout the tests.

Composition and chief characteristics

32 A signed copy of the chemical analysis, carried out by the manufacturer or a person acting on his behalf, confirming that the composition of the sample submitted for test lies within the limits stated, must accompany each explosive submitted for test for approval. Important characteristics, for example the velocity of detonation and the density, and such others as the Testing Officer may decide, may also be determined and recorded. These may assist the Testing Officer in deciding whether subsequent samples of the explosive differ significantly from those originally tested.

The continuity of detonation test

33 A 1 m length of explosive built up of cartridges of the smallest diameter and of the smallest weight in this diameter to be manufactured, and with cartridges held in loose contact, shall detonate throughout when the column of cartridges is contained in a three-thickness roll of paper of the quality used for the wrapping of explosives and is laid on a flat steel rail or plate and is not otherwise confined. Initiation shall be by a detonator of the strength recommended by the manufacturer for use with the particular explosive.

Appendix 2 Quantities of explosive required for test

Explosive group	Weight of explosive required
P1	30 kg
P1 (Emulsion)	35 kg
P3	40 kg
P4/P5	50 kg
P5	40 kg

The Testing Officer will adjust the weights of commercial cartridges, where necessary, to make up the explosive charges required for test purposes. Test cartridges will have normal ends.

For test purposes the weights of the explosive charges will be those of explosive, exclusive of wrapping materials, and will be correct to ± 5g.

The required quantity of explosive as given above should be sent, carriage paid to:

The Chief Testing Officer (Explosives)
Health and Safety Laboratory
Harpur Hill
Buxton
Derbyshire SK1 7 9JN

Appendix 3 Maximum charge weights allowed in any one shot hole

The maximum charge weights for each permitted explosive allowed in any one shot hole are given in the relevant Approval Document.