Ministry of Defence
Defence R&D Organisation

STEC PAMPHLET - 1

QUANTITY DISTANCE REGULATIONS FOR MILITARY EXPLOSIVES

2025

Issued by

Storage & Transport of Explosives Committee
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CONTENTS

PART-1

INTRODUCTION

PART-2

CLASSIFICATION OF MILITARY EXPLOSIVES

PART-3
QUANTITY DISTANCES

Appendix

APPENDICES

GLOSSARY

PREFACE

The pamphlet describes Quantity Distance regulations for Military explosives and ammunition. The regulations have been extensively revised and completely re-written by taking into account the International UN system of Classification of Explosives. According to this system, explosives are divided into six Hazard Divisions and thirteen Compatibility Groups depending on their characteristics and expected behaviour when suitably initiated. The essential features of their classification system are dealt in this pamphlet for better appreciation and understanding.

The regulations are based on extensive data generated through trials by STEC in recent years. The trial data have resulted in cogent enunciation of STEC principles for realistic assessment of quantity distances. New concepts like LRC Box type Igloos, Unit Risk Principle, Underground Storage, Containment Chamber, calculation of effective explosives quantities, orientation, blast resistant properties of buildings and different levels of protection etc., are highlighted in these regulations. This approach provides enough flexibility to the users to select the best option for optimum utilization of available land and financial resources without prejudicing safety. These regulations on quantity-distances are applicable for explosives facilities under the Ministry of Defence.

It is hoped that users will find this revised STEC Pamphlet 2025 simpler, easier to understand and implement, thereby promoting the safe storage and transportation of military explosive. This publication supersedes STEC Pamphlet, 2017 on the subject.

PART - 1

INTRODUCTION

SECTION I

GENERAL

Policy

1. The manufacture, handling, storage, conveyance, use and eventual disposal of military explosives are operations which present inherent risks to persons and property. The Ministry of Defence (MOD) through its Storage and Transport of Explosives Committee (STEC) ensures that these explosives present the minimum degree of risk. Being the main enforcement agency, the basic aim of STEC, is to regulate and control the storage, transportation and processing of explosives in such a way that in the event of an explosion, whether it results from accident, enemy attack or sabotage, the adjacent explosives stocks, facilities and personnel in the facilities near to the explosion site will be protected to a pre-determined, practical standard.

2. It is, therefore, the MOD policy to limit the exposure of a minimum number of persons, for a minimum time, to the minimum of ammunition and explosives consistent with safe and efficient operations.

Scope

3. Ammunition and explosives safety standards herein shall be considered minimum and greater protection shall be afforded when practicable. They are applicable to MOD ammunition and explosive facilities.

4. Standards described herein shall govern siting and construction of new MOD facilities. Existing facilities which do not comply with the standards shall be allowed for the balance of their useful life when it can be demonstrated clearly that re-design or modification is not feasible, and that the quantity of explosives cannot be reduced for reasons of operational necessity or other compelling reasons. **However, deviation sanction for the same shall be obtained from the Competent Authority.**

5. The prescriptions for Quantity Distances (Q-D) contained in these regulations do not assure absolute safety. It is impracticable to prescribe distances which would guarantee absolute immunity from the risks of propagation, damage or injury. The risk, therefore, inherent in these regulations represents a sensible balance between absolute safety and practical considerations of cost and operational requirements.

PART - 2

CLASSIFICATION OF MILITARY EXPLOSIVES

SECTION –II

UN INTERNATIONAL SYSTEM OF CLASSIFICATION

General

6. The UN International System of Classification was devised in order to promote the safe transport of dangerous goods and its use has since been extended almost universally for control of storage and manufacture as well. The basis of the system is the classification of goods by the type of hazard involved.

7. Full details of the system are contained in the Orange Book issued by UN titled: "Transport of Dangerous Goods: Recommendations of the Committee of Experts on the Transport of Dangerous Goods"

8. The system consists of 9 a class (1-9) of which Class 1 comprises explosive substances and articles.

9. Class 1 is divided into 6 Hazard Divisions (HDs). The first 4 indicate the type of hazard to be expected in the event of an accident: blast (HD 1.1), projection effects (HD 1.2), fire and radiant heat (HD 1.3) and no significant hazard (HD 1.4). The fifth Hazard Division (HD 1.5) comprises explosive substances which are so insensitive that there is very little probability of initiation or of transition from burning to detonation under normal conditions of transport. The Hazard Division 1.6 comprises extremely insensitive articles which do not have a mass explosion hazard. Strictly the initial Figure 1 in HD 1.1 etc. refers to the class of dangerous goods (i.e. Class 1-explosives) but it is common practice to include it when referring to Hazard Divisions or Hazard Classification Codes (e.g. 1.1D).

10. In order to identify the kinds of explosives deemed to be compatible and those which may have to be segregated to promote safety in storage and transport, they are assigned one or other of 13 Compatibility Groups (A through H, J, K, L, N and S) on the basis of similarity of characteristics, properties and accident effects potential. These groups have been defined so that, with the exception of Compatibility Group L and N, all explosives in any one group are compatible with one another in storage and in every mode of transport.

11. Explosives are considered to be compatible if they may be stored, stowed or carried together without significantly increasing either the probability of an accident or, for a given quantity, the magnitude of the effects of such an accident

Definitions of the Hazard Divisions

12. **Hazard Division 1.1**

(a) This division comprises substances and articles of Class 1 which have a mass explosion hazard.

(b) The major hazards of this division are blast, high velocity projections and other projections of relatively low velocity.

(c) The explosion results in severe structural damage, the severity and range being determined by the amount of high explosives involved. There may be a risk from heavy debris propelled from the structure in which the explosion occurs or from the crater.

(d) This division may display hazards associated with other divisions.

13. **Hazard Division 1.2**

(a) This division comprises substances and articles of Class 1 which have a projection hazard but not a mass explosion hazard.

(b) The explosion results in items burning and exploding progressively, a few at a time. Furthermore, fragments, firebrands and unexploded items may be projected in considerable numbers; some of these may explode on impact and cause fires or explosions. Blast effects are limited to the immediate vicinity.

(c) For the purpose of determining Quantity Distances, a distinction is made between those items which give small fragments of moderate range (for instance projectiles and cartridges of caliber from 20 to 60 mm) and those which give large fragments with a considerable range (for instance projectiles and cartridges exceeding 60 mm caliber, rockets and rocket motors in a propulsive state which do not have a mass explosion hazard).

14. **Hazard Division 1.3**

(a) This division comprises substances and articles of Class 1 which have a mass fire hazard and either a minor blast hazard or a minor projection hazard or both but not a mass explosion hazard.

(b) This division includes some items which burn with great violence and intense heat emitting considerable thermal radiation (mass fire hazard) and others which burn sporadically. Items in this division may explode but do not usually form dangerous high velocity fragments. Firebrands and burning containers may be projected.

15. **Hazard Division 1.4**

(a) This division comprises substance and articles of Class 1 which present no significant hazard.

(b) This division includes items which have primarily a moderate fire hazard. They do not contribute excessively to a fire. The effects are largely confined to the package. No fragments of appreciable size or range are to be expected. An external fire does not cause the simultaneous explosion of the total contents of a package of such items.

(c) Some but not all of the above items are in Compatibility Group S. These items are so designed or packaged that any hazardous effects arising from accidental functioning are confined within the package unless the package has been degraded by fire, in which case all blast or projection effects are limited to the extent that they do not significantly hinder firefighting or other emergency response efforts in the immediate vicinity of the package.

16. **Hazard Division 1.5**

(a) This division comprises very insensitive substances which have a mass explosion hazard.

(b) This division comprises explosive substances which are so insensitive that there is very little probability of initiation or of transition from burning to detonation under normal conditions of transport. As a minimum requirement, they must not explode in the external fire test.

(c) At present, there are no military explosive substances classified under HD 1.5.

17. **Hazard Division 1.6**

(a) This division comprises extremely insensitive articles which do not have a mass explosion hazard and which demonstrate a negligible probability of accidental initiation or propagation.

(b) The risk from articles of Hazard Division 1.6 is limited to the explosion of a single article.

(c) At present, there are no military explosive articles classified under HD 1.6

18. **Inert Ammunition**

Ammunition which does not contain any explosive or other dangerous goods (for instance dummy bombs, cartridges and projectiles) is excluded from the system of

hazard classification.

19. **Toxic and Pyrotechnic Ammunition**

(a) **Toxic Ammunition:** Ammunition containing an explosive dispersing charge and toxic chemical agent is assigned to the appropriate hazard division on the basis of the explosive hazard. If the toxic hazard is the dominant effect, the ammunition is assigned Class 6 of the International System of Classification for transport purposes. For storage purposes, such items may be assigned an appropriate hazard division and Compatibility Group K.

(b) Pyrotechnic Ammunition: Tear-gas, corrosive smoke agents, white phosphorous, Napalm, etc. without explosives are assigned the appropriate class (6, 8 etc.) of the International System of Classification for transport purposes. When made into ammunition which also contains explosives, the Class 1 classification takes precedence. The ammunition is assigned an appropriate Hazard Division and Compatibility Group together with any subsidiary risk (e.g. Class 6.1, 8 etc.).

SECTION –III

STORAGE COMPATIBILITY

Storage Principles

20. The highest degree of safety in ammunition and explosives could be assured if each item or division were stored separately. However, such ideal storage is generally not feasible. A proper balance of safety and other factors frequently requires mixing of several types of ammunition and explosives in storage.

21. Ammunition and explosives shall not be stored together with dissimilar materials or items that present positive hazards to the munitions. Examples are mixed storage of ammunition and explosives with flammable or combustible materials, acids or corrosives.

22. Different types, by items and division of ammunition and explosives may be mixed in storage provided they are compatible. Ammunition and explosives are considered compatible when they can be stored together without increasing significantly either the probability of an accident or for a given quantity, the magnitude of the effects of such an accident.

23. Subject to application of these standards and particularly to compatibility as defined herein, ammunition and explosives shall be mixed in storage when such mixing will facilitate safe operations and promote overall storage efficiency. Assignment of items to storage compatibility groups (SCG's) requiring separate storage shall be minimized consistent with actual hazards presented and not based on administrative considerations or end use.

Description of Compatibility Groups

24. Keeping in view ammunition and explosives storage principles and the considerations for mixed storage, ammunition and explosives are assigned the appropriate one of the 13 Storage Compatibility Groups (A through H, J, K, L, N and S). These are described in Appendix-1. The combination of Hazard Division and Compatibility Group is known as the Hazard Classification Code. Appendix-1 shows only 35 classification codes which are permitted although at first sight, the 6 Hazard Divisions and 13 Compatibility Groups should give 78 combinations. Appendix-2 shows, in the form of gaps in the matrix, the combinations that cannot exist, because the definitions of the division and group are mutually exclusive, or do not occur in practice because the resultant characteristics are highly improbable or useless for explosives.

Compatible Ammunition and Explosives

25. Different kinds of explosives may be stored together. However, items in one of the three groups listed below are not necessarily compatible with items in another of the

groups:

(a) Various kinds of initiating explosives which are compatible one with another.
(b) Various kinds of propellants which are compatible one with another regardless of hazard division.
(c) Various kinds of high explosives (HE) which are compatible one with another.

26. Different types of ammunition within any one of the following seven groups are compatible and may be stored together:

(a) All types of initiating devices.

(b) All types of HE ammunition without their own means of initiation and without a propelling charge.
(c) All types of HE ammunition without their own means of initiation and with a propelling charge.
(d) All types of HE ammunition with their own means of initiation, with or without a propelling charge.
(e) All pyrotechnics and all types of ammunition containing both explosives and illuminating, incendiary, smoke, or tear producing agents except:

i. Water activated pyrotechnics and ammunition.
ii. Ammunition containing white phosphorous (WP), flammable liquids or gases.

(f) All types of ammunition containing both explosives and WP.
(g) All types of ammunition containing both explosives and flammable liquids or gels.

27. Ammunition items in any one of the compatibility groups are generally not compatible with items in other groups except those illustrated in paras 28, 29 and 30 below.

28. Certain kinds of explosives may be stored with certain types of ammunition:

(a) Bulk propellants are compatible with propelling charges, and cartridges with inert or solid projectiles and without projectiles.
(b) Bulk HE is compatible with HE ammunition without its own means of initiation and without a propelling charge.

29. Ammunition and explosives in sub-standard or damaged packaging, in a suspect condition, or with characteristics that increase the risk in storage are not compatible with other ammunition and explosives and shall be stored separately.

30. (a) Inert items, ammunition and explosives of Compatibility Group S may be stored with items from any other compatibility group except Compatibility Groups A and L.

(b) Equal numbers of fuzes and other components of complete rounds of ammunition may be stored in the same buildings as the ammunition to which they belong without prior approval. When so stored, the compatibility group is that of the assembled round.

(c) Mixing of explosives and ammunition of Compatibility Groups C, D and E shall be limited upto 500 kg net explosive quantity (NEQ) only. Under exceptional operational considerations and when safety is not sacrificed, higher quantities of these can be mixed together with the prior approval of the Service HQ.

(d) Ammunition and explosives belonging to different Hazard Divisions but having the same compatibility group can be stored together in the same building. The required Q-D will be determined in accordance with para 74.

31. Attention is drawn to the descriptions of Compatibility Groups B, D, E and F. The essential differences between them are rather subtle and depend on such things as:

(a) Whether a means of initiation is or is not fitted.
(b) Whether the means of initiation have at least two protective features which prevent the initiation of the ammunition in the event of the accidental functioning of the means of initiation during handling, storage and transport.
(c) When the means of initiation is packed in the same package as the ammunition (but separate), the method of packaging is such as to prevent the initiation of the ammunition in the event of an accidental functioning of the initiating device.

32. These differences are best illustrated by examples as follows:

(a) A detonating fuze will be Compatibility Group B if it does not have two effective protective features, but will be Compatibility Group D when it does.
(b) A plugged HE shell will be Compatibility Group D.
(c) A HE shell fitted with a Compatibility Group D fuze will be classified Compatibility Group D.
(d) A HE shell fitted with a Compatibility Group B fuze will be classified Compatibility Group F.
(e) HE grenades packaged with their fuzes will be classified Compatibility Group D if it has been demonstrated that even if the fuzes function accidentally, the grenades will not be initiated, otherwise they will be classified Compatibility Group F.
(f) A HE round fitted with a Compatibility Group D fuze will be Compatibility Group E but will be Compatibility Group F if it has a Compatibility Group B fuze.

33. These differences are of practical and economic importance as in general; the storage and transport requirements for Compatibility Groups D and E ammunition are less restrictive than those for compatibility Groups B and F.

34. It is emphasized that Compatibility Group D applies to those secondary detonating explosives (high explosive) which are relatively sensitive to spark or friction or to black powder and only when they are properly packed in dust- tight containers. Otherwise, special precautions are essential and Compatibility Group L would apply.

SECTION –IV

TEST PROCEDURES FOR CLASSIFICATION OF MILITARY EXPLOSIVES

General

35. The process of classification of explosives consists of the allocation to military explosives as packaged or unpackaged when stowed and transported in such a condition, of the appropriate:

(a) Hazard Division as a result of tests or by analogy.
(b) Compatibility Group.
(c) UN Serial Number selected from the list of Dangerous Goods most commonly carried at Chapter 2 of the Orange Book and repeated at Table 3 of STEC Pamphlet-2.

36. The test scheme adopted by STEC is that detailed in the United Nations Manual "Test and Criteria for the classification of explosive Substances and Articles". The UN Test Scheme relates to explosive as transported but STEC has extended its use to cover storage. This UN Manual must be referred to for full details of the UN Test scheme. In this section this scheme is briefly outline.

Purpose of Test Scheme

37. The purpose of the UN Test Scheme is to determine the classification of explosives in normally packaged or unpackaged state during storage and transportation. Practical tests are essential to determine the hazard whenever required data cannot be made available or the hazards are not clear beyond doubt to the authorities responsible for the assessment of hazard classification.

38. The UN Manual presents the UN Scheme for the classification of explosives and a description of the test methods and procedures considered to be the most useful for providing competent national authorities with the necessary information to arrive at a proper classification of explosives. The Flow Charts at Figs. 1.1, 1.2 and 1.3 in the Manual are an essential part of the UN Scheme.

39. It should be noted that the Manual is neither a text book on explosive testing nor it is a concise formulation of testing procedure that will unerringly lead to a proper classification. It, therefore, assumes technical competence on the part of testing authority and leaves responsibility for the act of classification with the competent national authority; who also has the discretion to dispense with certain tests, to vary the details of tests, and to require additional tests, when this is justified to obtain reliable and realistic assessments of the hazards of the explosives. The STEC is the competent national authority for military explosives in India.

Hazard Classification Test Scheme

40. The UN Scheme consists of a series of 6 tests. The UN Manual describes the Test Scheme in detail. Flow Charts are provided covering both the Acceptance Procedure and the Procedure for Assignment of Hazard Division. Each test type is described in detail together with sentencing criteria. This information is not repeated in this Pamphlet; those responsible for classification should always work from the source document, the UN Manual—"Tests Criteria and for the Classification of Explosive Substances and Articles".

41. The UN Scheme consists of a series of 6 tests as follows:

(a) **Test Series 1.** Applied to substances and designed to answer the question

"Is it an explosive substance?" Consists of two types of tests as follows:

i. **Type 1.a:** Shock tests with a defined booster and confinement to determine the ability of the substance to propagate a detonation.
ii. **Type 1.b:** Combustion or thermal tests to determine the thermal response of the substance.

(b) **Test Series 2.** Applied to substances and designed to answer the question "Is the substances too insensitive for acceptance in Class 1?" Consists of two types of tests as follows:

i. **Type 2.a:** Shock test with a defined booster and confinement to determine sensitivity to shock.
ii. **Type 2.b:** Combustion and thermal tests to determine thermal sensitivity.

(c) **Test Series 3:** Applied to substances and designed to answer the question "Is substance too hazardous for transport (in the form in which it is tested)?" Consists of four type of tests as follows:

i. **Type 3.a:** Test to determine the sensitiveness to impact.
ii. **Type 3.b:** Test to determine the sensitiveness to friction (Including impacted friction)
iii. **Type 3.c:** Test to determine the thermal stability.
iv. **Type 3.d:** Test to determine the response to flame (i.e. they determine the ease of deflagration to detonation transition in small quantities when unconfined).

(d) **Test Series 4:** Applied to packaged and unpackaged explosive articles (ammunition) and to packaged explosive substance and designed to answer the question " Is the article, packaged article or packaged substance too hazardous for transport?" This test series is under review, but currently consist to two type of test as follows:

Type 4.a: Test to determine the thermal stability of packaged substances, packaged articles and unpackaged articles.

Type 4.b: Test to determine the effect of dropping the packaged substances, packaged articles or unpackaged articles from 12 m. There is a special test for liquids.

(e) **Test Series 5:** Applied to substances and designed to answer the question "Is it a very insensitive explosive substance (with a mass explosion hazard)?" Any candidate for HD 1.5 must pass all the following four types of tests:

i. **Type 5.**a : Shock Tests which determine the sensitivity to detonation By a standard detonator.

ii. **Type 5.**b : Thermal tests which determine the tendency of transition from Deflagration to detonation.

iii **Type 5.**c : Tests to determine if the substances, when in large quantities, Explode when subjected to a large fire.

iv. **Type 5.**d : Tests to determine if the substance ignites when subjected to an Incendiary spark (i.e. it is the intention to exclude easily ignitable substances – e.g. black powder – from HD 1.5

(f) **Test Series 6:** Tests to determine the correct Hazard Division and applied to packaged and Un-packaged explosive articles (ammunition) and to packaged explosives. Consists of three types of tests as follows:

(i) **Type 6.a:** (Single Package Test): Test on a single package for the purpose of determining:

i Whether initiation or ignition in the package causes burning or explosion and whether burning or explosion is propagated in the package.

ii In what way the surroundings would be endangered by these effects.

(ii) **Type 6.b** (Stack Test): Test on a stack of packages of explosive articles for the purpose of determining:

i. Whether burning or explosion in the stack is propagated from one package to another or from unpackaged explosive article to another.

ii. In what way the surroundings would be endangered by these events.

(iii) **Type 6.c:** [External Fire (Bonfire) Test]: Test on stack of packages of explosive articles or substances or unpackaged explosive articles for the purpose of determining:

i. How the packaged or unpackaged explosive articles in the stack behave when involved in an external fire simulating a realistic

accident.

ii. Whether and in what way the surroundings are endangered by blast waves, heat radiation and/ or fragment projection.

Note: Types 6.a and 6.b are carried out at least 3 times, unless explosion of the entire contents occurs earlier. Type 6.c is normally performed once only, but if the wood or other fuel used for the fire is consumed leaving a significant quantity of unconsumed explosive substance in the remains or in the vicinity of hearth, the consideration should be given to performing the test again using more fuel or a different method to increase the intensity and/or duration of the fire. If the results of the recommended number of tests do not enable the hazard division to be determined, the number of tests is increased.

Assessment of results

42. The military explosive is classified in the light of the test results, of the sentencing criteria contained in the UN Manual and of other relevant data in accordance with the characteristics of the Divisions of Class 1. Sometimes the observed hazard effects may vary among replicate tests or may not correspond exactly to the definitions. When this occurs, the STEC uses its judgment, or arranges for further testing. It is prudent to err on the side of caution, particularly in the crucial decision as to whether or not an article is susceptible to mass explosion.

Effect of Package on Classification

43. Particular care must be taken to ensure that the correct classification is determined for each condition when explosives are stored and transported in a variety of ways, for example, in inner packs only as well as in complete packages comprising both inner and outer packaging or indeed unpackaged where authorized.

Reclassification

44. The hazard classification of a particular type of explosive must be reviewed when a modification has been effected which is recognized as significant by the competent authority. This usually means:

(a) A new explosive substance or a mixture of explosive substances which is considered significantly different from other mixtures which are already classified.

(b) A new design of articles or an article containing a new explosive substance or mixture of explosive substances.

(c) A new design of package for an explosive article, including a new type of inner packaging. A relatively minor change in the inner or outer packing can be critical and may convert a single article risk into a mass explosion risk.

SECTION –V

EFFECTS OF EXPLOSIONS AT VARIOUS LEVELS OF PROTECTION

45. **Purpose of the Section**

(a) It is the aim of this section to define the kind of injuries and damages which can be expected at different levels of protection for Hazard Division 1.1 explosives.

(b) The purpose of providing Quantity-Distances in case of Hazard Division 1.1 explosives, between Potential Explosion Sites and Exposed Sites, is to ensure that the minimum practical risk is caused to personnel, structures and facilities. In principle, those functions and facilities not directly related to operation or the security of ammunition and explosives should be sited at or beyond the Inhabited Building Distance.

(c) In practice, it may not always be possible to provide this level of protection and some activities and facilities of necessity will be sited at less than this distance. In other cases, the nature of the facility or structure may require greater protection than that afforded by the Inhabited Building Distance and should be provided.

46. **Blast Pressure Output**

(a) **Blast Wave Phenomena:** The violent release of energy from detonation in a gaseous medium gives rise to sudden pressure increase in that medium. The pressure disturbance, termed as blast wave, is characterized by an almost instantaneous rise from the ambient pressure to a peak incident pressure P. This pressure increase, or shock front, travels radially from the burst point with a diminishing velocity that always is in excess of sonic velocity of the medium. Gas molecules making up the front move at lower velocities. This latter particle velocity is associated with a "dynamic pressure" or the pressure formed by the winds produced by the shock front.

(i) As the shock front expands into increasingly larger volumes of the medium, the peak incident pressure at the front decreases and the duration of the pressure increases.

(ii) If the shock wave impinges on a rigid surface oriented at an angle to the direction of propagation of the wave, a reflected pressure is instantly developed on the surface and the pressure is raised to a value that exceeds the incident pressure. The reflected pressure is a function of the pressure in the incident wave and the angle formed between the rigid surface and the plane of the shock front.

(b) Partially Confined Explosions: When an explosion occurs within a structure, the

peak pressure associated with the initial shock front will be extremely high and in turn, will be amplified by reflections within the structure. In addition, the accumulation of gases from the explosion will exert additional pressures and increase the load duration within the structure. The combined effects of both pressures eventually may destroy the structure if it is not strengthened sufficiently or adequate venting for the gas and the shock pressure is not provided, or both. For structures that have one or more strengthened walls, venting for relief of excessive gas or shock pressures, or both, may be provided by means of openings in or frangible construction of the remaining walls or roof or both. This type of construction will permit the blast wave from an internal explosion to spill over onto the exterior ground released from their confinement, expand radially and act on structures and/ or persons on the other side of the barrier.

Levels of Protection

47. The risks at various levels of protection (scaled distances) are described herein. The letter 'Q' refer to Net Explosive Quantity (NEQ) in kg and the distance 'm' is measured in meters.

(a) **Protection Levels 44.4 $Q^{1/3}$ – 33.3$Q^{1/3}$ (0.02-0.03 bar) / 2-3kPa**

Expected Effects

(i) Unstrengthen structures are likely to suffer only superficial damage.
(ii) When large panes of glass are exposed so as to face the Potential Explosion Site, 50% or more breakages may occur.
(iii) Personnel are afforded a high degree of protection from death or serious injury. Injuries that do occur will be caused principally by glass breakage.

(b) **Protection Level 22.2$Q^{1/3}$ (0.05 Bar)/ 5 kPa**

(i) General

I. This protection level is subject to a minimum distance of 400m irrespective of quantity of explosives at the Potential Explosion Site.
II. This distance is termed the "Inhabited Buildings Distances" and is the minimum distance at which inhabited buildings not directly connected with the functions of the Explosives Area should be sited.

(ii) Expected effect

I. Unstrengthened buildings will suffer minor damages particularly to parts such as windows, door frames and chimneys. In general, damage is unlikely to exceed approximately 5% of the replacement cost but some buildings may suffer serious damage.
II. Personnel are afforded a high degree of protection against the direct effects of an explosion but are likely to suffer injuries from glass

breakage and flying/falling debris.

III. The minimum distance of 400 m irrespective of the quantity of explosives at the Potential Explosion Site is required to provide a high degree of protection from injury due to fragments or debris.

(c) **Protection Level 14.8 $Q^{1/3}$ (0.09 bar)/ 9 kPa**

(i) General

I. This protection level is subject to a minimum distance of 270m for small quantities of explosives at the Potential Explosion Site.

II. This is the minimum distance at which facilities and activities involving members of the general public should normally be permitted.

III. This distance is sometimes described as the Public Traffic Route Distance and is the minimum distance at which routes used by significant numbers of general public for purposes unconnected with the explosives facilities should be sited.

(ii) Expected Effects

I. Unstrengthened buildings will suffer average damage costing in the range of 10% of the total replacement cost to repair.

II. Personnel under cover are afforded a high degree of protection from death or serious injury. Such injuries as do occur will be mainly caused by glass breakage and building debris.

III. Personnel in the open are not likely to be seriously injured by blast but some personnel injuries are likely to be caused by fragments and debris depending on the Potential Explosion Site structure, quantity of ammunition in the Potential Explosion Site and fragmentation characteristics thereof.

(iii) Control of Hazard

I. Some protection from the direct effects of high velocity fragments can be obtained by providing an effective traverse either by making use of a natural feature or by constructing a suitable artificial traverse at the Potential Explosion Site or at the Exposed Site.

II. For public roads, the risk of secondary injuries can be reduced by ensuring that the roadsides are free from obstacles which are likely to result in injuries to the occupants of vehicles leaving the road as a result of the drivers reaction to an explosion.

(d) **Protection Level 8.0 $Q^{1/3}$ (0.21 bar)/ 21 kPa**

(i) General

This distance is the minimum permissible distance between a Potential Explosion Site and a process building. It is also the minimum distance at which administrative and supervisory personnel should ordinarily be located.

(ii) Expected Effects

I. Buildings which are unstreng then can be expected to suffer serious damage which is likely to cost above 30% of the total replacement cost to repair.
II. Serious injuries to the personnel, which may result in death, are likely to occur due to fragments, debris, fire bands or other objects.
III. There is some possibility of delayed communication of the explosion as a result of fires or equipment failure at the Exposed Site. Direct propagation of the explosion is not likely.
IV. Cargo ships would suffer damage to decks and super-structure. In particular, doors and bulkheads on weather-deck are likely to be buckled by the over-pressure.
V. Aircrafts are expected to sustain considerable structural damage.

(iii) Control of Hazard

The hazard may be controlled:

I. By using light structures which are likely to be severely damaged by the overpressure but which will not produce additional hazardous debris. In this case, protection from high velocity debris and fragments by receptor traverses is essential.
II. By designing the structures to withstand the over-pressures and the debris and fragment attack.

(e) Protection Level 4.4 $Q^{1/3}$ (0.55 bar)/55 kPa

(i) General

This is the untraversed above ground magazine distance.

Expected Effects

I. Unstrengthened buildings will suffer damage approaching total destruction
II. Personnel are likely to be seriously injured due to blast, fragments, debris and translation.
III. There is a 20% risk of eardrum rupture.
IV. Explosives vessels are likely to be extensively damaged and delayed
V. Propagation of explosion may occur.
VI. Aircraft will be heavily damaged by blast and fragments; destruction by ensuing fire is likely.
VII. Transport vehicles will sustain severe body damage, minor engine damage and total glass breakage.

(iii) Control of Hazard

Traversing will reduce significantly the risk of propagation of explosion and injury of personnel by fragments.

(f) Protection Level 3.6 $Q^{1/3}$ (0.7 bar/70 kPa

(i) General

This risk level is only permitted in situations where production technology, communication requirements or necessity for rapid, emergency response dictate that greater distances cannot be used.

(ii) Expected Effects

I. Provides a high degree of protection against propagation of an explosion when traverses are interposed between the two explosive locations.
II. Explosions may subsequently occur in adjacent Potential Explosion Site from fire spread by lobbed debris or blast damage to an Exposed Site.
III. Un-strengthened buildings will suffer severe structural damage approaching total demolition.
IV. Severe injuries or death to occupants of the Exposed Site are to be expected from direct blast, building collapse or translation.
V. Aircraft will be damaged by both blast and fragments to the extent that they will be beyond economical repair. If aircraft are loaded with explosives, delayed explosions are likely to result from subsequent fires.
VI. Improperly designed traverses or protective structures may increase the hazard from flying debris, or may collapse in such a manner as to increase the risk to personnel and equipment.

(iii) Control of Hazard

Traversing is required if any Exposed Site is also a Potential Explosion Site. Hardening of target buildings or suppression of blast at the Potential Explosion Site both require very expensive and highly specialized designs which may not be cost-effective. Traversing, to be effective, requires that the barricades be designed for the particular source-target combination involved. Traverses are not effective in reducing overpressure except for very small quantities.

g) Protection Level 2.4 $Q^{1/3}$ (1.8 bar)/180 kPa

(i) General

The only function of this level of protection is to prevent communication between adjacent traversed Potential Explosion Sites.

(ii) Expected Effects

I. Un-strengthened buildings will be completely destroyed.
II. Personnel will be killed by direct action of blast, by being struck by building debris, or by impact against hard surfaces.
III. Transport vehicles will be overturned and crushed by blast.
IV. Explosives vessels will be severely damaged, with propagation of explosion likely.
V. Aircraft will be destroyed by blast, thermal and debris effect.

(iii) Control of Hazard

Traverses are effective in preventing immediate propagation of explosion, but provide only limited protection against delayed propagation of explosion.

48. **Effects on Personnel**

(a) The effects of air blast overpressure on human beings are given below:

Probable Effect	**Blast Pressure, bar (kPa)**
Ear Drum Rupture	
Threshold	0.48 (48)
50%	1.03 (103)
Lung Damage	
Threshold	2.07 –2.76 (207-276)
Severe	5.52 (552)
Fatal	
Threshold	6.90 –8.28 (690-828)
50%	8.28 –12.42 (828-1242)
Near 100%	13.80 –17.25 (1380-1725)

(b) The effects of thermal radiation on personnel depend on the degree of burn. Burn may be classified in ascending order of severity as:

First degree burn: This involves no more than a severe reddening of the exposed skin.

Second degree burn: This involves blistering but normally there is no immediate breakage of the skin.

Third degree burn: This involves charring or blackening of the skin, damage to the flesh underneath and normally produces open wounds.

The degree of burn injury is essentially a function of the total dose of radiant energy received. However, the rate at which radiant energy is received by the skin also

influences the degree of burning. For a given dose of radiant energy, maximum injury occurs when radiant heat is emitted in a short (<1sec) Pulse. For such a short pulse of radiation, doses of approximately 1.5, 3 and 4.5 cal/cm^2 produce respectively first, second and third degree burns. If the energy is radiated over a period of about 5 sec. without any intense short pulses, doses 3, 6 and 9 cal/cm^2 (i.e. about double that for a short pulse) are required to cause similar degrees of injury.

PART –3

QUANTITY DISTANCES

SECTION –VI

PRINCIPLES OF QUANTITY DISTANCES

GENERAL

49. Potential Explosion Sites such as buildings, stacks and vehicles (trucks, trailers and railway wagons) in which explosives are permitted are a potential risk to individuals and to property. MOD headquarters are responsible to ensure that such sites are located sufficiently clear of other buildings, stacks, roads, railways, or places frequented by persons (both within and outside the enclosed area) so as to ensure the minimum reasonably practicable risk to life and property should an explosion occur. This clearance, or distance, usually depends on the maximum net explosive quantity permitted at the potential explosion site and is, therefore, called the Quantity Distance (Q-D).

Kinds of Q-D

50. Inside Q-D: There are two kinds of inside Q-D for each Hazard Division:

(a) Storage inside Quantity Distances (SIQD).
(b) Process inside Quantity Distances (PIQD).

51. Outside Q-D: There are two kinds of outside Q-D for each Hazard Division:

(a) Public Traffic Route Distances (PTRD)
(b) Inhabited Building Distances (IBD)

Storage inside Quantity Distances (SIQD)

52. (a) These distances are the minimum permissible distances between a potential explosion site and storage sites containing explosives. These distances are intended to provide specified degrees of protection to the explosives at the exposed site, but the degree of protection is highly dependent upon factors such as the sensitiveness of explosives, the type of ammunition, the type of packaging, and the type and construction of a building at the potential explosion site or the exposed site, or both. In general, the provision of stronger buildings allows the use of smaller Q-D for a given degree of protection, or achieves a better standard of protection at a given distance, especially in the case of exposed sites near a potential explosion site containing explosives of Hazard Division 1.1

(b) The selection of the optimum combination of types of construction for the buildings, Q-D and degree of protection involves a balance between the cost of construction, the availability and cost of land, and the value of stocks of explosives, which might be rendered unserviceable at exposed sites in the event of an accident at the potential explosion site. The hazard divisions and compatibility groups of the explosives and the flexibility in the use of the sites should be taken into account.

These distances are intended to prevent the direct propagation of explosion/fire from the potential explosion site to the explosives at an exposed site by missiles, flame or blast. However, these minimum distances should not be expected to prevent explosives being rendered unserviceable as a result of destruction of building and the over-throw and scattering of open stacks when an explosion occurs in another building or stack.

SIQD for Hazard Division 1.1

53. The introduction into the STEC prescriptions of Q-D criteria for Igloos involves a new concept in the protection of explosives at an exposed site. Since an Igloo is designed to resist external blast and thereby prevent initiation of its contents by secondary projections, the concept assumes that the stocks generally will remain serviceable. However, at the D1 distances the ground shock may render sensitive electrical and electronic components of guided missiles, etc. unserviceable. For open stacks and buildings, other than those covered with earth, a general assessment is that for distances less than D3, it is probable that, even though propagation has not taken place, the stocks are likely to be unserviceable or covered by debris or the collapsed buildings. Stocks at distances of D5 and greater are likely to be serviceable although some structural damage at the D5 distance, dependent on the type of building, can be expected.

54. In the event of an explosion involving explosives of HD1.1 at PES, it is common to fight fires at the exposed sites until they are extinguished in the case of HD 1.3 and provided there is protection from fragments for the firemen for HD1.2 also. It is not prudent however, to remain in the vicinity of a fire involving HD1.1 at exposed site after the initial stage.

SIQD for Hazard Division 1.2

55. The damage to stocks at the exposed site is likely to be localized even in the event of propagation and in this case the extent of loss will be dependent on the effectiveness of the fire fighting arrangements.

SIQD for Hazard Division 1.3

56. The prescribed distances for HD1.3 essentially provide high degree of protection against immediate propagation of fire to the contents at an exposed site by flame, radiant heat, fire brands, fragments and lobbed items. There is a considerable risk that one or more of these effects, specially lobbed items is likely to ignite the contents

directly or as a result of ignition of combustible parts of the building unless prompt and effective fire fighting is able to prevent such consequences.

SIQD for Hazard Division 1.4

57. Distances from explosives of Hazard Division 1.4 to exposed sites are not a function of the net explosives quantity. Separation distances are prescribed on the basis of an assessment of fire risks and considerations of fire fighting facilities. Stacks or vulnerable buildings should normally be separated by 25 m to prevent ignition by radiation heat. Stacks or buildings not prone to ignition by radiant heat may not need 25 m, a smaller separation distance such as 10 m may be provided.

Process inside Quantity Distances (PIQD)

58. These distances are the minimum permissible distances between a potential explosion site and process buildings. The distances are intended to provide a reasonable degree of immunity for personnel within the process building from the effects of a nearby explosion such as flame, radiant heat, blast and projections. Light structures are likely to be severely damaged. These distances provide, also, a high degree of protection against immediate or subsequent propagation of explosion.

Outside Quantity Distances (OQD)

Public Traffic Routes Distances

59 (a) These distances are the minimum permissible distances between a potential explosion site and public traffic routes. Since the risks presented by public routes are so diverse, two basic alternatives are provided, firstly the use of the full inhabited buildings distance as a public traffic route distance and secondly the use of a reduced distance, generally two-thirds of the inhabited building distance.

(b) It is not practicable to give firm general prescriptions as to when to use the full inhabited building distance and when to use the two-thirds value since so much depends on local conditions. The local situations should, therefore, be assessed and a decision should be made taking into account the following guidelines. The dominant factors which determine the number and severity of road casualties are sudden transient blast loading of vehicles and startling of drivers, the presence or absence of roadside trees and ditches and of separated carriageways for opposing traffic. Factors of less importance are the traffic speed and density, the width of traffic lanes and their number, the presence of crash barriers, the surfaces condition and the radius of any curve.

(c) These public traffic route distances are also suitable for playing fields subject to a minimum to protect against projections. The minimum is 270 meter for traversed magazines for Hazard Division 1.1.

Use of large public traffic route distances

60. The full inhabited building distances should be used as public traffic route distances for roads if the nature of the traffic is such (e.g. constant, dense, fast traffic) that the reaction of drivers to sudden blast, windscreen breakage, loud noise, or fire-ball effects would result in unacceptable damage and injury or if the traffic cannot be stopped promptly.

Inhabited Building Distances

61. These distances are the minimum permissible distances between a potential explosion site and inhabited buildings or assembly places. These distances are intended to prevent serious structural damage by flame, thereby making consequential death or serious injuries to their occupants unlikely. Persons in the open, for example on playing fields, would not suffer direct injury from the blast itself. It may be pointed out that:

(a) These distances for Hazard Division 1.1 are not sufficiently large to prevent injuries to occupants of buildings by flying glass, especially where glass cladding is used in their construction.

(b) There is a significant hazard even at 270m from ammunition and explosives of Hazard Division 1.1 due to fragments and a considerable amount of debris, unless these projections are intercepted by structural protection. This hazard may be tolerable for sparsely populated areas, where there would be a small expectation of damage and injury from such projections. In densely populated areas consideration should be given to the use of a minimum inhabited building distance of 400m for Igloos.

Notified Area

62. It is the responsibility of the Ministry of Defence to restrict the construction of any public utility within the area upto the inhabited building distance around sites containing explosives. To ensure compliance with this stipulation, all Military Establishments handling explosives and ammunition should declare the aforesaid area as 'Prohibited/ Protected Area by forwarding safe-guarding maps of their establishments to the local State Authorities for issue of necessary Government notification to this effect, viz. "warning the Government and private agencies not to encroach or undertake any new civil construction in this area without the prior approval of the Ministry of Defence." To avoid any legal dispute at a later stage, it is preferable that land upto OQD should be acquired for all futuristic projects.

STEC Principles

63. Quantity Distance regulations described in this pamphlet are based on STEC principles enumerated below:

(a) It is assumed that if explosives are regularly present in storage or processing activities, then the probability for an explosion always exists at some time during the life cycle of the activity.

(b) To assess the distribution of explosives present in a facility to decide what parts of the whole quantity will sympathetically detonate to effectively cause one explosion. These parts are defined as the "Unit Risks" for that distribution of explosives

(c) To assess design of the building containing the explosives, the processes to be carried out there, the adjacent buildings and their orientations, the numbers and disposition of operating staff and of any member of the public and their property that may be in the vicinity, to see if the situation is acceptable.

(d) To put Q-D criteria upon a more scientific basis, taking into account the recent data from STEC trials and accidents so as to reduce the matters of judgment and factors of safety as far as possible without in any way compromising the basic standards of safety.

(e) To provide a more flexible and realistic set of criteria which offer the user some freedom of choice, so that the most cost effective solution may be adopted in each circumstance, instead of restricting the user to arbitrary and over-simplified prescriptions.

SECTION –VII

DETERMINATION OF QUANTITY DISTANCES

Basis of Q-D

64. The Q-D is based on an extensive series of trials and a careful analysis of all available data on accidental explosions in different countries. However, Q-D is subject to uncertainty due to the variability of explosions. These quantity distances are generated by distance functions subject, in certain cases, to a fixed minimum or maximum distances the fixed values are independent of the Net Explosive Quantity (NEQ) because they are based on the projection hazard from individual rounds or operational factors.

Q-D Tables

65. The Q-D required for each hazard division is given in tables.

66. For an intermediate quantity between those given in the tables, the next greater distance in the tables should be used when determining a Q-D. Conversely the next lesser quantity in the tables should be used when determining an explosives quantity limit for a given intermediate distance. It is, however, permitted to calculate a Q-D using the distance function formulae at the foot of the appropriate column. An accurately calculated distance may be used in place of the tabulated value.

Measurement of Q-D

67. Q-D are measured from the nearest point of the potential explosion site to the nearest point of the exposed site. Distances are measured along a straight line without regard to traverses.

Unit Risk

68. Where the total Quantity of explosives in a storage site or process building is so separated into stacks that the possibility of mass explosion is limited to the quantity in any one stack (unit risk), distances are measured from the outside of the wall adjacent to the controlling explosives stack to the nearest outside wall of another structure. If the separation to prevent mass explosion is provided by one or more substantial dividing walls, then the distances are measured from these walls, if appropriate, instead of from the outside walls of the building. Where not so separated, the total quantity subject to mass explosion is used for Q-D computations. In the case of HD 1.1 explosives, the thickness of partitioning wall with proper foundation and supported on all four sides between different compartments/rooms of the bin type building to prevent propagation of explosion from one room to another is given as under:

Wt of explosives in kg		Thickness of the RCC wall in cm for percentage of reinforcement by volume		
Over	**Upto**	**0.2%**	**0.5%**	**1.0%**
0	50	10	10	10
50	75	10	10	10
75	100	15	15	10
100	150	20	20	15
150	200	25	25	20
200	250	30	25	25
250	300	30	30	25
300	350	35	35	30
350	400	-	-	30
400	450	-	-	35
450	500	-	-	35

Note:

1. The explosives will be kept at a minimum distance of 1m from the wall.
2. The thicknesses given above do not ensure the protection of machinery And other equipment.
3. The wall, if made of brick, should be twice the thickness as that of RCC with 0.2 % reinforcement.
4. In the case of HD 1.2 and 1.3 explosives, the partition wall, carried from the floor to roof without any gap, should be constructed of 23cm thick brick.

Net Explosives Quantity

69. The total net explosives quantity of explosives in a single potential explosion site is used for the computation of Q-D unless it has been determined that the effective quantity is significantly different from the actual net explosives quantity. It does not include such substances as white phosphorus, war gases or smoke and incendiary compositions unless these substances contribute significantly to the dominant hazard of the hazard division concerned. Distances quoted for HD 1.1 explosives are strictly applicable to quantities of TNT. Where explosives having a significantly more powerful or less powerful effect than TNT are being considered, a 'TNT equivalent' may be used to determine the appropriate Q-D. However, presently the Q-D tables based on TNT as reference explosive are recommended to avoid operational and practical problems involved in computing Q-D for more/less powerful explosives than TNT.

70. Where two or more potential explosion sites are not separated by the appropriate inter-magazine distances, they are considered as a single site and the aggregate net explosives quantity is used for determining Q-D. If two or more Hazard Divisions are involved, the principles mentioned in Para 74 apply.

Determination of Q-D

71. The location of buildings or stacks containing explosives with respect to each other and to other exposed sites is based on the total net explosives quantity in the individual buildings or stacks unless this total quantity is so sub-divided that an incident involving any one of the smaller concentrations cannot produce practically instantaneous explosion of others.

72. The Q-D required from each of two or more nearby storage sites or process buildings to contain explosives of one Hazard Division only is determined by considering each as a potential explosion site. The quantity of explosives permitted in the storage sites or process buildings is limited to the least quantity allowed by the appropriate table for distances separating the storage sites or process buildings concerned.

73. The Q-D required from each of two or more nearby storage sites to contain explosives of different Hazard Divisions at different times are determined as follows:

(a) Consider each building or stack, in turn, as a potential explosion site.
(b) Refer to the table of each Hazard Division which may be stored in the building or stack considered as a potential explosion site.
(c) Determine the Q-D for each Hazard Division as the minimum to be required from the building or stack.
(d) Record the Q-D in terms of each Hazard Division in each instance as those to be required from the building or stack.

Required Q-D for Explosives of more than one Hazard Division in a Single Site

74. When explosives of different Hazard Divisions are kept in a single site at the same time, the required Q-D is determined as follows using the Q-D tables. Sub paras b, c and e are applicable only when HD 1.1 explosives/ammunition comprises **at least 10% of the aggregate quantity.**

(a) When explosives of Hazard Divisions 1.4 are kept in the same site as explosives of one or more other Hazard Divisions, Hazard Division 1.4 is ignored subject to the overriding requirement of 10m or 25m where appropriate.

(b) When explosives of Hazard Divisions 1.1 and 1.2 are kept in the same site, determine the Q-D for the aggregate quantity (i.e. the total quantity of Hazard Divisions 1.1 and 1.2) considered as Hazard Division 1.1. Next, determine the Q-D for the aggregate quantity considered as Hazard Division 1.2. The required Q-D is the greater of these two distances.

(c) When explosives of Hazard Divisions 1.1 and 1.3 are kept in the same site, determine the Q-D for the aggregate quantity (i.e. the total quantity of Hazard Divisions 1.1 and 1.3) considered as Hazard Division 1.1. Next, determine the Q-D for the aggregate quantity considered as Hazard Division 1.3. The required Q-D is the greater of these two distances.

(d) When explosives of Hazard Division 1.2 and 1.3 are in the same site, determine the Q-D for the quantity of Hazard Division 1.2. Next, determine the Q-D for the quantity of Hazard Division 1.3. The required Q-D is the greater of these two distances.

(e) When explosives of Hazard Divisions 1.1, 1.2 and 1.3 are kept in the same site, determine the Q-D for the aggregate quantity(i.e. the total quantity of Hazard Divisions 1.1, 1.2 and 1.3) considered as Hazard Division 1.1, next as Hazard Division 1.2 and finally as Hazard Division 1.3. The required Q-D is the greatest of these three distances.

Relaxation of Q-D

75. **Inside Q-D:**

a. Relaxation of inter-magazine distances may result in a greater risk of total loss of stocks in other buildings or stacks or at least their being rendered unserviceable. Furthermore, a much larger explosion may result than that used as the basis for outside Q-D. Disastrous damage to property and injury to the general public may be the consequence. **Hence relaxation in SIQD is not permitted**.

b. Relaxation of process building distances should only be permitted in exceptional circumstances and where the facilities are judged by competent persons to be capable of providing the necessary protection. Furthermore relaxation should be permitted where the persons working in the building are very few.

Outside Q-D:

76. Relaxation of Outside Q-D may result in an unacceptable hazard to life and property and should not be permitted.

77. All relaxation cases involving PIQD should be permitted only with the written consent of the competent departmental head after risk assessment and specific recommendations of the STEC.

SECTION –VIII

QUANTITY DISTANCE TABLES

General Instructions on Use of Q-D Tables

78. This section presents quantity distance tables, which contain information to determine quantity distances between sites containing ammunition and explosives of HD 1.1, 1.2 and 1.3.

79. For explosives of HD 1.1, tables IA, IB and IC and ID are relevant. Table IA in the matrix form is based on the type of construction and orientation aspects of the storage buildings. For a given combination of construction and orientation, ascertain the D distance (from D1 to D6 distances) to be followed from intersection of the relevant column and row of Table IA. For determining the actual distances for the quantity of explosives under consideration, use appropriate column of Table IB, Tables IC and ID give the PIQD and OQD distances to be followed for conventional ESHs and LRC Box type Igloos respectively for different quantities of explosives/ammunition of HD 1.1.Table IF shall be referred for underground ammunition storage facilities.

80. For storage of very sensitive explosives like primary explosives and certain other explosives like blasting gelatine etc., it is possible for the blast effects at an exposed site to cause practically their instantaneous initiation even under traversed conditions at D2 distances. It is, therefore, recommended that a minimum storage distance D5 be followed for such explosives.

81. For explosives of HD 1.2 and 1.3, Tables II and III give SIQD, PIQD and OQD distances to be observed for various quantities.

82. For explosives of HD 1.4, quantity distance tables have not been given as separation distances are not a function of net explosives quantity. Separation distances of 10m or 25m are to be followed based on assessment of fire risk (viz. to prevent ignition by radiant heat) and consideration of fire fighting facilities.

83. Tables I, II and III prescribe Q-Ds for quantities of 50kg and above. For quantities less than 50kg, Table 1D should be referred.

84. When explosive buildings are designed based on Unit Risk Principle (URP), the Quantity Distance with respect to adjoining explosive buildings or facilities will correspond to the quantity and hazard division of explosive stored in a single bay. The design of explosive building for based on URP will be limited to 1100 - 2000 kg (HD 1.1) per bay and up to 50,000 kg(HD 1.3) per bay respectively.

85. Normally process buildings wherein HD 1.1 explosives are handled should be traversed. However, in case of untraversed process buildings being utilized for handling HD 1.1 bulk explosives and thin/non-metallic cased ammunition not exceeding 50kg, a minimum separation of 45m should be observed between these and other buildings

such as process, storage, offices, etc.

Blast Walls

86. Blast walls made of either brick or concrete, may be used as container traverses for small quantities (up to 125kg) of explosives. The thickness of such blast walls which will contain the explosion for quantities up to 125kg of HD 1.1 explosives when constructed 1m, 1.25 m and 1.5 m away from the building/stack are:-

Net Explosives Quantity	**Blast wall thickness of brick in metres**			**Thickness of reinforced concrete wall with buttresses at every 3m & 0.2% reinforcement (area to area) in metres**		
kg	**1m**	**1.25m**	**1.5m**	**1m**	**1.25m**	**1.5m**
5	0.34	0.23	0.23	-	-	-
10	0.46	0.46	0.34	-	-	-
15	0.56	0.46	0.46	0.25	0.20	0.20
20	0.81	0.70	0.56	0.35	0.30	0.25
25	-	-	-	0.40	0.30	0.25
35	-	-	-	0.50	0.40	0.35
50	-	-	-	0.60	0.50	0 40
75	-	-	-	0.80	0.65	0.55
100	-	-	-	1.00	0.80	0 .65
125	-	-	-	1.15	0.90	0.75

Brick or concrete blast walls for quantities greater than those given above are also permissible but as the required thicknesses may be excessive, earth traverse is preferable. The thickness of blast wall to contain the effects of explosion of Hazard Division 1.1 explosives is calculated from the formula

$$T = \frac{2.9\, Q^{2/3}}{Md}$$

where 'T' is the thickness in cm, 'Q' is the quantity of explosives in kg,'d' is the distance in metres and 'M' is a constant with value 0.332 for brick and 0.608 for RCC

SECTION –IX

QUANTITY DISTANCES FOR VARIOUS EXPOSED SITES

87. The separation distances for various utilities from PES are prescribed below:

(a) Utilities requiring OQD

(i) Main offices, main engineering workshops, main canteens, main rest sheds, main store houses for non-explosives.

(ii) Dwelling houses, places of assembly like cinema, playing field, shopping area, schools, hospitals, places of worship etc.

(iii) Central boiler houses, unprotected above ground POL/inflammable liquids storages; where the POL facilities are vital, a minimum distance of 450m must be observed.

(iv) Main fire stations.

(v) Electrical main generating stations.

(vi) National super grid overhead power transmission lines (400 KV and above) should be 2/3 OQD subject to a minimum of 120 m , provided the loss of the line would not cause serious social or economic hardship even if the line in question is a part of grid system serving a large distance area. A certificate to the effect that loss of the line would not cause serious social or economic hardships to be furnished by State Electricity Board/District Administrative authorities.

(a) In case where serious social or economic hardships would be caused or the certificate mentioned above cannot be furnished the distance between explosive building and overhead HT line to be OQD subject to minimum of 120 m.

(b) To avoid snapping of HT line, traverse or buildings to be re-designed.

(vii) Compressed gas cylinder storages.

(viii) Public traffic routes, main national highways and trunk rail lines with heavy density of traffic.

(ix) Radio frequency transmitters-1.5 OQD distance to be provided if considered vital.

(x) Short /long proof ranges, subject to a minimum of 275m. The surrounding utilities should not be in the line of fire and be preferably behind the firing/battery point. A minimum clearance of 275 m should be provided for non- explosive utilities from the firing point, which should be provided with a sand bag partition or RCC wall for the safety of firing crew.

(xi) Over-head water tanks, subject to a minimum of 275m in case of HD1.1

(xii) Directional aerials of Mobile Phone high frequency towers.

(xiii) Static rocket firing bay subject to a minimum 275 m.

(xiv) Baffle range for live-fire training/practice with small arms ammunition of calibres 9mm Caliber and Pistol, 5.56mm INSAS Carbine, Rifle and LMG, 7.62mm sub-caliber for 106 RCL, 9mm sub calibre for 84mm RCL, 7.62mm SLR and AK-47 should be sited at a minimum distance of

360m from civil residential area. However, these can be sited at 115m from Defence residential area. Following conditions should be adhered to

- The ideal orientation is with firing from south to north thus a baffle range should be sited facing north.
- A 3.6m high RCC/ brick boundary wall should be constructed all around the direct firing zone at 13.5m from edges of the stop butt.
- The line of fire should not be in the direction of residential areas.
- No multi-storey complex be allowed within 100m on sides and behind the stop butt of the range body.
- Up-to at least 35m, no man land outside the boundary wall and back of baffle range.
- No airport, Railway line and high ways should exist within 400m of Baffle range particularly in the line of firing.

(b) Utilities requiring PIQD

(i) Group offices, sectional or regional canteen and section rest sheds. However in depots and storage areas of factories, these may be sited at SIQD.

(ii) Single Fire Stations and Sub-stations, package type (oil fired) boilers serving a few buildings.

(iii) Manned electrical substations should be provided a distance of PIQD from the nearest explosive building or 45m whichever is larger. The electrical substations should be enclosed in a structure of 34 cm brick and should be in the shadow of traverse as far as possible.

(iv) Water closets/toilets serving more than one building. However, the same when serving only one building, no Q-D is required.

(v) Burning ground for disposal of bulk explosive (up to 100 kg) by burning, subject to a minimum separation of 275 m.

(vi) Burning pit for disposal of small arms ammunition by burning, subject to a minimum separation of 275 m.

(vii) Local demolition ground for disposal of ammunition by detonation, limited to 7 kg NEC at a time can be sited at PIQD, subject to a minimum separation distance of 275 m from magazine/ESH and with the following stipulations:

- Local demolition ground should be barricaded with a traverse.
- RCC shelter for working personnel should be provided in demolition ground.
- Man limit shall not exceed 10 persons during preparation and 4 persons during actual disposal.

(viii) Single process building in any MoD establishment can be sited at PIQD with a stipulation that no other process building will be constructed near this process building in future.

(ix) All checkout facilities/MMPU/APL/Inspection Buildings of Missiles can be sited at PIQD inside explosive area with following stipulations.

a) Man limit should be less than 20 persons.
b) NEC of MMPU/APL/Checkout Facilities/Inspection Building

should be less than 5MT subject to the condition that Capacity of adjoining storage buildings are limited to 10MT NEC of HD1.1.

(c) Utilities requiring SIQD

(i) Non-explosive sub-storages.

(ii) Water pipe line underground. However, above ground water pipe line should be at twice SIQD.

(iii) Marshalling yards.

(iv) Transit storage buildings, with ammunition in approved packages.

(v) POL/flammable liquids underground with overhead protection, SIQD with a minimum of 45m.

(vi) POL/flammable liquids above-ground with bunds, earth backed wall and RCC roof-twice SIQD with a minimum of 45m.

(vii) Electrode type boiler. It should normally be sited at SIQD. However, when required as a process necessity, may be located on the outer-half of the traverse or outside the building or inside the building in a separate room/cubicle with adequate wall thickness and RCC roof.

(viii) Central loading platforms

(ix) Unmanned electrical substations serving a group of buildings, should be sited at a distance of SIQD from the nearest explosive building or 45m whichever is larger.

(x) Underground POL & PNG pipelines (Layout conforming to IS Standard No:14885) except those serving to the PES are to be separated from an explosive building as under..

c) For HD1.1 – Half of SIQD subject to minimum of 25m.
d) For HD1.2 & HD1.3 – Minimum separation distance of 25m.
e) For HD1.4 – Minimum separation distance of 10m.

(d) Utilities requiring different quantity distances under varying conditions.

(i) Location of AC plant room for different types of explosive building shall be as under

Type of Explosive Building	Location of AC Plant Room
Single traversed building	Outside Traverse
A group of traversed buildings	At SIQD and separate weather maker room for each building
Single untraversed building	Separated by a blast wall
A group of untraversed buildings	At SIQD and separate weather maker room for each building

Man-limit of AC plant-room should be included in the man-limit of the explosive building.

(ii) Overhead electric lines (LT) and telephone lines-15m.

(iii) Static water tanks for firefighting-minimum of 100m and not exceeding 200m.

(iv) Watch Tower- to be sited as far away as possible, keeping security considerations in view.

(v) Ancillary non explosives store houses with very few or no personnel- No QD need to be observed.

(vi) Safe distance of 10 OQD subject to a minimum of 5 km shall be provided between explosives establishment (Ordnance Factory producing ammunition) and open cast mine

(vii) Unmanned electrical substations serving only one building should be located beyond traverse or beyond 45 m in case of untraversed explosive building.

(e) Utilities requiring Zero Quantity Distances.

Ammunition disposal facility comprising of Blast Containment Structure of capacity upto 8kg TNT (HD1.1).

Separation of Process Area from Storage Area

88 Storage area comprising mainly of explosives magazines and storehouses should be sited at a minimum distance of 275 m from the process area.

SECTION –X

QUANTITY DISTANCES TO AIRFIELDS

General

89. Explosives storages should normally be sited at as great a distance as possible from airfields, both military and civil so as to preclude:

(a) The possibility of damage to aircraft which may be on ground or in the process of landing or taking off, from an accidental explosion in the explosives storages, and

(b) Any risk to the explosives storages arising from a crash of aircraft around or near the explosives storage.

90. Based on considerations of the tactical requirements of Military airfields and importance of civil airfields, quantity distances requirements for each are dealt with separately.

Military Airfields

91. From the considerations based on type of protection, quantity distances in metres for HD 1.1 ammunition not exceeding 5000 kg per shelter under different situations can be calculated as follows:

(a) Between aircraft parked in the open but traversed. ---$7.2Q^{1/3}$

(b) Between aircraft parked in hardened shelters ---$3.6Q^{1/3}$

(c) Between ready service magazines(Q not exceeding 10,000 kg HD 1.1) used to store assembled ammunition for combat aircraft loading

(i) Aircraft parked in hardened shelters ---$3.6Q^{1/3}$

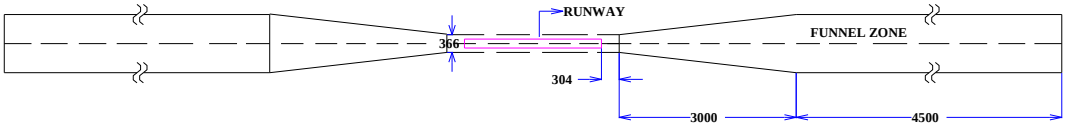
(ii) Aircraft parked in the open but traversed ---$7.2Q^{1/3}$

(iii) Aircraft parked in the open only ---$12Q^{1/3}$

where 'Q' is the Net Explosive Quantity (NEQ) in kilograms.

Funnel Zone for Military Airfields

92 The funnel zone for military airfields is given below



Funnel/Cone Angle: 15° (7.5° on both sides)

(All Dimensions in meters)

93. For separation of any PES, where explosives are present on a long term basis from squadron operations buildings, flight-line maintenance functions, flight-line fire rescue stations and other activities in direct support of flight-line and aircraft servicing, distances of $8Q^{1/3}$ are to be used.

94. Open storage of ammunition, traversed effectively, is permitted at a distance not less than $12Q^{1/3}$ from parked aircraft outside shelters.

95. General public and central airfield administrative support facilities should be located at a distance of $22.2Q^{1/3}$ (OQD) from PES, where explosives are present on a long term basis subject to a minimum of 275m or 400m depending on the nature of PES (open or igloo) and ES (density of population).
Military runways and Parallel Taxi Track (PTT) should be sited at OQD from PES.

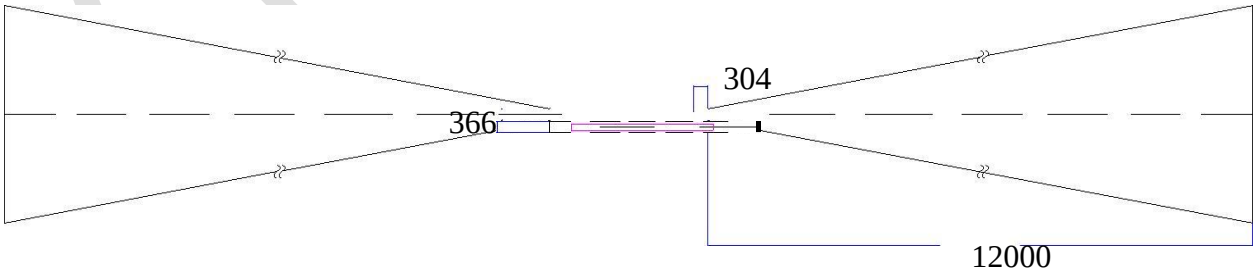
96. **Civil Airfields**

(a) Important airfields (Runway) (e.g. in metropolitan cities): Should be sited at a minimum distance of 2.OQD from explosives storages of HD 1.1 and at OQD for explosives of HD 1.2 and 1.3.

(b) Airfields (Runway and PTT) other than important ones: Should be sited at twice the OQD from explosives storages of HD 1.1 and should be sited at OQD from explosives storages of HD 1.2 and HD 1.3.

Funnel Zone for Civil Airfields

97. Funnel Zone as stipulated by DGCA for civil airfields is given below:



Funnel/Cone Angle: 15° (7.5° on both sides)

(All Dimensions in meters)

Over Flight

98. Ammunition and explosive facilities shall be prohibited under the funnel zone.

99. As far as possible, flight of military and civil aircraft over explosives areas should be avoided. If the above is not feasible, then there should be no flight of aircraft at less than 900m over explosives areas.

100. No aircraft shall cross the sound barrier at altitudes/distances less than 900m over/near any explosives area.

Quantity distances to helipads

101. Helipads should not be sited close to ammunition dumps/storages. A minimum distance of 275m or PIQD whichever is greater should be observed.

SECTION –XI

QUANTITY DISTANCES FROM SHIPS AND BARGES CONTAINING EXPLOSIVES

General

102. The quantity distances prescribed are intended to give maximum protection from vessels loaded with military explosives to other vessels, facilities and to personnel working in the vicinity as well as to the general public when such vessels are anchored/moored or berthed in ports.

103. The military explosives in a vessel are considered to be traversed when they are stored at least 0.6m below the water line.

104. Quantity distances to be observed by the vessels when carrying, loading or unloading military explosives at piers, jetties, wharves or anchorages are given in the succeeding paras to ensure adequate protection of exposed sites.

Separation Distances between Vessels, each loaded with Military Explosives

105. The quantity distance to be applied depends upon the HD of military explosives concerned. For HD 1.1, distances corresponding to $8Q^{1/3}$, $4.8Q^{1/3}$ and $3.2Q^{1/3}$ will provide a high degree of protection, limited degree of protection and limited protection with possibility of subsequent propagation respectively.

106. For HD 1.2, fixed separation distances of 90 m and 135 m are applied for ammunition upto 60mm and above 60mm respectively.

107. For HD 1.3, a fixed distance of 90 m is to be provided.

108. For HD 1.4, a fixed distance of 25 m is to be provided.

Separation Distances from Vessels Loading or Unloading Military Explosives

109. Vessels loading or unloading military explosives of HD 1.1 are treated as untraversed and a separation distance of $8Q^{1/3}$ will provide a high degree of protection to other vessels containing military explosives. Because of the increased risk of accidents in handling military explosives, the greater protection requiring $16Q^{1/3}$ distances should be provided, wherever possible to limit damage to vessels to that of very minor nature.

110. For HDs 1.2, 1.3 and 1.4, quantity distances given at paras 106, 107 and 108 respectively apply.

Separation Distances to Other Cargo Vessels not Carrying Explosives

111. Quantity distances to be observed from vessels containing military explosives to other cargo vessels not containing explosives are as follows:

(a) HD 1.1: $16Q^{1/3}$ distances are preferred as they provide higher protection and restrict damage to that of a very minor nature. If space limits prohibit these distances, $8Q^{1/3}$ can be used for reasonable protection.

(b) For HDs 1.2, 1.3 and 1.4, quantity distances given at paras 106, 107 and 108 respectively are applied.

Separation Distances for Other Utilities on Shore

112. The separation distances from vessels loaded or loading/unloading military explosives to other utilities on shore, viz. explosives storages, explosives workshops, traffic routes, residential buildings, offices, etc. are based on the NEQ and HD of explosives within the vessel. Quantity distances as applicable to these utilities for normal above-ground storages are to be followed and Tables I, II and III should be referred.

Separation Distances from Explosives Vessels to Oil Tankers

113. Tankers containing POL are very susceptible to fire hazard and present a greater risk than other types of ships. The separation distance required for tankers will be full OQD (as given in Tables I, II and III), subject to a minimum of 450 m. If full OQD distance is not available, then 2/3 OQD subject to a minimum of 450 m may be applied.

PART IV

SECTION –XII

QUANTITY DISTANCES FOR UNDERGROUND STORAGE OF AMMUNITION

General

114. In case of underground storage of explosive, Quantity Distances depend on the various variables i.e. ground shock debris and air blast, including the local geology and site specific parameters. These parameters vary significantly from site to site. The QD for ground shock is the same in all directions for homogeneous geological media, whereas QDs for other hazards (blast, debris, thermal, impulse etc) vary markedly in different direction due to configuration specific features such as the locations of adits and ventilation shafts, hazard mitigation designs and terrain. The underground storage of ammunition and explosives typically includes natural caverns and excavated chambers. The minimum distance from the perimeter of a storage area to an external surface should exceed 0.6m and $0.1Q^{1/3}$ (m, kg). Otherwise, aboveground siting criteria should be followed. The acceptable QD in a given direction is generally taken as the maximum QD determined for the various hazards.

Effects of underground explosion

115. The explosion effects, peculiar to underground storage sites, must be taken into consideration for quantity-distance purposes and are given below:

Inside Underground Installation:

(a) Because of limited space, an explosion in an underground facility typically results in long-duration, high pressures and temperatures that spread throughout the entire volume available to the shock front. Each chamber must be provided with properly designed blast doors.

Outside Underground Installation:

(b) Blast waves from adits exhibit highly directional flow-fields along the extended centreline of the passageway. Consequently, the blast wave effects (overpressure and impulse) do not attenuate as rapidly along the centreline axis as they do off the centreline axis.

The following effects should be considered for an external Exposed Site (ES):

i Blast from tunnel adits
ii Blast from craters, if the rock cover is insufficient.
iii Debris from tunnel adits
iv Debris from crater
v Ground Shock

vi Flame and hot gases

Quantity-Distances

116. QD should be provided for the following:

a) Inside UG facilities

i Chamber Interval

b) Outside UG facilities

i Inhabited Building Distance (IBD)
ii Public Traffic Route Distance (PTRD)
iii PIQD
iv SIQD for LRC Igloos
vSIQD for Aboveground Magazine

Measuring Quantity-Distances

117. **a) Inside Underground Installation**

The Chamber Interval is the shortest distance between the walls of two adjacent chambers. Minimum separation distance should be provided between two chambers to prevent major damage by spall, propagation through passageways, blast, flame and hot gases, cracks and fissures.

Scaled cover thickness	= Earth cover (m) / $Q^{1/3}$ where earth cover is actual thickness of earth over the underground facility
Minimum scaled earth cover thickness to be provided	= 0.35 $Q^{1/3}$
Chamber interval	= 1.4 $Q^{1/3}$ (for soft rock or soil) = 2.0 $Q^{1/3}$ (for hard rock)

b) Outside Underground Installation

Distances to ESs outside the underground facility are normally measured as radial distances

i IBD for air blast, debris, and thermal effects issuing from tunnel openings shall be measured from a distance equal to ten times of tunnel diameter at rear of the adit to the nearest wall or point of the location to be protected. Extended centrelines of the openings should be used as reference lines for directional effects.

ii A distance determined by ground shock should be measured from the nearest wall of chamber containing ammunition or explosives to the nearest wall or point of the location to be protected.

iii A distance determined for air blast and debris from a breached cover shall be the minimum distance from the centre of the breach (CCB), at ground surface level, to the location to be protected

QDs for Underground Storage of Hazard Division 1.2 and 1.3 Explosives/ Ammunition

118. Distances shall be determined from the total quantity of explosives /ammunition in the individual chambers. Aggregate of NEQ of Hazard Divisions 1.1 and 1.3 should be considered for QD determination.

a) Hazard Division 1.2 materials: When line-of-sight conditions exist, use distances common to aboveground situations. QD requirements do not apply if the exterior ES is located outside the line-of sight or if barricades (constructed or natural) intercept fragments issuing from an opening.

b) HD 1.3 material should be treated as HD 1.1 material when it is stored underground.

Inhabited Building Distance (IBD)

119. An explosion in an underground storage chamber may produce external air blast from two sources; the exit of blast from existing openings (tunnel entrances, ventilation shafts, etc.) and the rupture or breach of the chamber cover by the detonation. Required IBDs are independently determined for each of these air blast sources, with the maximum IBD used for siting.

a) A breaching chamber cover will produce external air blast. The chamber cover should be more than $0.35Q^{1/3}$ so that air blast through the ruptured cover is negligible. Required IBD due to air blast is negligible as compared to IBD required due to other effects.
b) The QD for tolerable ground shock is the same in all directions for homogeneous, geological media, whereas QDs for other hazards (blast, debris thermal and impulse, etc.) vary markedly in different directions. IBD in a given direction must be the largest of the distances determined for protection against blast, debris and ground shock.
c) Minimum Inhabited building Distance (IBD) should be provided so that in case of cover rupture due to accidental explosion, there is negligible air blast hazard due to crater blast.
d) Minimum IBD should be provided along the extended centreline axis of an opening/adit to prevent from hazard due to overpressure higher than 5 kPa.

e) OQD around chamber of underground ammunition storage facility should be determined as follows:

$$\text{OQD around chamber (crater debris)} = 6Q^{1/3}$$

TABLES

Table I A- Quantity Distances for Hazard Division 1.1

Numbers at intersection Identify columns of various "D" storage distances of Table 1B

		Igloo				Bunkers				Above ground Magazine	
From PES	To ES	a Side	b. Rear	c. Front UT	d. Front T	a Side	b. Rear	c. Front UT	d. Front T	UT	T
Igloo	a.Side	D1	D1	D3	D3	D1	D1	D5	D5	D5	D4
	b.Rear	D1	D1	D2	D2	D1	D1	D5	D5	D5	D4
	c.Front UT	D3	D2	D6	D5	D3	D2	D6	D5	D6	D5
	d.Front T	D3	D2	D5	D5	D3	D2	D5	D5	D5	D5
Bunkers	a.Side	D1	D1	D3	D3	D3	D3	D5	D5	D5	D5
	b.Rear	D1	D1	D2	D2	D3	D3	D5	D5	D5	D5
	c.Front UT	D5	D5	D6	D5	D5	D5	D6	D5	D6	D5
	d.Front T	D5	D5	D5	D5	D5	D5	D5	D5	D5	D5
Above Ground Magazine	a.UT	D5	D5	D6	D5	D5	D5	D6	D5	D6	D5
	b.T	D4	D4	D5	D5	D5	D5	D5	D5	D5	D5

UT: Untraversed **T: Traversed**

Note: - (i) For LRC Igloo, the minimum separation distance should be greater than the crater radius i.e. $0.5\ Q^{1/3}$

(ii) The earth cover of one Igloo / Earth covered Magazine should not merge with earth cover of adjacent Igloo / Earth covered Magazine

Table I B - Quantity distance for Hazard Division 1.1 (SIQD)

Use with Table IA

Net Explosive Quantity (kg)	Quantity Distances in meters					
	$D1 = 0.5Q^{1/3}$	$D2 = 0.8Q^{1/3}$	$D3 = 1.1Q^{1/3}$	$D4 = 1.8Q^{1/3}$	$D5 = 2.4Q^{1/3}$	$D6 = 4.8Q^{1/3}$
50	10	10	10	10	10	18
100	10	10	10	10	12	23
150	10	10	10	10	13	26
200	10	10	10	11	14	29
300	10	10	10	12	17	33
400	10	10	10	14	18	36
500	10	10	10	15	20	39
600	10	10	10	16	21	41
700	10	10	10	16	22	43
800	10	10	11	17	23	45
900	10	10	11	18	24	47
1000	10	10	11	18	24	48
1500	10	10	13	21	28	55
2000	10	11	14	23	31	61
2500	10	11	15	25	33	66
3000	10	12	16	26	35	70
3500	10	13	17	27	36	73
4000	10	13	18	29	38	76
4500	10	13	18	30	40	79
5000	10	14	19	31	41	82
6000	10	15	20	33	44	87
7000	10	15	21	35	46	92
8000	10	16	22	36	48	96
9000	11	17	23	38	50	100
10000	11	17	24	39	52	105
15000	13	20	27	45	59	120
20000	14	22	30	49	65	135
25000	15	24	32	53	70	145

Table I B - Quantity distance for Hazard Division 1.1 (SIQD)

Use with Table IA

Net Explosive Quantity (kg)	Quantity Distances in meters					
	$D1 = 0.5Q^{1/3}$	$D2 = 0.8Q^{1/3}$	$D3 = 1.1Q^{1/3}$	$D4 = 1.8Q^{1/3}$	$D5 = 2.4Q^{1/3}$	$D6 = 4.8Q^{1/3}$
30000	16	25	34	56	75	150
35000	17	26	36	59	79	160
40000	17	27	38	62	82	165
45000	18	29	39	64	86	175
50000	19	30	41	67	89	180
60000	20	32	43	71	94	190
70000	21	33	46	74	100	200
80000	22	35	48	78	105	210
90000	23	36	49	81	110	215
100000	23	37	51	84	115	225
112500	24	39	53	87	120	235
125000	25	40	55	90	120	240
136000	26	41	57	93	125	250
150000	27	43	59	96	130	260
175000	28	45	62	101	135	270
200000	30	47	65	106	145	285
220000	31	49	67	109	145	290

Table I C - Quantity Distances for Hazard Division 1.1 for Conventional ESH (PIQD and OQD)

Net Explosive Quantity in kg at PES (Traversed)	Process inside Quantity Distances. To process buildings		Quantity Distances in meters			
			Outside Quantity Distances (OQD)			
			To main offices, engg. workshops, main canteens etc.		To public Traffic Routes PTRD	To dwelling houses, places of assembly, hospitals, National Highways etc.
	D7	D8= $8Q^{1/3}$	D9	D10= $22.2Q^{1/3}$	D11= $14.8Q^{1/3}$	D12= $22.2Q^{1/3}$
50	18		45		180	275
100	23		45		180	275
150	26		45		180	275
200	29		52		180	275
300	33		68		180	275
400	36		82		180	275
500	39		95		180	275
600	42		110		180	275
700	45		120		180	275
800	48		130		180	275
900	50		140		180	275
1000	53		150		180	275
1500	66		200		180	275
2000	78		240		190	280
2500	90		280		205	305
3000	105		305		215	320
3500	115		330		225	340
4000	130	130	350		235	355
4500		135	370	370	245	370
5000		140		380	255	380
6000		150		405	270	405
7000		155		425	285	425
8000		160		445	300	445
9000		170		465	310	465

Table I C - Quantity Distances for Hazard Division 1.1 for Conventional ESH (PIQD and OQD)

Net Explosive Quantity in kg at PES (Traversed)	Quantity Distances in meters					
	Process inside Quantity Distances. To process buildings		Outside Quantity Distances (OQD)			
			To main offices, engg. workshops, main canteens etc.		To public Traffic Routes PTRD	To dwelling houses, places of assembly, hospitals, National Highways etc.
	D7	D8	D9	D10	D11	D12
10000		175		480	320	480
15000		200		550	365	550
20000		220		605	405	605
25000		235		650	435	650
30000		250		690	450	690
35000		265		730	485	730
40000		275		760	510	760
45000		285		790	530	790
50000		295		820	545	820
60000		315		870	580	870
70000		330		920	610	920
80000		345		960	640	960
90000		360		995	665	995
100000		375		1035	690	1035
120000		395		1100	730	1100
136000		415		1145	765	1145
150000		430		1180	790	1180
175000		450		1245	830	1245
200000		470		1300	870	1300
220000		485		1345	895	1345

Note: In the case of Igloos D10, D11 and D12 distances should be a minimum of 400 m irrespective of quantity

Table I D - Outside Quantity Distances for Hazard Division 1.1 for NEQ less than 50 kg

S. No.	NEQ (kg)	OQD
1.	5	65
2.	10	65
3.	15	80
4.	20	115
5.	25	140
6.	30	165
7.	35	180
8.	40	195
9.	45	220

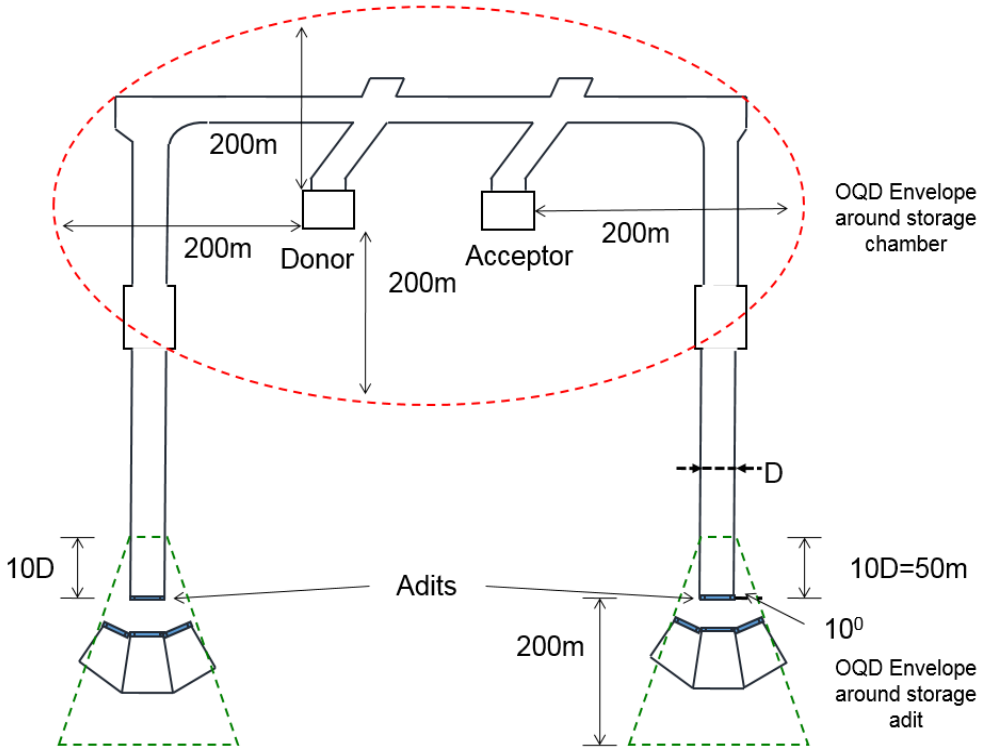
Table I E - Quantity Distances(PIQD and OQD) for Hazard Division 1.1
for LRC Box type Igloo

Type of Building	Q-Ds	Orientation	Protection level constants
LRC Box Type Igloo		Front	$7.2\ Q^{1/3}$
	PIQD	Side	$6.8\ Q^{1/3}$
		Rear	$6.0\ Q^{1/3}$
		Front	$19.0\ Q^{1/3}$
	OQD	Side	$18.0\ Q^{1/3}$
		Rear	$16.0\ Q^{1/3}$

Note: For detailed design of LRC Box type Igloos and their orientations refer STEC Pamphlet No. 21

Table I F – Quantity Distances for Hazard Division 1.1 for Underground Storage Facility

Capacity of each chamber	40 MT NEC
Loading Density	less than 10 kg/m^3
Scaled cover thickness	12m
Chamber interval	1.4 $Q^{1/3}$ = 48m (for soft rock or soil) 2.0$Q^{1/3}$ = 69m (for hand rock)
OQD around chamber	205m (crater debris) 6.0$Q^{1/3}$
OQD around Adit	465m (without barricade) 200m (with barricade)



Various Quantity Distances required for two chambered ammunition storage facility of 40 MT HD1.1 capacity per chamber

Table I G – Quantity Distances for Hazard Division 1.1 for Underground Storage of Ammunition of 40MT NEC per chamber having vertical shafts.

Structure	Direction	AGM (T)	AGM (UT)	IGLOO	Process Bldg.	PTR	OQD
Underground Chambers	Rear	$2Q^{1/3}$	$4Q^{1/3}$	$2Q^{1/3}$	$5Q^{1/3}$		
Main Tunnel	Away from Chambers	$2Q^{1/3}$		$2Q^{1/3}$	$4Q^{1/3}$		
Blast Escape Shafts	Away from Chambers	$2Q^{1/3}$		$2Q^{1/3}$	$4Q^{1/3}$		$4Q^{1/3}$
Lift Shafts	Away from Chambers	$2Q^{1/3}$		$2Q^{1/3}$	$4Q^{1/3}$		$4Q^{1/3}$

The QDs for single underground process chamber will be same as that of storage chamber.

Table II - Quantity Distances for Hazard Division 1.2

Net Explosive Quantity (kg)	Quantity Distances in meters			
	To Storage Buildings (SIQD)	To Process Buildings (PIQD)	Outside Quantity Distances (OQD)	
			To dwelling houses, places of assembly, hospitals, main offices, main engg. workshops, main canteens	
			Calibre upto 60 mm	Calibre over 60 mm
	D1	D2	D3	D4
50	10	20	180	275
100	10	20	180	275
150	10	20	180	275
300	10	24	180	275
500	10	27	180	275
1000	10	32	180	275
2000	13	37	190	280
3000	16	40	215	320
5000	20	45	255	350
10000	24	51	295	390
15000	25	55	315	420
20000	26	58	335	445
25000	27	60	345	460
30000	28	62	360	475
40000	30	66	375	500
50000	30	68	390	520
60000	30	70	400	525
70000	30	72	410	530
80000	30	74	410	540
90000	30	75	410	550
100000	30	76	410	560
120000	30	79	410	560
136000	30	80	410	560
150000	30	82	410	560
175000	30	80	410	560
200000	30	85	410	560
220000	30	87	410	560

Table III - Quantity Distance for Hazard Division 1.3

Net Explosive Quantity (kg)	Quantity Distance in meters				
	To storage building (SIQD)		To process building (PIQD)	Outside Quantity Distance	
	Traverse/ untraversed	Bunker		To public traffic route	To main office main engg. workshop, dwelling houses etc.
	$D1 = 0.22Q^{1/2}$	$D2 = 0.11Q^{1/2}$	$D3 = 3.2Q^{1/3}$	$D4 = 4.3Q^{1/3}$	$D5 = 6.4\ Q^{1/3}$
50	10	10	12	60	60
100	10	10	15	60	60
150	10	10	17	60	60
200	10	10	19	60	60
300	10	10	22	60	60
400	10	10	24	60	60
500	10	10	26	60	60
600	10	10	27	60	60
700	10	10	29	60	60
800	10	10	30	60	60
900	10	10	31	60	60
1000	10	10	32	60	60
1500	10	10	37	60	60
2000	10	10	41	60	65
2500	12	10	44	60	73
3000	13	10	46	60	80
3500	14	10	49	60	86
4000	15	10	51	62	92
4500	16	10	53	66	98
5000	16	10	55	74	110
6000	16	10	58	78	120
7000	19	10	62	82	125
8000	21	11	64	86	130
9000	22	11	67	89	135
10000	23	12	69	92	140
15000	28	14	79	110	160
20000	32	16	87	120	175
25000	36	18	94	125	190
30000	40	20	100	135	200
35000	43	22	105	140	210
40000	46	23	110	150	220
45000	48	24	115	155	230
50000	51	26	120	160	240

Table III - Quantity Distance for Hazard Division 1.3 (continue)

Net Explosive Quantity (kg)	Quantity Distance (in meters)				
	To storage building (SIQD)		To process building (PIQD)	Outside Quantity Distance	
	Traverse/ untraversed	Bunker		To public traffic route	To main office main engg. workshop, dwelling houses etc.
	D1	D2	D3	D4	D5
60000	56	28	130	170	255
70000	60	30	135	180	265
80000	64	32	140	185	280
90000	68	34	145	195	290
100000	72	36	150	200	300
120000	79	40	160	215	320
136000	84	42	165	220	330
150000	87	44	175	230	345
175000	95	48	180	245	360
200000	100	50	190	255	375
220000	105	52	195	260	390

Appendix 1

HAZARD CLASSIFICATION CODES

Description of substance or articles to be classified	Compatibility-Group	Hazard Classification Code
Primary explosive substance	A	1.1A
Article containing a primary explosive substance and not containing two or more effective protective features	B	1.1B 1.2B 1.4B
Propellant explosive substance or other deflagrating explosive substance or article containing such explosive substance	C	1.1C 1.2 C 1.3 C 1.4 C
Secondary detonating explosive substance or black powder or article containing a secondary detonating explosive substance, in each case without means of initiation and without a propelling charge or article containing a primary explosive substance and containing two or more effective protective features.	D	1.1D 1.2D 1.4 D 1.5 D
Article containing a secondary detonating explosive substance, without means of initiation, with a Propelling charge (other than one containing a Flammable liquid or gel or hypergolic liquids)	E	1.1 E 1.2 E 1.4 E
Article containing a secondary detonating explosive substance with its own means of initiation, with a Propelling charge (other than one containing a flammable Liquid or gel or hypergolic liquids) or without a propelling charge.	F	1.1 F 1.2 F 1.3 F 1.4 F
Pyrotechnic substance or article containing a pyrotechnic substance or article containing both an explosive substance and an illuminating, incendiary, tear or smoke producing substance (other than a water-activated article or one containing white phosphorous, phosphides, a pyrophoric substance, a flammable liquid or gel or hypergolic liquids)	G	1.1 G 1.2 G 1.3 G 1.4G
Article containing both an explosive substance and white phosphorous	H	1.2 H 1.3 H
Article containing both an explosive substance and a flammable liquid or gel	J	1.1 J 1.2 J 1.3 J
Article containing both an explosive substance and a toxic chemical agent	K	1.2 K 1.3 K

Description of substance or articles to be classified	Compatibility-Group	Hazard Classification Code
Explosive substance or article containing an explosive substance and presenting a special risk (e.g. due to water-activation or presence of hypergolic liquids, phosphides or a Pyrophoric substance) and needing isolation of each type	L	1.1 L 1.2 L 1.3 L
Articles containing only extremely insensitive detonating substance	N	1.6 N
Substance or article so packed or designed that any hazardous effects arising from accidental functioning are confined within the package unless the package has been degraded by fire, in which case all blast or projection effects are limited to the extent that they do not significantly hinder or prohibit firefighting or other emergency response efforts in the immediate vicinity of the package.	S	1.4 S

Appendix – 2

SCHEME OF CLASSIFICATION OF EXPLOSIVES, COMBINATION OF HAZARD DIVISION WITH COMPATIBILITY GROUP

COMPATIBILITY GROUPS														
														A-S
Hazard division	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**N**	**S**	**Σ**
1.1	1.1A	1.1B	1.1C	1.1D	1.1E	1.1F	1.1G		1.1J		1.1L			9
1.2		1.2B	1.2C	1.2D	1.2E	1.2F	1.2G	1.2H	1.2J	1.2K	1.2L			10
1.3			1.3C			1.3F	1.3G	1.3H	1.3J	1.3K	1.3L			7
1.4		1.4B	1.4C	1.4D	1.4E	1.4F	1.4G						1.4S	7
1.5				1.5D										1
1.6												1.6N		1
Σ(1.1-1.6)	1	3	4	4	3	4	4	2	3	2	3	1	1	35

GLOSSARY

***ABOVE GROUND BUILDING*:** A building at natural ground level, the roof and at least one side of which are exposed to open air.

Adit : A passage or tunnel leading into an underground storage site

AMMUNITION: An enclosed explosive substance designed to produce an explosive effect. For the purpose of these regulations, the term explosives 'defined below includes ammunition as well.

AMMUNITION WITH ITS MEANS OF INITIATION: Ammunition which has its normal initiating device assembled to it and this device is considered to present a significant risk during transport. The term does not apply, however, to a contrivance packed together with its means of initiation provided the device is so packaged as to eliminate the risk of causing detonation of the contrivance in the event of accidental functioning of the initiating device. The means of initiation can be assembled to the contrivance provided there are protective features such that the device is unlikely to cause detonation of the contrivance in normal conditions of storage and transport.

AMMUNITION WITH A PROPELLING CHARGE: Ammunition which is assembled with a propelling charge, or packed with a propelling charge in the same package, or palletized with a propelling charge on the same pallet.

ARMING MECHANISM: A safety feature to preclude the accidental initiation of the main explosive charge of ammunition by interrupting the pick-up of the detonating reaction in a fuze assembly.

ASSEMBLY PLACE: A place or building where it is customary for members of the public to assemble, e.g. places of worship, school, sports stadium etc.

ADMINISTRATIVE AREA: The area in which administrative buildings are located that function for the installation as a whole, excluding those offices located near and directly serving components of explosives storage and process areas.

BARRICADE OR TRAVERSE: A natural ground feature, artificial mound or wall, which is capable of preventing direct communication of explosion by high velocity projections from one quantity of explosives to another although it may be destroyed in the explosion.

BIN TYPE BUILDING: A building in which the interior is divided into a number of compartments by partitions sufficiently strong to prevent the simultaneous explosion of the whole contents of the building.

BUNKER TYPE BUILDING: A building at natural ground level, the roof and sides of which are covered by earth, access being provided in one side.

BLAST: A destructive wave produced in the surrounding atmosphere by an explosion. The blast includes a shock front, high pressure behind the shock front and a rarefaction following the high pressure.

CHARGE / WEIGHT RATIO: It is the ratio, expressed as a percentage, of the Net Explosives Quantity to the gross weight of the packaged or unpackaged ammunition.

***CHAMBER INTERVAL*: The** interval between the natural or artificial walls of adjacent underground storage chambers/sites

CLASSIFICATION: The allocation of a United Nations Hazard Division, Compatibility Group and Serial Number to an explosive according to its general properties and characteristics and to those of its packaging during storage and transport. Military explosives are classified by the STEC.

CLEAN AREA: That portion of an explosives building or area from which it is essential to exclude extraneous grit or dust.

CLEAN CONDITIONS: The conditions necessary to minimize the special risk associated with handling, storage and securing of certain nature of explosives.

COMPATIBILITY: Explosives, including ammunition, are considered to be compatible if they may be stored or transported together without significantly increasing either the probability of an accident or for a given quantity, the magnitude of the effects of such an accident.

COMPATIBILITY GROUP: In the United Nations Classification System for Dangerous Goods, Class I is divided into compatibility Groups denoted by a letter (e.g. A, B etc.). With the exception of items in Group L and N, explosives in the same group are compatible with one another and may be stored together.

COVER : The solid ground situated between the ceiling or the wall of an underground chamber and the nearest exterior surface

CRACK : A short, primary discontinuity, which is not pervasive and may not be visible

CRATER : A hole or chasm in the cover (burden) caused by an underground explosion

DEBRIS: Any portion of a building, fittings, machinery, equipment, etc., which is propelled from the site of an explosion.

DIVIDING WALL: A wall designed to prevent, control or delay propagation of an explosion between quantities of explosives in adjacent rooms/bays.

DEFLAGRATION: A rapid chemical reaction in which the out-put of heat is sufficient to enable the reaction to proceed and be accelerated without input of heat from another source. Deflagration is a surface phenomenon with the reaction products flowing away from the unreacted material along the surface at subsonic velocity. The effect of a deflagration under confinement is an explosion. Confinement of the reaction increases pressure, rate of reaction and temperature and may cause transition into a detonation.

DEFLAGRATING EXPLOSIVE: A deflagrating explosive is an explosive which reacts by

deflagration rather than by detonation when used in its normal manner.

DETERIORATED EXPLOSIVE: An explosive which has, for any reason, undergone such deterioration or change in condition as materially to increase the risk likely to be present during its conveyance and storage.

DETONATION: A violent chemical reaction within a chemical compound or a mechanical mixture evolving heat and high pressures. A detonation, as opposed to a deflagration, is a shock wave induced chemical reaction which proceeds through the unreacted material at a constant supersonic velocity causing extremely high pressures on the surrounding media.

DETONATING EXPLOSIVE: An explosive whose function is to react by detonation, rather than by deflagration, under the stimulus of an appropriately applied energy source.

DETONATOR: An explosive device filled with an initiatory composition, which provides the first of the detonating reactions in an explosives charge system.

EFFECTIVE NEQ: The effective NEQ is the sum of the NEQ that will contribute significantly to the dominant hazard for the Hazard Division concerned.

EXCHANGE SIDING: A set of sidings designed to facilitate the transfer of rail wagons between a depot rail network and the main line system.

EXPLOSION: The rapid production of hot gases at a high pressure as a result of a chemical or nuclear reaction and the sudden release of this energy to cause strong dynamic stresses in the surroundings. The term usually relates to the effect of a detonation of initiating explosives and high explosives. It has been variously applied to deflagration reactions in high explosives propellant, explosives and to sudden high energy releases such as from failures of high pressure gas cylinders, steam boilers etc.

EXPLOSIVE: An explosive is any substance or mixture made with an aim of producing an explosive, incendiary or pyrotechnic effect. An explosive atmosphere of gas, vapour or dust is not considered to be an explosive. For the purpose of these regulations, the terms ‘explosives’ ‘ammunition’ well.

EXPLOSIVES AREA: An area designated for explosives activities. It is usually enclosed by a security fence. When there is no security fence, it is usually taken as being the area within a radius of 50 meter from any building or stack containing explosives.

EXPLOSIVES BUILDING: A building containing or likely to contain explosives or ammunition.

EXPLOSIVES LIMIT: The authorized quantity of explosives in a building, site or location.

EXPLOSIVES LIMIT LICENCE: A license issued by the competent authority (STEC) laying down the explosives limit for a building.

EXPLOSIVES STORE HOUSE (ESH): A building designed and erected for the sole purpose of storing explosives or a building modified, adopted or appropriated for that purpose and approved

by the competent authority. Explosives store houses may be of above ground type, bunker type or of Igloo type.

EXPOSED SITE (ES): A magazine, store house, cell, stack, truck or trailer loaded with explosives, process building, workshop transit shed, inhabited building, assembly place or public traffic route exposed to the effects of an explosion or fire from a Potential Explosion Site (PES).

FIGURE OF INSENSITIVENESS: A value determined on a standard falling weight machine which compares the behavior of a sample of an explosive material with that of a standard explosive (normally RDX).

FRAGMENT: Any metal portion of the ammunition or its package which is propelled from the site of an explosion.

FUSE/FUZE: Although these two words have a common origin (French fusee, fusil) and are sometimes considered to be synonyms, it is useful to maintain the convention that fuse refers to an igniting or explosives device in the form of a cord or a tube whereas fuze, refers to a device which incorporates mechanical, chemical or hydrostatic components to initiate a train of fire or detonation. The word fuse is also applied to a weak link which is incorporated in an electrical circuit as a safety device.

GROUP OFFICE: An office serving any one section or unit of an establishment and employing a small number of persons.

HAZARD DIVISION: A division of the United Nations Dangerous Goods Class I (viz explosives) indicating the main type of hazard to be expected in the event of an accident. There are 6 such divisions HDs 1.1, 1.2, 1.3, 1.4, 1.5 and 1.6, although the last two are unlikely to be used to any extent for military purposes.

HIGH EXPLOSIVE: An explosive which when suitably initiated is capable of sustaining a detonation reaction throughout its mass. When suitably desensitized, such explosives are used to form the main charge for munitions with general or specific destructive purposes as may be provided by blast or projections.

HIGH VELOCITY PROJECTION: Debris or fragments having a high velocity as a result of an explosion (usually a detonation) and with sufficient remaining energy to propagate an explosion to another site.

HOLDING YARD: A specified area used to accommodate explosives laden carriers before or during movement.

IGLOO:A magazine or store house normally built at ground level, earth covered and constructed in corrugated steel or reinforced concrete, provided with a strong head wall and door(s). Earth covers the roof, the sides and the rear. The magazine or store house and its earth cover are designed to stringent criteria for resistance to external blast loading and attack by high velocity projections. The cross section of the igloo may be semicircular, elliptical, rectangular, etc.

IGNITION: The initial heating of a deflagrating explosive or pyrotechnic composition, by flame or other sources of heat, upto its point of inflammation. Means of ignition may include propellants, primers, igniters, squibs, fuse-lighters etc.

INHABITED BUILDING: A building or structure occupied in whole or in part by people.

INITIATION: The transmission of a violent chemical reaction at supersonic velocity from one explosive into an adjacent explosive to cause its detonation. Means of initiation may include fuses, primers and detonators.

INSENSITIVE/VERY INSENSITIVE SUBSTANCE: An explosives substance which is so insensitive that there is very little probability of initiation or transition from burning to detonation under normal conditions of transport.

LOBBED AMMUNITION: Unexploded ammunition projected from an exploding building or stack. It may explode on impact.

LOW ORDER DETONATION: An incomplete and relatively slow detonation, being more nearly combustion than an explosion

MAGAZINE: An explosives store house, where observance of clean conditions is necessary, construction of which embodies certain special features and intended primarily for the storage of Hazard Division 1.1 explosives relatively more sensitive to spark and friction. The special requirements are enumerated in STEC Pamphlet No.3.

MAIN OFFICE or "GROUP OFFICE": An office, wherein considerable number of persons are employed and valuable records maintained. The Service Headquarters will use their discretion in deciding whether a particular office is to be treated a 'main office' or a

MARSHALLING YARD: A group of railway sidings in which freight trains are formed and reformed.

MASS EXPLOSION: An explosion, which affects, practically instantaneously, virtually the entire quantity of explosives under consideration. The term usually relates to detonation but also applies to deflagration when the practical effects are similar e.g. the mass deflagration of propellant under strong confinement so as to produce a bursting effect and a serious hazard from debris.

MASS FIRE: A rapid deflagration of the entire quantity of explosives under consideration in circumstances that avoid a bursting effect and a serious hazard from debris. A typical mass fire occurs in a few seconds at most and produces extensive flame, intense radiant heat and minor projection effects.

MEANS OF IGNITION: A device to cause the deflagration of an explosive or the ignition of a pyrotechnic device e.g. primer for a propelling charge, electric squib, igniter for a rocket motor etc.

MEANS OF INITIATION: A device intended to cause the detonation of an explosive or the activation of a detonating train. e.g. blasting cap, detonator for ammunition, detonating fuze etc.

MODERATE FIRE: A fire comparable with that involving an ordinary commercial building which burns comparatively slowly and with a moderate flame radius. Some items may be thrown out of such a fire for a short distance.

MUNITION: A complete device, (e.g. missile, shell, mine, demolition store etc.) charged with explosives, propellants, pyrotechnics, initiating compositions or nuclear, biological or chemical material, for use in connection with offence, or defence, or training, or non-operational purposes, including those parts of weapon systems containing explosives. It is synonymous with Ammunition.

NET EXPLOSIVES QUANTITY (NEQ): The quantity of the explosives substance present in the ammunition. It does not include such substances as white phosphorous, war gases or smoke and incendiary compositions unless the substances contribute significantly to the dominant hazard Division concerned.

PALLET: A portable item of equipment affording a platform upon which goods may be placed to form a unit load for lifting by means of rigid forks or blades.

PETROLEUM, OIL AND LUBRICANTS (POL): A term covering all petroleum and associated products.

POTENTIAL EXPLOSION SITE (PES): The building, Cell, Chamber or stack which contains or is intended to contain explosives, the explosion of which will affect the Exposed Site (ES) being assessed.

PRIMARY EXPLOSIVE (PRIMARY DETONATING EXPLOSIVE): The terms 'primary explosive" and 'secondary explosive' are used to distinguish between relatively sensitive initiating element of a detonation train and the relatively insensitive main charge whose function is to provide the main explosive effect.

A primary explosive is one in which the probability of development of the detonation from the reaction initiated by a mild stimulus, is adequate for that explosive to be used as the source of the detonation wave in an explosives train. (Mercury Fulminate, Lead Azide and Lead Styphnate are typical examples).
For transport purposes some explosives, such as cap composition are considered as primary explosives because of their great sensitiveness to the contact of a flame, to impact or to friction.

PRIMER: An item using a primary explosive substance or a composition with such characteristics.

PROCESS BUILDING: A building authorized for the manufacture, filling, assembly, and inspection, breakdown testing or repairing of explosives (including ammunition). The term also includes explosives laboratory, explosives preparation room, explosives workshop and a paint shop or other shops within the enclosed explosives area of an explosives or filling factory etc., where work is regularly carried on.

PROPELLANT: A deflagrating explosive used to generate hot gases and do useful work at a predetermined rate in a system e.g. to accelerate and propel a missile, start an engine etc.

PUBLIC TRAFFIC ROUTES: Roads, railways and waterways outside an explosives area where passengers (public or private) carrying vehicles and vessels have to be afforded safeguarding measures.

PYROTECHNIC: A compound or a mixture designed to produce an effect by heat, light, sound, gas or smoke or a combination of these as a result of a non-detonative self-sustaining exothermic chemical reaction.

QUANTITY DISTANCE (Q-D): The quantity of explosives material and distance separation relationship that provide defined types of protection. These relationship are based on levels of risk considered acceptable for the stipulated exposures and are tabulated in the appropriate Q-D tables. Separation distances are not absolutely safe distances but are relatively protective/safe.

QUANTITY DISTANCE: Quantity distances are of two main types, inside and outside:

INSIDE QUANTITY DISTANCE (IQD)

STORAGE INSIDE QUANTITY DISTANCE **(SIQD):** The distance from a building or a stack containing explosives to a storage building which will prevent direct propagation of explosion or fire from one to the other by missile, flame or blast.

PROCESS INSIDE QUANTITY DISTANCE **(PIQD):** The distance from a building or a stack containing explosives to a process building which will provide a reasonable degree of safety to the operatives within the other process buildings and a high degree of protection against immediate or subsequent propagation of explosions.

OUTSIDE QUANTITY DISTANCE (OQD):

Inhabited building distance**:** The minimum permissible distance from a PES to inhabited buildings, dwelling house, place of assembly, main offices, main engineering workshops etc. which is such that the ignition or the explosion of the explosives at the PES will not cause severe structural damage to buildings etc. or danger to their occupants.

PUBLIC TRAFFIC ROUTE DISTANCE**:** The minimum permissible distance from a PES to public traffic routes which is such that the ignition or explosion of the explosives at the PES will not cause danger to the occupants of vehicles at the ES. Two basic alternatives are available depending upon the local conditions viz full inhabited building distance or 2/3 of this.

RAILWAYS: All railways outside the enclosed explosives area, used for public passenger traffic.

RIVERS: Those having tidal waters and others used by passenger carrying craft.

SAFETY CLASS EXPLOSIVES**:** Explosives in Hazard Division 1.4 Compatibility Group ***"S"*** These are so designed or packaged that any hazardous effects arising from accidental functioning are confined within the package unless the package has been degraded by fire, in which case all blast or projection effects are limited to the extent that they do not significantly

hinder fire fighting or other emergency response efforts in the immediate vicinity.

SECONDARY EXPLOSIVE: An explosive capable of detonation from a strong stimulus. The probability of the development of a detonation wave in such an explosive from a mild stimulus is low compared with a primary explosive e.g. TNT, RDX/HMX based explosives.

***SENSITIVENESS*:** A measure of the ease with which an explosive may be ignited or initiated by a prescribed stimulus.

SERIOUS STRUCTURAL DAMAGE: Damage which renders inhabitable building with 23 cm brick walls or their equivalent e.g. serious weakening or displacement of foundations, supporting walls, interior supports, side walls, floors or ceiling structures, breaking numerous rafters or other important supporting members of roofs or floors. Damage which is readily repairable is not considered serious structural damage.

***SERVICE HEADQUARTERS*:** Army HQ in the case of the Army, the Naval HQ in case of the Navy, the Air HQ in the case of the Air Force and the Ordnance Factory Board in case of the ordnance factories.

SINGLE CHAMBER STORAGE SITE: A chamber storage site with one chamber, which has its own entrance from the exterior and is not connected by air ducts or passageways to any other storage chamber

SHOT GUN TYPE MAGAZINE: A single chamber storage site with one exit and a direct line-of-sight from the chamber to the outside of the underground installation

***SITE*:** Abbreviation for Exposed site (ES) or Potential Explosion Site (PES).

SMALL ARMS AMMUNITION: Ammunition intended for firing from weapons of caliber not greater than 19.0 mm.

SYMPATHETIC DETONATION: The detonation of an explosive as a consequence of another detonation. The term is usually used in connection with accidents. It is restricted, for the purpose of Quantity Distance, to practically instantaneous propagation.

TRANSIT SHED: A shed in an explosives area where consignments of explosives are stored prior to dispatch.

TRAVERSE: See Barricade.

UNDERGROUND: A natural or excavated space underground with a ceiling not less than 600mm below the natural ground level, specially adapted for the storage of explosives. Access is by tunnel or lift-shaft

UNDERGROUND STORAGE: *Storage, normally in solid rock, in a cavern or chamber storage.*

***UNIT RISK*:** In a given situation, the greatest quantity of explosives which can function virtually instantaneously to provide an explosive effect

WATERWAYS: Canals, rivers, etc., used by passenger vessels or where cargo vessels are berthed and other waterways where special consideration is warranted in regard to passenger vessels.