Quantity-Distance Principles

Table of Contents

D. Mixing and Aggregation Rules

E. Barricades

F. Determination of Quantity-Distance

Part 1: Introduction

1.1 Safe Storage

Explosives General Regulations require that explosives be stored at a safe distance from susceptible sites. Following the principles in these guidelines will help to ensure that safe storage is achieved, although it is impracticable to prescribe distances which would guarantee absolute immunity from propagation, damage or even injury. There is a certain amount of risk inherent in these guidelines in terms of probability of an accident and resulting damage or injury. That risk, however, represents an acceptable risk in accordance with internationally recognized standards. In other words, there is a compromise between absolute safety and practical considerations. The actual degree of risk can not yet be quantified but a great deal of study is being carried out internationally.

It is not possible to formulate a definitive standard to cover all situations because of the myriad factors involved in selecting a safe storage site. If a particular situation is not covered in these guidelines, an inspector of explosives should be consulted.

1.2 Grandfathering

These principles replace tables and requirements currently in force, however, any explosives storage sites with a valid licence may continue to apply the superseded requirements. The old tables have proven to be adequate, however, because of more recent test results, updated principles have evolved. In some situations grandfathering cannot realistically be maintained for all time (eg., population encroachment). Existing facilities are encouraged to convert to these principles at the first opportunity.

1.3 Application

These principles shall apply to new licences and amendments to existing licences for the siting of explosives being stored under authority of the Explosives Act (Canada) in above ground storage. They do not apply, for example, to unlicensed storage or to day boxes for the temporary storage (no overnight storage) of blasting explosives at work sites which come under provincial Occupational Health and Safety legislation. They do not cover underground or earth-covered (igloo) storage magazines. Primary explosives in Compatibility Group A may need additional safeguards to those contained in these guidelines.

1.4 Responsibilities

The applicant for a licence is responsible for accurately measuring applicable distances and for providing all pertinent information. The applicant shall make the first level determination of how much explosive may be stored at a particular site. An inspector shall review a licence application and, based on the information provided and subsequent confirmation, if required, shall confirm that the determinations of the applicant are valid.

1.5 Mandatory Requirements and Interpretation of Principles

All requirements in these guidelines shall be considered as mandatory, unless otherwise approved by an inspector, prior to an applicable licence being issued. Where there is scope for interpretation or where there is disagreement in the interpretation of these principles, an inspector shall have the final say.

1.6 Appeal

Any decisions made by an explosives inspector may be appealed, in writing, to the Chief Inspector of Explosives.

1.7 Wharfs

The Interdepartmental Technical Committee on Dangerous Goods has prepared guidelines for assessing wharfs and facilities. Those guidelines are being applied to Ports Canada facilities and some Harbours and Ports wharfs. The guidelines are similar to those contained in this document.

1.8 Burning, Destruction and Test Areas

Burning, destruction and test areas shall be sited bearing in mind that a burning high explosive could transition to detonation. Burning, destruction and test areas shall be included on the appropriate licence.

1.9 Conversion of Gross Weight (g.w.) to Net Explosive Quantity (NEQ) for Fireworks

The regulations for some explosives such as fireworks are based on gross weight (g.w.) rather than net explosives quantity (NEQ). Sometimes it is difficult to calculate actual NEQ directly because of the diverse nature of articles and the many types of articles that may be stored. NEQ may be calculated by either of the following two methods:

i) actual NEQ from information provided by manufacturers

ii) by using the 50% or 25% rules as applicable, i.e., 50% of the g.w. of display fireworks shall be considered NEQ, and 25% of the g.w. of consumer fireworks shall be considered NEQ.

1.10 Specialized Segments of the Explosives Industry

Quantity-Distance requirements for some specialized segments of the explosives industry are found in regulations, such as, Oil and Gas Well Service Regulations.

1.11 References

Further references that may be consulted for situations not covered in these guidelines include:

DND

C-09-153-001/TS-000 Explosives Safety Manual Volume 1 Ammunition Depots and Fixed Ammunition Facilities. 1991-01-31

NATO

Allied Ammunition Storage and Transport Publication 1 (AASTP-1) Manual of NATO Safety Principles for the Storage of Military Ammunition and Explosives (May 1992)

UK/ESTC

ESTC Leaflet No. 5 — Part 1. Quantity-Distances for Military Explosives December 1979

ESTC Leaflet No. 5 - Part 2 Quantity-Distances for Military Explosives 1992 prepared by The Explosives Storage and Transport Committee Ministry of Defence.

United States

TM5-1300 Structures to Resist the Effects of Accidental Explosions.

DOD/4145.26-M DOD Contractors' Safety Manual for Ammunition and Explosives

HNDM-1110-1-2 Suppressive Shields — Structural Design and Analysis Handbook.

DOD/6055.9-STD Department of Defence — Ammunition and Explosives Safety Standards

Notes

Part 2: Definitions

2.1 To avoid confusion with general usage, certain terms in this standard have the following particular meanings:

above ground storage

Storage in magazines and structures (and sometimes in the open) at surface level. An accidental explosion at the storage site results in blast, fire and projections.

assembly place

A building or structure where it is customary for people to assemble (e.g., sports stadium).

barricade

An intervening barrier (artificial mound, traverse, berm or wall) or natural feature which, for storage purposes, is capable of preventing the direct communication of an explosion from one quantity of explosives to another, although it may be destroyed in the process.

blast impulse

The product of the overpressure from the blast wave of an explosion and the time during which it acts at a given point (i.e., the area under the positive phase of the over pressure-time curve).

blast overpressure

The pressure exceeding the ambient pressure manifested in the blast wave of an explosion.

burning area

An area for the destruction of explosives by burning located at a safe distance from susceptible sites.

classification code

The alpha-numeric symbol (e.g. 1.1D) which denotes the complete hazard classification for a particular type of explosive. The code comprises two digits, indicating the hazard division, followed by a letter corresponding to the compatibility group.

compatibility

Different types of explosives 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 an accident.

compatibility group

In the United Nations Classification System for Dangerous Goods, Class 1 is divided into 13 compatibility groups denoted by letters (A-H, J, K, L, N and S). (See *Authorization of Explosives Regulations* for definitions and see section 4.3 of these guidelines.)

curtain wall building

A building of skeletal frame construction with exterior walls that carry no load other than their own weight. (See definition for 'vulnerable construction').

debris

Any portion of the natural ground or of a structure (e.g., rocks, structural materials, fittings, equipment, barricade materials) which is propelled from the site of an explosion.

deflagration

A chemical reaction proceeding at subsonic velocity along the surface of, and/or through an explosive, producing hot gases at high pressures. A deflagration under confinement increases the pressure, the rate of reaction and the temperature which may cause transition into a detonation.

deflagrating explosives

A deflagrating explosive is a secondary explosive which reacts by deflagration rather than detonation when used in its normal manner. (Also known as low explosive).

destruction area

An area for the destruction of explosives by detonation located at a safe distance from susceptible sites.

detonation

A violent and complete chemical reaction proceeding at supersonic velocity within an explosive, generating gases at extremely high pressure and temperature. The sudden and enormous pressure of hot gases violently disrupts the surroundings, and a shock wave is propagated at supersonic velocity.

detonating explosive

A detonating explosive is an explosive which reacts by detonation rather than deflagration when used in its normal manner. (Also known as high explosive).

dividing wall

A wall designed to control or delay propagation of an explosion between quantities of explosives located on opposite sides of the wall. (See reference TM5-1300)

donor site

A potential explosion site such as a structure, safe haven, or transport unit (or temporary stack in the open) which contain explosives and require quantity-distance consideration based on the type and amounts of explosives present (or which could be present).

explosive

A substance manufactured to produce an explosion, detonation, pyrotechnic or propulsive effect and includes articles containing such substances. (Therefore, the definition encompasses the term ammunition.)

explosives area

An area used for the handling, processing, or storing of an explosive (includes magazine areas and factory sites).

explosives limit

The maximum quantity of explosive permitted in a magazine, laboratory, process building or other specific site, derived by these guidelines and considering other safety or unique factors.

fragment

Any metal portion of an explosive or its packaging which is propelled from the site of an explosion.

hazard classification

The assignment of a type of explosive to the appropriate hazard division and compatibility group using the recognized UN test series.

hazard division (HD)

The classification of an explosive into numbered divisions according to the hazard they present. (See section 4.2.)

high velocity projections

Debris or fragments at high velocity (usually low angle) resulting from an explosion and with sufficient remaining energy to propagate an explosion at another location.

inhabited building

Building or structure occupied in whole or part by people including, but not limited to an office, school, church, residence, store, hospital, theatre, or indoor recreational facility.

Inside Quantity-Distance (IQ-D)

The minimum permissible distance between a donor site and a susceptible site inside an explosives area.

isolation magazine

A magazine used for the temporary storage of an explosive which, for safety reasons, must not be stored in a magazine with other explosives.

lobbed explosive

Projected unexploded explosive which may explode on impact.

mass explosion

An explosion which affects virtually the entire quantity of explosives under consideration practically instantaneously. The term usually relates to detonation but also applies to deflagration when the practical effects are similar, for example, the mass deflagration of black powder or propellants under very strong confinement so as to produce a burst effect and a serious hazard from debris.

mass fire

A 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.

moderate fire

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

mutually hazardous site

This term applies to sites that present a hazard to explosives being stored nearby as well as being hazarded by the explosives.

navigable waterways

Those parts of streams, channels or canals capable of being used in their ordinary or maintained condition as highways of commerce over which trade and travel are or may be conducted in the customary modes, including waterways extensively and regularly used for the operation of pleasure boats.

net explosives quantity (NEQ)

Is the total explosives content of an explosive unless it has been determined that the effective quantity is significantly different from the actual quantity.

non-combustible construction

A stone, brick, concrete or metallic structure free from fixtures or fittings which could ignite under intense heat produced by a propellant fire or by a mass explosion in adjacent buildings.

Outside Quantity-Distance (OQ-D)

The minimum permissible distance between a donor site and a susceptible site outside the explosives area.

POL

petroleum, oil and lubricants

projections

Debris and fragments.

public traffic route

A road used for general public traffic; a railway outside the explosives area which is used for public passenger traffic; a navigable waterway.

Quantity-Distance (Q-D)

The minimum permissible distance between a donor site containing a given quantity of explosives and a susceptible site.

safe haven

A designated (licensed) area requiring Q-D consideration for the temporary stopover of defined motor vehicles carrying explosives; the safe haven must meet specific standards promulgated by Explosives Branch.

susceptible site

A site containing explosives (magazine, transport unit, explosives process building) or people (assembly place, inhabited building, public traffic route), or is mutually hazardous with a donor site, which is exposed to the potential effects of an explosion (or fire) at a donor site under consideration. (Included are the Groups described in Appendix C.)

test area

An area for the testing of explosives located at a safe distance from susceptible sites.

underground pipeline

An underground pipeline (POL, gas, water, etc.) is a pipeline with a cover of at least 1.2 m of earth or 10 cm of concrete.

underground POL tank

An underground tank for POL with a minimum cover of 1.2 m of earth or 10 cm of concrete.

vulnerable construction

Buildings requiring extra consideration.

Notes

Part 3: Principles of Quantity-Distance

3.1 Basis

In case of accident, for protection from the effects of an explosion, it makes intuitive sense that the more explosives there are, the further away one should be. That is the basic premise for Quantity-Distance. The quantity-distances (Q-Ds) used in these guidelines are based on extensive analysis of trials, some wartime bombing damage data, and data from accidental explosions in many countries. It must be remembered, however, that quantity-distances are subject to uncertainty because of the variability of the factors associated with explosions. Also, quantity-distances are subject to revision as more data become available through further trials and explosives accidents. The quantity-distances presented in these guidelines are based extensively on those developed by the North Atlantic Treaty Organization (NATO).

The NATO tables allow for various degrees of protection. These guidelines offer a high degree of protection - there is no option for a lower degree of protection.

3.2 General

Donor sites such as buildings or transport units (e.g. trucks, trailers, railcars) present an obvious risk to persons and property. Donor sites shall be located at carefully chosen distances from each other and from other susceptible sites, using the guidelines in this manual. The careful siting of a donor site will ensure the minimum practicable risk to life and property. These distances are functions of quantity of explosives (NEQ) and hazard division (HD), and are called Quantity-Distances (Q-D). Q-Ds are generated by distance functions subject, in certain cases, to fixed minimum distances.

Susceptible sites that require protection include places where explosives are present (magazines, process buildings, structures, or even temporary stacks in the open) and places where people may be present (assembly place, inhabited building, public traffic route). The donor site to susceptible site distances are explained in Parts 5, 7, 8, and 9. Also included are sites which may be mutually hazardous to explosives, such as bulk POL storage, electrical power lines and airports. These are explained in Part 6. A more complete listing of sites requiring Q-D consideration is found in Appendix C.

3.3 Types of Quantity-Distances

3.3.1 Inside Quantity-Distances (IQ-D)

There are two types of Inside Quantity-Distance:

a. Inter-Magazine Distances

   These are applied between a donor site and another explosives storage (magazine, structure, transport unit or temporary stack in the open) site.

b. Process Building Distances (also called Workshop Distances)

   These are applied between a donor site and a facility where explosives are being manufactured or worked on or between two sites where explosives are being manufactured or worked on.

3.3.2 Outside Quantity-Distances (OQ-D)

There are two types of Outside Quantity-Distance:

a. Public Traffic Route Distances

   These are applied between a donor site and public traffic routes.

b. Inhabited Building Distances

   These are applied between a donor site and buildings or sites where members of the general public or persons not involved in explosives handling, work, live or congregate.

See Appendix A for the symbols used.

3.4 Quantity-Distance Considerations

3.4.1 Inter-Magazine Distances

These distances are the minimum permissible distances between a donor site and storage sites containing explosives. The degree of protection is highly dependent upon factors such as sensitiveness of explosives, type of explosives, type of packaging and construction of buildings. Sometimes, the provision of stronger buildings allows the use of smaller Q-D for a given degree of protection. The hazard divisions and compatibility groups of the explosives must be taken into consideration.

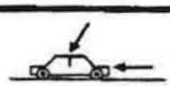
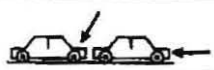
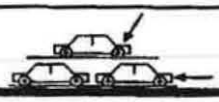
3.4.2 Process Building Distances

These distances are the minimum permissible distances between a donor site (including a process building) and process buildings (also called explosives workshops hence the term Workshop Distance). The distances are intended to provide a reasonable degree of protection for personnel within the process building from the effects (such as blast, flame, radiant heat and projection) of a nearby explosion. Light structures could be severely damaged. These distances also provide a high degree of protection against immediate or subsequent propagation of explosion.

3.4.3 Public Traffic Route Distances

These distances are the minimum permissible distances between a donor site and a public traffic route (road, railway and navigable waterway) that is used by a significant number of people. The exposure to roads is so diverse that three basic alternatives are provided. The dominant factors which determine the potential consequences are traffic speed, density, width of lanes, number of lanes, presence of crash barriers, surface conditions and radius of any curves. Less important are presence or absence of roadside trees and ditches, and whether or not it is a divided highway.

The three alternatives for roads are (an inspector may make a similar determination for railways and waterways):

Vehicles*	Class	Symbol
space traffic — Hardly measurable	light traffic	
up to 5000	medium traffic	
more than 5000	heavy traffic	

*number of vehicles in a 24 hour period (peak seson during explosive storage)

3.4.4 Inhabited Building Distances

These distances are the minimum permissible distances between a donor site and inhabited buildings or assembly places. The distances are intended to prevent serious structural damage by blast, flame or projections to ordinary types of inhabited buildings (23 cm of brick or equivalent) or trailers. Persons in the open would not suffer direct injury from the blast or radiated heat, but might be struck by projections.

3.5 Vulnerable Construction

Buildings of vulnerable construction are of three main types as follows:

a. **Type 1.** A building of curtain wall construction which has four storeys or more and is constructed with external non-load-bearing panels on a separate sub-frame which is supported off the structural frame or floors for the full height of the building. Where these cladding panels are large (greater than 1500 mm square) and constructed of glass or similar light weight frangible material, which is liable to shatter producing dangerous fragments or be displaced under the effect of lateral explosive blast loads greater than the designed wind forces, the curtain walling would be considered a hazard to personnel both inside and outside the building because of flying fragments or falling panels.

b. **Type 2.** A building of largely glass construction which has four storeys or more and has more than 50 per cent of its wall area glazed.

c. **Type 3.** The third type of Vulnerable Construction is impracticable to define precisely. This covers any large building which employs non-load-bearing cladding panels, eg, glass covered market gardens or warehouse type retail stores. The explosion effects on such buildings depends on many factors, including:

   (1) the weight per unit area and frangibility of the cladding material;

   (2) the detailed design of the frame structure including stiffening partitions;

   (3) the use to which the building is dedicated; and

(4) the local population inside and outside the building.

NOTE: Definition of this type of construction cannot be more precise because of the variation in types of modern structures and the complexity of the interaction of the factors given. There is no real alternative to individual assessment of any large building within two times Inhabited Building Distance which is not of traditional house construction.

Notes

Part 4: Hazard Classification

4.1 Introduction

The system of hazard classification used in Canada is based on the international system of classification as devised by the United Nations. Under that system dangerous goods are divided into nine (1-9) classes with explosives designated as Class 1. Class 1 is further divided into six divisions. The first four indicate the type of hazard to be expected in the event of an accident: blast (HD 1.1), projection (HD 1.2) fire and radiant heat (HD 1.3) and no significant hazard (HD 1.4). The last two indicate the ease of initiation: very insensitive (HD 1.5) and extremely insensitive (HD 1.6).

These guidelines use the term "Hazard Division" or "HD" to avoid the cumbersome alternatives such as "Division 1 of Class 1". The purpose of using hazard division is to simplify the preparation of guidelines and regulations for the safe transport, storage, production and handling of explosives. The system also facilitates the marking of explosives with a simple code to identify the danger from a particular explosive.

The complete hazard classification of an explosive is its classification code (see definition).

4.2 Explanations of Hazard Division

The official definitions for the hazard divisions are found in the Authorization of Explosives Regulations. Further information on the hazard divisions follows:

a. **Hazard Division 1.1** This division is comprised of explosives which have a mass explosion hazard:

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

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

b. **Hazard Division 1.2** This division comprises explosives which have a projection hazard but not a mass explosion hazard:

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

(2) For the purpose of determining Quantity-Distances, a distinction, depending on the size and range of fragments, is made between those items which give:

(a) small fragments of moderate range, ie, projectiles and cartridges from 20 to 60 mm; and

(b) large fragments with a considerable range, ie, projectiles and cartridges exceeding 60 mm, and certain rockets and rocket motors in a propulsive state which do not have a mass explosion hazard. (see Section 7.2)

c. **Hazard Division 1.3.** This division comprises explosives which have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard. This division includes some items which burn with great violence and intense heat emitting considerable thermal radiation. Others, burn sporadically. Items, in Hazard Division 1.3, may explode but do not usually form dangerous fragments. Firebrands and burning containers may be projected. (see Section 8.2)

d. **Hazard Division 1.4.** This division comprises explosives which present no significant hazard:

(1) This division comprises explosives which present only a small hazard in the event of ignition or initiation. The effects are largely confined to the package and no projection of fragments of appreciable size or range is to be expected.

(2) Explosives of this division are in Compatibility Group S if they are so packaged or designed that any hazardous effects arising from accidentalfunctioning are confined within the package unless the package has been degraded by the 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 of the package.

e. **Hazard Division 1.5.** This division comprises explosives which have a mass explosion hazard but are so insensitive that there is only a small probability of initiation or of transition from burning to detonation under normal storage and transport conditions. For storage purposes the explosives are treated as HD 1.1 since, if an explosion should occur, the hazard is the same as for explosives in HD 1.1 (i.e., blast).

f. **Hazard Division 1.6.** This division comprises explosives articles which contain only extremely insensitive detonating substances and which demonstrate a negligible probability of initiation or transition from burning to detonation.

NOTE: Currently there are no explosives classified as HD 1.6 in Canada and, consequently, no definitive Quantity-Distances have been established. Should such explosives be required to be stored or transported, advice shall be obtained from Explosives Branch.

4.3 Explanations of Compatibility Groups

The official definition for compatibility groups are found in the Authorization of Explosives Regulations. Further information on Compatibility Groups follows:

a. **Group A.** Compatibility Group A consists of initiating explosive substances and bulk initiating explosives that have the necessary sensitivity to heat, friction or percussion to make them suitable for use as initiating elements in an explosive train.

Examples are: lead azide and lead styphnate.

b. **Group B.** Compatibility Group B consists of detonators and similar initiating devices not containing two or more effective protective features, and items containing primary explosive substances that are designed to initiate or continue the functioning of an explosive train.

Examples are: detonators and fuzes.

c. **Group C.** Compatibility Group C consists of bulk solid propelling charges and devices containing propellant with or without their means of ignition. It includes items that upon initiation will deflagrate, or detonate.

Examples are: single, double, triple-base and composite propellants, rocket motors (solid propellant).

d. **Group D.** Compatibility Group D consists of black powder, high explosive (HE), ammunition containing HE without its own means of initiation and without propelling charge, or a device containing an initiating explosive and containing two or more effective protective features. This group includes explosives that can be expected to deflagrate or detonate when any given item or component is initiated except for devices containing initiating explosive substances with independent safety features.

Examples are: bulk trinitrotoluene (TNT), black powder, wet RDX or PETN, bombs, projectiles, blasting explosives, boosters, and detonating cord.

e. **Group E.** Compatibility Group E consists of ammunition containing HE without its own means of initiation and with propelling charge (other than one containing a flammable or hypergolic liquid), and ammunition or devices containing HE and containing propelling charges.

Examples are: artillery ammunition, rockets and guided missiles.

f. **Group F.** Compatibility Group F consists of ammunition containing HE with its owns means of initiation and with a propelling charge (other than one containing a flammable or hypergolic liquid) or without a propelling charge.

Examples are: rockets and guided missiles.

g. **Group G.** Compatibility Group G consists of pyrotechnic substances, or articles containing pyrotechnic substances, or articles containing both explosives and illuminating, incendiary, lachrymatory or smoke-producing substances (other than a water-activated device or one containing white phosphorus, phosphide or a flammable liquid or gel).

Examples are: flares, signals, incendiary or illuminating ammunition, fireworks and other smoke or tear producing devices.

h. **Group H.** Compatibility Group H consists of ammunition containing both explosives and white phosphorus (WP) or other pyrophoric material. Ammunition in this group contains fillers which are spontaneously flammable when exposed to the atmosphere.

Examples are: WP, plasticized white phosphorus (PWP) and other ammunition containing pyrophoric material.

i. **Group J.** Compatibility Group J consists of ammunition containing both explosives and flammable liquids or gels. Ammunition in this group contains flammable liquids or gels other than those which are spontaneously flammable when exposed to water or the atmosphere.

Examples are: liquid or gel-filled incendiary ammunition, fuel-air explosive (FAE) devices and flammable liquid-fuelled missiles.

j. **Group K.** Compatibility Group K consists of ammunition containing both explosives and toxic chemical agents. Ammunition in this group contains chemicals specifically designed for incapacitating effects more severe than lachrymatory.

Examples are: artillery or mortar ammunition, fused or unfused grenades and rockets, or bombs filled with a lethal or incapacitating chemical agent.

k. **Group L.** Compatibility Group L consists of explosives not included in other compatibility groups. This includes explosives or ammunition having characteristics that do not permit storage with other types of explosives, or dissimilar explosives of this group.

Examples are: water-activated devices, prepackaged hypergolic liquid-fuelled rocket engines, certain fuel-air explosive devices, triethyl aluminum (TEA) and damaged or suspect explosives of any group. Types presenting similar hazards may be stored together but not mixed with other groups.

l. **Group N.** Compatibility Group N consists of articles containing only extremely insensitive detonating substances which demonstrate a negligible probability of accidental initiation or propagation.

m. **Group S.** Compatibility Group S consists of explosives presenting no significant hazard. Explosives so packaged 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 hinder fire fighting significantly.

Examples are: explosive switches or valves, small arms ammunition, other explosive items packaged to meet the criteria of this group.

NOTE: Black powder in dust-tight packaging is normally assigned CG D. When it is not in dust-tight packaging it shall be stored as if it was in CG L.

4.4 Combination of HD and CG.

The possible combinations of HD with CG are demonstrated in the first table in Appendix D. The matrix of 6 Hazard Divisions and 13 Compatibility Groups suggests that 78 combinations should be possible. However, some divisions and groups are mutually exclusive, and some combinations are omitted as improbable. The table is included for information purposes. It is not to be used for mixing or aggregation.

Appendix D gives guidance on mixing and aggregating hazard divisions and compatibility groups.

Part 5: Quantity-Distance for Hazard Divisions 1.1 and 1.5

5.1 Basis for Table 1

Table 1 gives Inside and Outside Quantity-Distances for explosives of HD 1.1 and 1.5

- Column D1 is based on scaled factor 0.8
- Column D2 is based on scaled factor 2.4
- Column D3 is based on smaller distances for certain process buildings
- Column D4 is based on scaled factor 8.0
- Column D5 is based on 3.6 $Q^{1/2}$ for $Q < 4500$ and scaled factor 14.8 for $Q \geq 4500$
- Column D6 is based on scaled factor 11.1
- Column D7 is based on 5.5 $Q^{1/2}$ for $Q < 4500$ and scaled factor 22.2 for $Q \geq 4500$
- Column D8 is based on scaled factor 44.4

(See Appendix B for an explanation of scaled factor.)

5.2 Inter-Magazine Distances

The anticipated damage to explosives at a susceptible site from an accidental explosion will vary widely. Although detailed prediction of such effects is outside the scope of these guidelines, a measure of guidance is given.

These guidelines are based on a high degree of protection (virtually complete protection can not be guaranteed unless much larger distances or earth covered igloo type magazines are used). There may be occasional fires or subsequent explosions caused by ground shock, blast, flame, high velocity projections or lobbed explosives. Heavy cased ammunition is likely to be serviceable although covered by building debris. Magazines not separated by an effective barricade (see Appendix E) shall be separated by D6 distances or the aggregate of the quantities in the magazines shall be added together for Q-D consideration.

Where a magazine is effectively barricaded from a donor site there is a choice between using D1 or D2. D1 shall not be used if the magazine contains primary explosives or other explosives in HD 1.1. (D1 may be used if magazines contain only ANFO or other explosives in HD 1.5).

5.3 Process Building Distances

The standard Process Building Distance is D4. At this distance the major effects to be considered are the peak side-on overpressure, which is anticipated to be no greater than 20 kPa (3 psi) and projections, which are extremely difficult to quantify but would be very significant.

The smaller Process Building Distances in D3 (valid below 4000 kg) will still provide a reasonable degree of protection for persons within a process building at the susceptible site. These smaller distances are based on impulse considerations since smaller explosive events are of shorter duration and a higher pressure is therefore needed to produce the same level of damage as that expected at D4 distances for much larger quantities of explosives. However, the actual risk depends as much on the type of structures involved as on the quantity of explosives at the donor site. It is rather unpredictable in general terms although it could be evaluated in individual cases. These smaller distances should only be used with the following provisos:

a. the number of persons involved in the process building is small (up to 10)

b. the buildings should be constructed in accordance with high standards

When siting and designing process buildings the following effects should be considered. A person in a building designed to withstand the anticipated blast loading and without windows would be merely startled by the noise of the explosion at an adjacent site whereas a person in a brick building with windows might suffer eardrum damage, or suffer indirect injuries through being pushed by blast and subsequent impact on hard objects, or through possible collapse of the building.

Where the quantity-distance table specifies a Process Building Distance less than 270 m this may not give protection to personnel in process buildings having light roofs from debris projected from the donor site. Therefore consideration should be given to maintaining this 270 m distance as the minimum separation from the nearest storage site containing explosives of HD 1.1/1.5, in order to provide additional protection from debris.

Where a process building is not effectively barricaded D7 is used.

5.4 Public Traffic Route Distances

For light traffic D4 distance is used. Note that traffic volume is only one consideration. Provincial numbered highways, or the Trans Canada Highways must never be classified as light traffic distance.

For medium traffic D5 distance is used and for heavy traffic D7 distance is used.

Note that to protect from projections there are overriding minimum distances for medium and heavy traffic of 180 m and 270 m respectively.

5.5 Inhabited Building Distances

The D7 distances are based on a tolerable level of damage expected from a peak side-on overpressure of 5 kPa. The distances are not sufficiently large to either prevent superficial damage to buildings which are largely of glass construction or to avoid injuries to their occupants by flying glass.

For single isolated dwellings there is an overriding minimum distance of 270 m. For built-up areas the minimum distance is 400 m.

In test sites or factories where bulk explosives, devoid of metal components, are in fibre-board packaging, not on pallets and are either in open stacks or in light frangible buildings D7 distance without any overriding minimum distance may be used. Scaled factor 22.2 may be used to calculate distances.

5.6 Buildings of Vulnerable Construction

Normal Inhabited Building Distances (D7) are not sufficiently large to prevent breakage of glass and other frangible panels or cladding in buildings of vulnerable construction. As a general guideline, buildings which stand out dimensionally or in construction against a normal background of dwelling houses should be subject to closer examination. Cases which fall within or near the definition of vulnerable construction, or where it is suspected that they may be particularly vulnerable to blast may require a further assessment of the potential risks.

The variation and complexity of modern building construction and materials along with the need to consider usage and population make it impossible to define universal rules for the positioning of such buildings relative to explosives facilities.

A building classified as vulnerable is sited twice the normal Inhabited Building Distance from a donor site (D8).

5.7 Blasting Explosives

Blasting explosives stored at or near fixed surface blasting operations use D5 where an effective emergency plan is in force and D7 where no effective emergency plan is in force, for separating magazines from the blast site.

No HD 1.1 explosive should be stored in a Type 11 magazine (as described in the booklet Magazine Standards for Blasting Explosives and Detonators 1982) unless it has been converted to hold bullet resistant material in the walls and a 1/2" steel door has been installed.

The normal maximum quantity of explosies in one area is 136,000 kg. (Note that some provincial authorities may limit the amount in any one area.) In remote locations temporary stacks containing no more than 80,000 kg may be permitted. Multiple stacks should be separated by the appropriate Q-D.

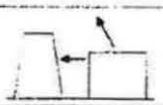
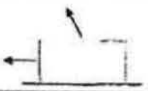
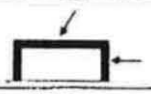
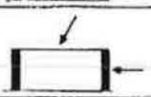
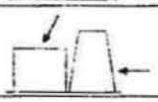
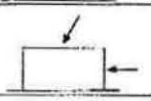
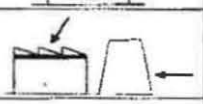
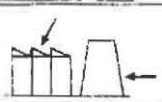
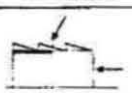
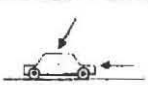
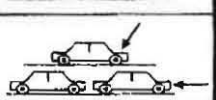
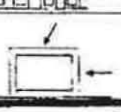
For blasting explosives in quantities from 0 to 50 kg, use the distances in the table for 50 kg. Note that small quantities of detonators may be stored in appropriate magazines inside a warehouse or stores area without regard for Q-D. Normal precautions as required by an inspector apply.

5.8 Tankers, and Bulk and Mix Trucks

A tanker, or a bulk and mix truck containing explosives is sited as if it was a donor site, using full Q-D criteria in this Part. If pumping or augering is planned to/from the unit or if mixing or gassing on the unit is planned then the unit is sited as a process building, otherwise it is sited as a magazine.

Notes

Tableau 1: Tableau des quantités-distances applicable aux divisions de risque 1.1 et 1.5

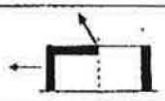
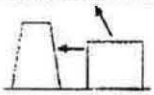
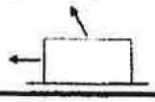
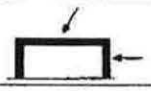
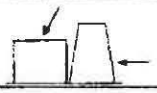
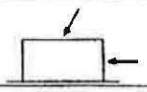
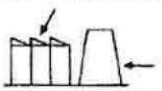
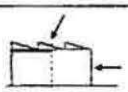
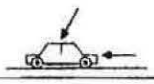
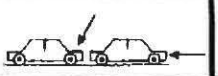
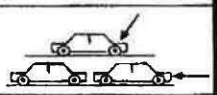
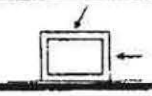
Site potentiel d'explosion / Site exposé		A	B	C
				
1		D2	D2	D2
2		D2	D2	D2
3		D1 ou D2	D1 ou D2	D1 ou D2
4		D6	D1 ou D2	D6
5		D3 ou D4	D3 ou D4	D3 ou D4
6		D3 ou D4 (≥270m)	D3 ou D4	D3 ou D4
7		D7	D3 ou D4	D7
8		D4	D4	D4
9		D5(≥180m)	D5(≥180m)	D5(≥180m)
10		D7(≥270m)	D7(≥270m)	D7(≥270m)
11		D7(≥270m)	D7(≥270m)	D7(≥270m)
12		D7(≥400m)	D7(≥400m)	D7(≥400m)
13		D8(≥400m)	D8(≥400m)	D8(≥400m)

Les symboles sont définis à l'annexe A

Tableau 1: Quantités-distances applicable aux divisions de risque 1.1 et 1.5 (Suite)

QEN	Quantité-distance (mètres)							
kg	D1	D2	D3	D4	D5	D6	D7	D8
50	5	10	16	30	180	45	270	400
60		10	19	32		45		
70		10	20	33		46		
80		11	21	35		48		
90		11	22	36		50		
100		12	23	38		53		
120		12	24	40		55		
140		13	25	42		60		
160		14	27	44		63		
180		14	28	46		65		
200	5	15	29	47		65		
250	6	16	31	51		70		
300	6	17	33	54		75		
350	6	17	34	57		80		
400	6	18	36	59		83		
450	7	19	38	62		88		
500	7	20	39	64		90		
600	7	21	42	68		95		
700	8	22	45	72		100		400
800	8	23	48	75		105		415
900	8	24	50	78		108		430
1000	8	24	53	80		113		445
1200	9	26	58	86		120		475
1400	9	27	63	90		125		500
1600	10	29	68	94		130		520
1800	10	30	73	98		135		540
2000	11	31	78	105	180	140	270	560
2500	11	33	90	110	185	153	275	610
3000	12	35	105	120	205	163	305	640
3500	13	37	115	125	220	170	330	680
4000	13	39	130	130	235	178	350	710
5000	14	42	140	140	255	190	380	760
6000	15	44	150	150	270	203	405	810
7000	16	46	155	155	285	213	425	850
8000	16	48	160	160	300	223	445	890
9000	17	50	170	170	310	235	465	930
10000	18	52	175	175	320	240	480	960
12000	19	55	185	185	340	255	510	1020
14000	20	58	195	195	360	270	540	1080
16000	21	61	205	205	375	280	560	1120
18000	21	63	210	210	390	295	590	1180
20000	22	66	220	220	405	305	610	1220
25000	24	71	235	235	435	325	650	1300
30000	25	75	250	250	460	345	690	1380
35000	27	79	265	265	485	365	730	1460
40000	28	83	275	275	510	380	760	1520
50000	30	89	295	295	550	410	820	1640
60000	32	94	315	315	580	435	870	1740
70000	33	99	330	330	610	460	920	1840
80000	35	105	345	345	640	480	960	1920
90000	36	110	360	360	670	500	1000	2000
100000	38	115	375	375	690	520	1040	2080
120000	40	120	395	395	730	550	1100	2200
140000	42	125	420	420	770	580	1160	2320
160000	44	135	435	435	810	610	1220	2420
180000	46	140	455	455	840	630	1260	2520
200000	47	145	470	470	870	650	1300	2600
250000	51	155	510	510	940	700	1400	2800

Tableau 1: Tableau des quantités-distances applicable aux divisions de risque 1.1 et 1.5

Site exposé \ Site potentiel d'explosion		A	B	C
				
1		D2	D2	D2
2		D2	D2	D2
3		D1 ou D2	D1 ou D2	D1 ou D2
4		D6	D1 ou D2	D6
5		D3 ou D4	D3 ou D4	D3 ou D4
6		D3 ou D4 (≥270m)	D3 ou D4	D3 ou D4
7		D7	D3 ou D4	D7
8		D4	D4	D4
9		D5(≥180m)	D5(≥180m)	D5(≥180m)
10		D7(≥270m)	D7(≥270m)	D7(≥270m)
11		D7(≥270m)	D7(≥270m)	D7(≥270m)
12		D7(≥400m)	D7(≥400m)	D7(≥400m)
13		D8(≥400m)	D8(≥400m)	D8(≥400m)

Les symboles sont définis à l'annexe A

Tableau 1: Quantités-distances applicable aux divisions de risque 1.1 et 1.5 (Suite)

QEN	Quantité-distance (mètres)							
kg	D1	D2	D3	D4	D5	D6	D7	D8
50	5	10	18	30	180	45	270	400
60		10	19	32		45		
70		10	20	33		46		
80		11	21	35		48		
90		11	22	36		50		
100		12	23	38		53		
120		12	24	40		56		
140		13	25	42		60		
160		14	27	44		63		
180		14	28	46		65		
200	5	15	29	47		65		
250	6	16	31	51		70		
300	6	17	33	54		75		
350	6	17	34	57		80		
400	6	18	36	59		83		
450	7	19	38	62		88		
500	7	20	39	64		90		
600	7	21	42	68		95		
700	8	22	45	72		100		400
800	8	23	48	75		105		415
900	8	24	50	78		108		430
1000	8	24	53	80		113		445
1200	9	26	58	86		120		475
1400	9	27	63	90		125		500
1600	10	29	68	94		130		520
1800	10	30	73	98		135		540
2000	11	31	78	105	180	140	270	560
2500	11	33	90	110	185	153	275	610
3000	12	35	105	120	205	163	305	640
3500	13	37	115	125	220	170	330	680
4000	13	39	130	130	235	178	350	710
5000	14	42	140	140	255	190	380	760
6000	15	44	150	150	270	203	405	810
7000	16	46	155	155	285	213	425	850
8000	16	48	160	160	300	223	445	890
9000	17	50	170	170	310	235	465	930
10000	18	52	175	175	320	240	480	960
12000	19	55	185	185	340	255	510	1020
14000	20	58	195	195	360	270	540	1080
16000	21	61	205	205	375	280	560	1120
18000	21	63	210	210	390	295	590	1180
20000	22	66	220	220	405	305	610	1220
25000	24	71	235	235	435	325	650	1300
30000	25	75	250	250	460	345	690	1380
35000	27	79	265	265	485	365	730	1460
40000	28	83	275	275	510	380	760	1520
50000	30	89	295	295	550	410	820	1640
60000	32	94	315	315	580	435	870	1740
70000	33	99	330	330	610	460	920	1840
80000	35	105	345	345	640	480	960	1920
90000	36	110	360	360	670	500	1000	2000
100000	38	115	375	375	690	520	1040	2080
120000	40	120	395	395	730	550	1100	2200
140000	42	125	420	420	770	580	1160	2320
160000	44	135	435	435	810	610	1220	2420
180000	46	140	455	455	840	630	1260	2520
200000	47	145	470	470	870	650	1300	2600
250000	51	155	510	510	940	700	1400	2800

5.9 Storage of up to 50 kg of HD 1.1 in Special Circumstances

The reference for this section is Australian Ordnance Council Proceeding 1/82.

In the derivation of Table 1 mathematical relationships have been formulated between explosive quantities and distances based on blast damage criteria. For small quantities, there is a non-linearity in this relationship because projectile hazards could remain constant and out- weigh blast considerations. Therefore, fixed safety distances are applied in Table 1. If, however, it can be demonstrated that projectile hazards from the explosive and any storage structure can be contained, these fixed distances for small quantities may be considered excessive.

Containment of fragments and structural debris becomes increasingly difficult as the NEQ rises and becomes both expensive and exceedingly difficult for quantities greater than 50 kg. The US Department of Defense Explosives Safety Board makes provision for the relaxation of fixed minimum distances if it can be shown that fragments and structural debris will be contained. Such containment should be proven or demonstrated such as providing a dividing wall designed in accordance with TM5-1300, prior to adopting Q-D in this section. If blast, as well as fragments and debris, can be completely confined further lessening of the Q-D in this section could be permitted although no values are defined. Where containment of fragments and debris cannot be achieved, normal fixed minimum Q-D apply.

Note that the following table does not apply to manufacturing or production processes because the risk of accidental initiation is increased.

Susceptible Site / NEQ at Donor Site	Inhabited Building	Public Traffic Route	Process Building of Magazine (Barricaded or Not)
kg			
Over — Up to & Including	m	m	m
0 – 0.5	18	12	7
0.5 – 1.0	23	16	8
1 – 2	30	20	10
2 – 5	40	26	14
5 – 10†	50	32	18
10 – 50††	70	47	30

Notes

†The distances for 1-10 kg may only be used when fragments and debris can be completely contained. In special circumstances lesser distances may be used if blast, as well as fragments and debris, can be completely contained or controlled.

††Quantities 10-50 kg may only be stored on an infrequent basis and where fragment and debris containment is adequate.

5.10 Bulk Ammonium Nitrate

Whenever bulk ammonium nitrate (AN) is located near blasting explosives (either HD 1.1 or 1.5) storage, the National Fire Protection Association (NFPA) 495 Explosive Materials Code shall be used to determine whether or not the AN is situated far enough away from a donor site to be ignored. If it is not far enough away then one half of the weight of the AN must be considered as explosive for Q-D calculations.

Table 6-4(c) from NFPA 495 is used (reproduced below). Note that the table is in feet and pounds -- the applicable conversions must be made.

This table is used to determine if a bulk AN storage site e.g. silo is located at a sufficient distance from a donor site, and whether or not there is an adequate barrier in between the two.

An example should help to illustrate the use of the table.

A 30,000 kg bulk AN silo is near a 20,000 kg blasting explosives magazine. How far away from the magazine must the silo be to be ignored in the Q-D calculation?

The donor (magazine) is 20,000 kg = 44,000 lbs.

For 44,000 lbs donor weight the distance to AN (see column headed Ammonium Nitrate) must be 22 feet. This distance applies if there is a minimum 35 inch artificial barricade between the silo and the magazine (see column on far right and Note 3).

If there is no barrier or an inadequate barrier the distance must be 22 ft x 6 = 132 ft. (see Note 2).

Therefore, if the distances are greater than those calculated above, the AN may be ignored for Q-D. If the distances as calculated are inadequate then the AN (1/2 weight) must be considered. In the latter case, the NEQ equivalent is:

20,000 kg (magazine) + 1/2 x 30,000 (silo) = 35,000 kg.

Table of Recommended Separation Distances of Ammonium Nitrate and Blasting Agents from Explosives or Blasting Agents[1]			
Donor Weight		Minimum Separation Distance of Acceptor when Barricaded[2](ft)	
Pounds Over	Pounds Not Over	Ammonium Nitrate	Minimum Thickness of Artificial Barricades[3] (in)
	100	3	12
100	300	4	12
300	600	5	12
600	1000	6	12
1000	1600	7	12
1600	2000	8	12
2000	3000	9	15
3000	4000	10	15
4000	6000	11	15
6000	8000	12	20
8000	10000	13	20
10000	12000	14	20
12000	16000	15	25
16000	20000	16	25
20000	25000	18	25
25000	30000	19	30
30000	35000	20	30
35000	40000	21	30
40000	45000	22	35
45000	50000	23	35
50000	55000	24	35
55000	60000	25	35
60000	70000	26	40
70000	80000	28	40
80000	90000	30	40
90000	100000	32	40
100000	120000	34	50
120000	140000	37	50
140000	160000	40	50
160000	180000	44	50
180000	200000	48	50
200000	220000	52	60
220000	250000	56	60
250000	275000	60	60
275000	300000	64	60

For SI Units: 1lb = 0.454kg; 1ft = 0.305m; 1in = 2.54cm

Notes

[1]Recommended separation distances to prevent explosion of ammonium nitrate and ammonium nitrate-based blasting agents by propagation from nearby stores of high explosives or blasting agents referred to in the table as the "donor." Ammonium nitrate, by itself, is not considered to be a donor when applying this table. Ammonium nitrate is an acceptor.

[2]When the ammonium nitrate is not barricaded, the distances shown in the table shall be multiplied by 6. These distances allow for the possibility of high velocity metal fragments from mixers, hoppers, truck bodies, sheet metal structures, metal containers, and the like which may enclose the donor.

[3]Earth, sand dikes, or enclosures filled with the prescribed minimum thickness of earth or sand are acceptable artificial barricades. Natural barricades may also be acceptable. (see Appendix E)

Notes

Notes

Part 6: Mutually Hazardous Sites

The term mutually hazardous is applied to those sites that present a hazard to the explosives as well as being hazarded by the explosives. Types of mutually hazardous sites include:

a. volatile carbon fuels (bulk and pipelines)

b. radio frequency transmitters

c. electrical installations and power lines

d. airports

6.1 Carbon Fuels

The following is a non-exhaustive list of types of volatile carbon fuels which require consideration.

a. petroleum

b. liquid petroleum gas (LPG)

c. natural gas

d. coal gas

e. methane

f. propane

g. butane and

h. paraffin

6.1.1 Non-volatile Carbon Fuels

Non-volatile carbon fuels (e.g. diesel fuel) held in storage tanks for daily use (capacity 1000 litres) shall be separated from a donor site by 25 m. This does not apply to fuels used as ingredients in the production of an explosive, e.g., ANFO (however, the 25 m distance to bulk ammonium nitrate storage should be maintained).

6.1.2 Small quantities of POL

Small quantities of POL required in a process building shall be kept in approved metal cabinets marked "Flammable".

6.1.3 Aboveground Bulk Storage

Unprotected aboveground bulk stocks of volatile carbon fuels must be separated from a donor site by the normal Inhabited Building Distance. Stocks of bulk fuel assessed as being vital are to be provided a overriding minimum distance of 450 m to a donor site containing HD 1.1 or 1.2.

Where aboveground stocks are protected from blast and projection hazards, the distances may be reduced upon assessment by an inspector.

6.1.4 Underground Pipelines or Bulk Storage

Underground pipelines or bulk storage shall be separated from a donor site containing HD 1.1 by 1/2 of the D2 distance in Table 1 and from H.D 1.2 or 1.3 by a minimum distance of 25 m. Bulk storage shall be separated from HD 1.4 by a minimum distance of 25 m.

6.2 Radio Frequency Transmitters

Transmitters are sited at Inhabited Building Distance from any donor site. For transmitters considered to be vital, 1.5 times Inhabited Building Distance should be used.

Detonators and other electro-explosive devices may be hazarded by electro-magnetic radiation. The siting of these facilities is outside of the scope of these guidelines. Specialist advice from an inspector should be sought.

6.3 Electrical Installations and Power Lines

The following minimum distances are observed:

a. 45 m from electrical generators and unprotected substations.

b. 10 m from transformers at protected substations which are designed to withstand the effects of an internal explosion with provision to contain the cooling oil

c. for power lines

1. The greatest of the following distances from overhead cables

(i) 15 m or

(ii) $D = \frac{S}{2} - H$ where S is the span and H is the height of the supporting line insulators on the pylon or structure

2. Power lines exceeding 15 kV use medium traffic route distance (subject to minimum of 60 m).

3. Where power lines serve a national grid or are otherwise vital, use 1.5 times Inhabited Building Distances.

6.4 Airports

Because of the broad range of airports (isolated runways to major international airports) it is virtually impossible to present definitive guidelines. An inspector should be consulted.

Notes

Part 7: Quantity Distance for Hazard Division 1.2

7.1 Basis for Table 2

Table 2 gives Inside and Outside Quantity-Distances for HD 1.2.

The functions used for calculating D1 and D2 are:

$$D1 = 53\ Q^{0.18}$$

$$D2 = 68\ Q^{0.18}$$

For less than 50 kg NEQ an inspector should make the determination for Q-D.

7.2 Subdivisions

Articles in HD 1.2 are generally military in nature. Military authorities have recognized that the range of fragments and lobbed ammunition which may be projected from a donor site would vary with the calibre of the ammunition. An arbitrary dividing point between more and less hazardous types of ammunition has been chosen as 60 mm.

The more hazardous items of HD 1.2 include most rounds and projectiles greater than 60 mm. This group is called "rounds above 60 mm" and may be called Hazard Division 1.21 or Sub-division 1.2.1 by various military authorities.

The less hazardous items of HD 1.2 include most rounds up to and including 60 mm calibre (high explosives), pyrotechnic or lachrymatory rounds, rounds of any calibre with inert projectile, fragmentation hand grenades and fuses with boosters. This group is called "rounds up to 60 mm" and may be called Hazard Division 1.22 or Sub-division 1.2.2 by various military authorities.

It is important not to exaggerate the significance of "60 mm". It was chosen merely as a convenient criterion to differentiate two groups of data on fragment ranges. Test data have been used to assign ammunition to one or more sub-divisions. The List of Authorized Explosives does not subdivide HD 1.2 into sub-divisions. For military type ammunition, this information will need to be obtained prior to applying these guidelines. Commercial explosives in HD 1.2 shall be assessed on an individual basis.

> NOTE: These sub-divisions have no other role other than for Q-D calculation, i.e., they are not to be used for transportation.

7.3 Fragments and Lobbed Items

The number of fragments and lobbed items which hazard the occupants or the explosives at a susceptible site depends on the rate of production and the period of exposure unless the construction of the donor site provides effective containment or the susceptible site is constructed to give adequate protection from fragment attack. The rate, and thus also the period of exposure, depends on what action is taken to fight the fire at a donor site, including any secondary fires which may affect explosives at a susceptible site which thereby become further explosion sites. Moreover the period of exposure depends on what arrangements

are in force to evacuate people from a susceptible site and to divert traffic promptly from public traffic routes.

7.4 Inter-Magazine Distances

The standard for Inter-Magazine Distances for HD 1.2 is generally either virtually complete protection (if the susceptible site is a heavy walled building with protective roof) or a high degree of protection. However, there is only a limited degree of protection from a donor site that is not effectively barricaded. Therefore, the donor site should be barricaded or the 90 m in column C may need to be increased.

7.5 Process Building Distances

Fixed distances are specified for process buildings. It is considered that for explosives of HD 1.2 the total NEQ which would react simultaneously would not exceed 50 kg. Hence the effect of increased quantities of HD 1.2 explosives is to prolong the duration of an incident and increase the density of projections at any specific point with no significant effect on the intensity of the explosions or range of the projections. For the less hazardous explosives of HD 1.2, reduced fixed distances are used, i.e., the larger fixed distances are for rounds above 60 mm.

7.6 Public Traffic Route Distances

For light and medium traffic, constant distances are used. This is based on an acceptable risk from fragments and lobbed ammunition to be expected in the first half-hour of an incident. It is assumed that traffic can be stopped before the final fragment saturation has been reached, otherwise D1 or D2, as applicable, should be used.

For heavy traffic, D2 for rounds above 60 mm and D1 for rounds up to 60 mm are used.

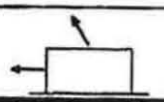
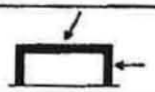
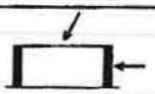
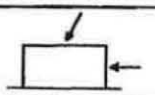
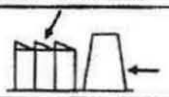
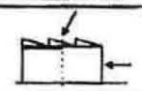
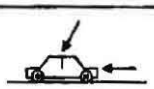
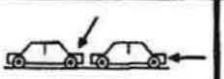
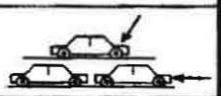
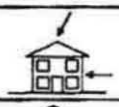
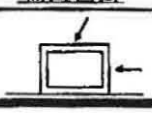
7.7 Inhabited Building Distances

The distances for HD 1.2 are based on acceptable risk from fragments. Under normal conditions D2 for rounds above 60 mm and D1 for rounds up to 60 mm are used, however, for isolated dwellings, fixed minimum distances, 270 m and 180 m respectively, have been established.

7.8 Vulnerable Construction

Distances for HD 1.2 to vulnerable construction are the same as for Inhabited Building Distance.

Table 2: Q-D Table for Hazard Classification 1.2

Susceptible Site \ Donor Site		A		B		C	
							
1		10m		10m		10m	
2		90m		90m		90m	
3		90m		90m		90m	
4		90m		90m		90m	
5		25m		25m		25m	
6		135m 90m	or	135m 90m	or	135m 90m	or
7		135m 90m	or	135m 90m	or	135m 90m	or
8		135m 90m	or	135m 90m	or	135m 90m	or
9		135m 90m	or	135m 90m	or	135m 90m	or
10		D2 D1	or	D2 D1	or	D2 D1	or
11		270m 180m	or	270m 180m	or	270m 180m	or
12		D2 D1	or	D2 D1	or	D2 D1	or
13		D2 D1	or	D2 D1	or	D2 D1	or

Symbols are defined in Appendix A

Note: In blocks with two choices, the upper one is for rounds above 60mm

Table 2: Quantity-Distance Table for Hazard Division 1.2 (Contituned)

NEQ	Quantity-Distance (Metres)		NEQ	Quantity-Distance (Metres)	
kg	D1	D2	kg	D1	D2
50	180	270	3500	230	300
60			4000	235	310
70			5000	245	320
80			6000	255	330
90			7000	260	340
100			8000	270	345
120			9000	275	355
140			10000	280	360
160			12000	290	370
180			14000	300	385
200			16000	305	390
250			18000	310	400
300			20000	320	410
350			25000	330	425
400			30000	345	440
450			35000	350	450
500			40000	360	460
600			50000	375	480
700			60000	390	500
800	180		70000	400	520
900	185		80000	410	530
1000	185		90000		540
1200	190		100000		560
1400	195		120000		
1600	200		140000		
1800	205		160000		
2000	210	270	180000		
2500	220	280	200000		
3000	225	290	250000	410	560

Notes

Part 8: Quantity Distance for Hazard Division 1.3

8.1 Basis for Table 3

Table 3 gives Inside and Outside Quantity Distances for HD 1.3.

The functions used for calculating the tables are:

$D1 = 0.22\ Q^{1/2}$

$D2 = 3.2\ Q^{1/3}$

$D3 = 4.3\ Q^{1/3}$

$D4 = 6.4\ Q^{1/3}$

For less than 50 kg NEQ an inspector should make the determination for Q-D.

8.2 Subdivisions

HD 1.3 has been subdivided into more and less hazardous types. Although some hazardous effects are common to both types, the dominant hazard used as the basis of Q-D is different in the two. In order to simplify reference to each type, they have been subdivided as follows.

The more hazardous items of HD 1.3 include such items as propellant and bulk stocks of pyrotechnic substances which, on ignition, are likely to produce a fire ball with intense radiant heat, firebrands and some fragments. The firebrands may be only small glowing particles of packaging materials or they may be massive fiery chunks of burning propellant. The effect of quite normal winds may augment a calculated flame radius by 50 per cent. This group is called "bulk propellant and pyrotechnic substances". (Military authorities may call this type Hazard Division 1.33 or sub-division 1.3.3.

The less hazardous items of HD 1.3 include such items as fireworks shells and are likely to produce minor projections and firebrands. The projections include fragments but are less hazardous than those which characterize HD 1.2. The group is called "fireworks articles". (Military authorities may call this type Hazard Division 1.34 or sub-division 1.3.4.). Table 3 is arranged such that values on the left hand side refer to the more hazardous type and the values on the right hand side refer to the less hazardous type, in each block.

NOTE: These sub-divisions have no other role other than for Q-D calculation, i.e., they are not to be used for transportation.

8.3 Inter-Magazine Distances

The Inter-Magazine Distances for HD 1.3 essentially provide either virtually complete protection (superscript "a") or a high degree of protection (superscript "b") against propagation of fire caused by flame, radiant heat, firebrands, projections and lobbed ammunition. For high degree of protection there is a risk that one or more of the effects, especially lobbed ammunition, is likely to ignite the contents directly or as the

result of ignition of combustible parts of the building unless effective fire-fighting is able to prevent such consequences.

8.4 Process Building Distances

For the most hazardous explosives of HD 1.3, the D2 distance is used. These distances depend on the susceptible site providing some protection against the expected thermal effects, however, a minimum distance of 60 m is imposed.

For the less hazardous explosives, the stated minimum distances are to be observed.

8.5 Public Traffic Route Distances

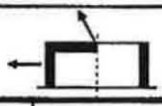
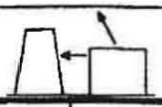
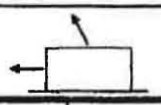
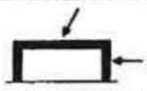
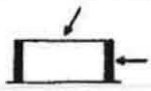
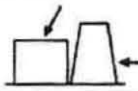
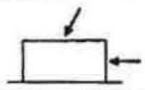
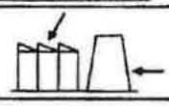
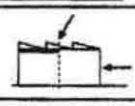
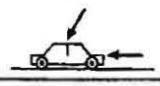
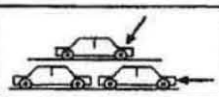
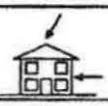
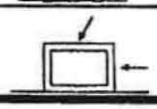
For the more hazardous types, for light traffic, D2 is used; for medium traffic, D3 is used, and for heavy traffic D4 is used.

For the less hazardous type a minimum of 60 m is used for light or medium traffic and D4 distance is used for heavy traffic.

8.6 Inhabited Building Distances

The distances for HD 1.3 are based on a thermal dose criterion of 62.8 kJ per m^2 (1.5 cal per cm^2). It is anticipated that occupants of traditional types of inhabited buildings would not suffer injury unless standing in front of windows. D4 distances are used for isolated dwellings, inhabited buildings and vulnerable construction.

Table 3: Q-D Table for Hazard Division 1.3

Susceptible Site \ Donor Site		A		B		C	
		1.33	1.34	1.33	1.34	1.33	1.34
							
1		2^am	10^am	10^bm	10^am	10^bm	10^am
2		D1[a]	25^bm 60^bm* 60^am	D1[b]	60^bm	D1[b]	60^bm
3		D1[a]	25^bm 60^bm* 60^am	D1[b]	60^bm	D1[b]	60^bm
4		D1[a]	25^bm 60^bm* 60^am	D1[b]	60^bm	D1[b]	60^bm
5		D2	25m	D2	25m	D2	25m
6		D2	60m	D2	60m	D2	60m
7		D2	60m	D2	60m	D2	60m
8		D2	60m	D2	60m	D2	60m
9		D3	60m	D3	60m	D3	60m
10		D4	D4	D4	D4	D4	D4
11		D4	D4	D4	D4	D4	D4
12		D4	D4	D4	D4	D4	D4
13		D4	D4	D4	D4	D4	D4

Symbols are defined in Appendix A.

NOTE: The left side values (25^bm and 60^am) in these three blocks are for donor site with heavy walls with protective roof. The right side value (60^bm) is for donor site with heavy wall without protective roof.

Table 3: Quantity-Distance Table for Hazard Division 1.3 (Continued)

NEQ	Quantity-Distance (Metres)				NEQ	Quantity-Distance (Metres)			
kg	D1	D2	D3	D4	kg	D1	D2	D3	D4
50	25	60	60	60	3500			65	98
60					4000			68	105
70					5000			73	110
80					6000		60	78	120
90					7000		62	82	125
100					8000		64	86	130
120					9000		67	89	135
140					10000		69	92	140
160					12000	25	74	98	150
180					14000	27	78	105	155
200					16000	28	81	110	165
250					18000	30	84	115	170
300					20000	32	87	120	175
350					25000	35	94	125	190
400					30000	39	100	135	200
450					35000	42	105	140	210
500					40000	44	110	150	220
600					50000	50	120	160	240
700					60000	54	130	170	255
800				60	70000	59	135	180	265
900				62	80000	63	140	185	280
1000				64	90000	66	145	195	290
1200				69	100000	70	150	200	300
1400				72	120000	77	160	215	320
1600				75	140000	83	170	225	335
1800				78	160000	88	175	235	350
2000				81	180000	94	185	245	365
2500			60	87	200000	99	190	250	375
3000			62	93	250000	110	205	270	405

Part 9: Quantity Distances for Hazard Division 1.4

9.1 General

From the chart on page D-1, the possible combinations of compatibility groups for HD 1.4 are B, C, D, E, F, G and S. For classification purposes there are essentially two types of explosive articles -- those that receive their classification because of the packaging of the article (eg. a detonator normally 1.1 B may be heavily packaged and receive a classification 1.4 B or even 1.4 S) and those that receive their classification because of the intrinsic nature of the article. Because articles in storage may not always be in outer packaging as offered for transportation, storage should be based on the intrinsic nature of the article (eg. a detonator classed as 1.4 B or 1.4 S would be stored as if it was classed 1.1 B). For storage principles applying to rare combinations of CG and HD 1.4, consult an inspector.

9.2 Small Quantities of Specific Types

Small quantities of specific types of HD 1.4 explosives shall be stored in accordance with the principles in the appropriate specific explosives regulations, i.e.,:

Consumer Fireworks Regulation
Display Fireworks Regulation
Propellant and Ammunition Regulation
Theatrical Fireworks Regulation
Model Rocket Engine Regulation

The above regulations generally give sufficient guidance for consumers/users and retailers. Wholesalers and manufacturing facilities may need to store larger quantities. Because of the difficulty of establishing the specific NEQ of a wide variety of items, e.g., consumer fireworks, some of the above regulations give guidance in terms of gross weight rather than NEQ.

9.3 Larger Quantities 1.4 G

For larger quantities, storage is based on NEQ. The following table applies to explosives classified 1.4 G. For inter-magazine distance use D1, for process building distance use D2, for public traffic route distance use D3 and for inhabited building distance use D4. Note that at a fireworks factory observing only minimum process building distance, unless the process building is constructed of brick or concrete, the process building should be screened (eg., corrugated iron, brick store on other suitable material). The following distances apply whether barricaded or unbarricaded.

	D1	D2	D3	D4
NEQ (kg)			(metres)	
Up to 50	9	12	9	16
100	9	12	10	16
200	9	12	11	19
300	9	12	13	22
400	9	12	14	25
500	9	12	15	29
750	9	12	17	31
1000	9	12	18	33
1250	10	15	18	36
2500	13	21	21	37
5000	17	25	23	42
10,000	21	27	25	46
12,500	23	27	26	50
15,000	24	27	27	52
20,000	25	27	28	54
25,000	26	27	29	55
30,000	27	27	30	59
40,000	27	27	30	60
50,000	27	27	30	60
75,000	27	27	32	65
100,000	27	27	33	70

9.4 Larger Quantities of Explosives Intrinsically 1.4 S.

For larger quantities of 1.4 S explosives, the consideration should be the accessibility of fire fighters and fire fighting equipment.

Notes

Appendices

Appendix A: Pictographs

A.1 General Notes on Pictographs

The pictographs that follow are introduced to simplify the presentation of information in the Q-D Tables. The pictographs are purely diagrammatic; their shapes do not imply that actual structures should have similar shapes and proportions. The orientation shown is intended to indicate the direction of principal concern for blast, flame, radiant heat and projections as shown by arrows. In an actual situation every direction must be considered in turn. At a donor site there are relatively few significant variations but at a susceptible site it is necessary to distinguish among different types of construction and among different functions of buildings. For these reasons, a given building may require one symbol when it is being considered as a donor site and another symbol when it is considered as a susceptible site. The term "light structure" includes magazines built to Magazine Standards as promulgated by Explosives Branch.

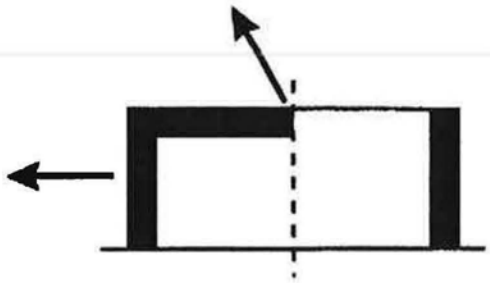
A.2 Pictographs for Donor Sites

These descriptions are merely for easy identification of the pictographs used in the Q-D Tables. A susceptible site is assumed to exist to the left of each pictograph illustrated in the following figures.

Column in Table

A **Heavy-Walled Building**

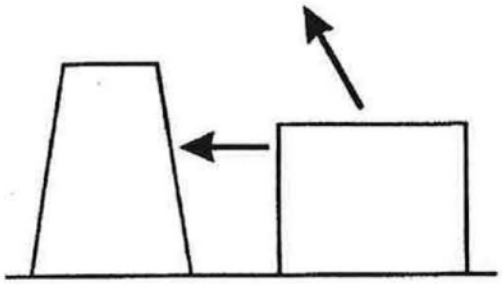
Building with heavy walls, with or without protective roof.



B **Barricaded Site**

Open-air stack or light structure, barricaded

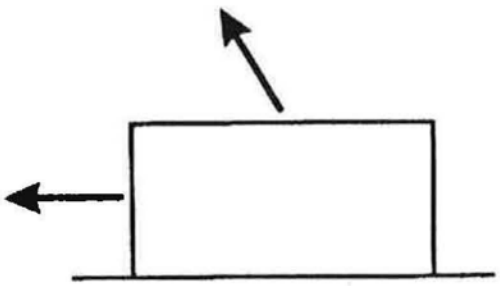
Truck, trailer or railcar loaded with explosives, barricaded.



C **Unbarricaded Site**

Open-air stack or light structure, unbarricaded.

Truck, trailer or railcar loaded with explosives, unbarricaded.



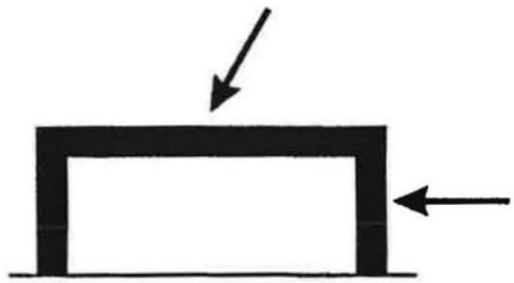
A.3 Pictographs for Susceptible Sites

These descriptions are merely for easy identification of the pictographs used in the Q-D Tables. A donor site is assumed to exist to the right of each pictograph illustrated in the following figure.

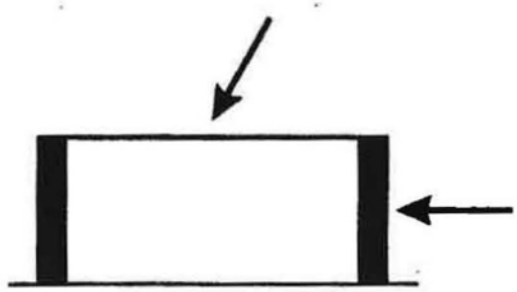
Row in Table

Heavy-walled Building

1 Building of non-combustible construction, used for explosives storage, with walls of 45 cm reinforced concrete, 70 cm concrete or solid brick or equivalent and protective roof of 15 cm reinforced concrete with suitable support. The door is barricaded if it faces a donor site.



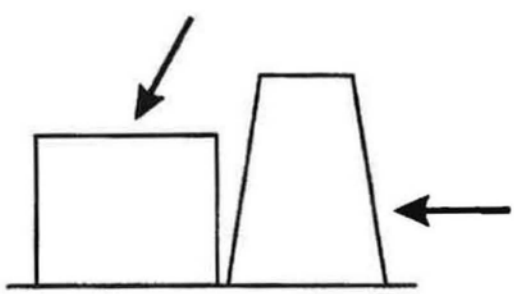
2 The same building as above but without protective roof. The door is barricaded if it faces a donor site.



Barricaded Site

3 Open-air stack or light structure, barricaded.

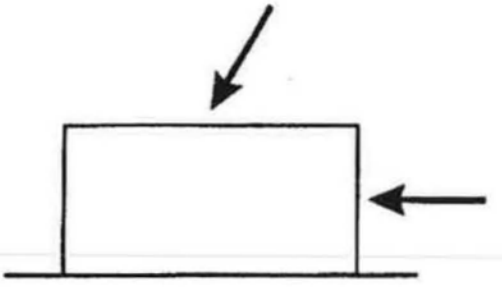
Truck, trailer or rail-car loaded with explosives, barricaded.



Unbarricaded Site

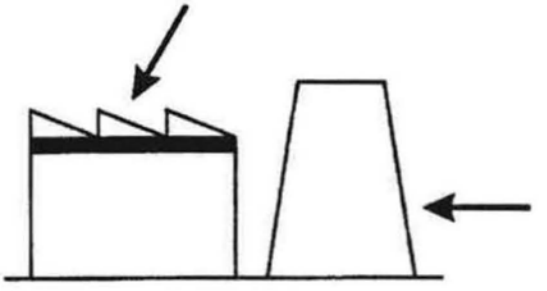
4 Open-air stack or light structure, unbarricaded.

Truck, trailer or railcar loaded with explosives, unbarricaded.

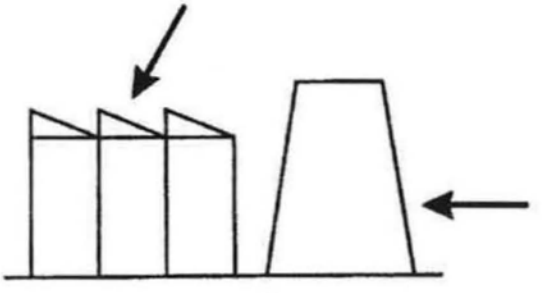


Explosives Process Building

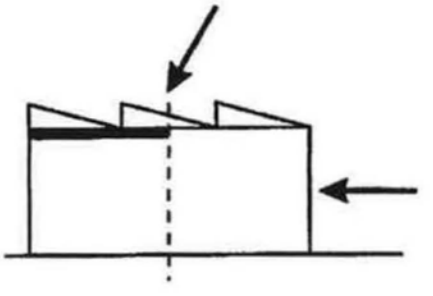
5 Explosives process building with protective roof, barricaded (a heavy wall may constitute the barricade).



6 Explosives process building without protective roof, barricaded (a heavy wall may constitute the barricade).

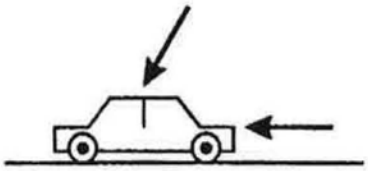


7 Explosives process building with or without protective roof, unbarricaded.

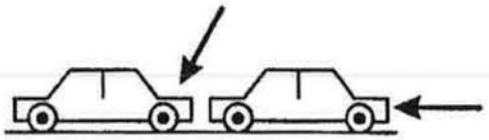


Public Traffic Route

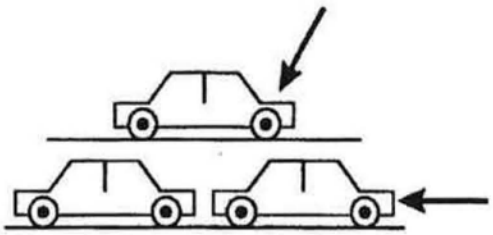
8 Public traffic route - light traffic



9 Public traffic route - medium traffic

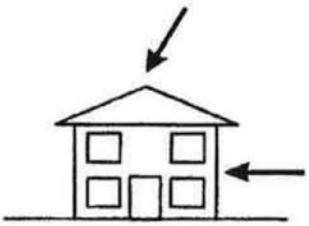


10 Public traffic route - heavy traffic



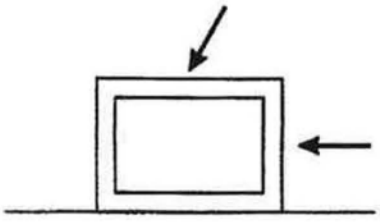
Inhabited Building

11 Inhabited building



12 Built up area of inhabited buildings

13 Vulnerable construction buildings



Notes

Appendix B: Blast Damage Assessment

B.1 Injury to persons or damage to property from an explosion may result from blast, projections and/or thermal radiation. The expected effects may vary because of factors already discussed.

B.2 Blast Overpressure - HD 1.1

To obtain the expected effects from a detonation of HD 1.1, the distance of the susceptible site from the donor site must be known as well as the NEQ of HD 1.1 at the donor site. As barricades have no significant effect on blast overpressures, they are ignored.

The distance (d) in metres is divided by the cube root of the NEQ in kilograms to provide a scaled factor. The mathematical formula is shown below.

$$\frac{d}{\sqrt[3]{\text{NEQ}}} = \text{scaled factor}$$

It can be assumed that the blast overpressures from stocks in the open or above ground magazines are:

Scaled Factor	Peak Incident (side-on) Overpresure Expected
	kPa
44.4	1.5
22.2	5
14.8	9
8.0	21
3.6	70
2.4	180

To convert kPa to psi, multiply by 0.15.

The determined scaled factor is then compared to one of the following headings which has the expected effects listed. For scaled factors falling between those that are provided, the expected effects should be estimated.

B.3 Scaled Factor 55.5

The expected results are:

a. The overpressures at this distance will cause little or no damage to an unstrengthened structure.

b. Vulnerable Construction Buildings or buildings with large areas of glass, particularly where they face the donor site, may suffer some breakage of glass or displacement of cladding.

c. Personnel are afforded a very high degree of protection from death or injury. The primary hazard is from broken glass or cladding falling from a considerable height and striking people at a high speed.

B.4 Scaled Factor 44.4

The expected results are:

a. Unstrengthened structures are likely to suffer only superficial damage.

b. When large panes of glass are exposed facing the donor site, 50 per cent or more breakage may occur.

c. Personnel are afforded a high degree of protection from death or serious injury. Injuries that do occur will be caused principally by broken glass.

This distance is required for buildings in Group 6 (see Appendix C). This is the scaled factor used for calculating Vulnerable Construction Distance (twice Inhabited Building Distance).

B.5 Scaled Factor 22.2

The expected results are:

a. Unstrengthened buildings will suffer minor damage particularly to parts such as windows, door frames and chimneys. In general, damage is unlikely to exceed approximately 5 per cent of the replacement cost but some buildings may suffer serious damage.

b. Personnel are afforded a high degree of protection against the direct effects of an explosion but are likely to suffer injuries from broken glass and flying/falling debris.

c. Metal buildings will have corrugated aluminum/steel panelling moderately buckled with joints separated.

d. Roof rafters in wood frame structures will crack.

e. Large and small glass windows will shatter, and frames will occasionally fail.

This distance is required for Group 5 buildings and heavy traffic.

B.6 Scaled Factor 17.6

The expected results are:

a. Unpressurized liquid storage tanks will be slightly damaged.

b. Aircraft will suffer minor damage to control surfaces and other areas.

B.7 Scaled Factor 14.8

The expected results are:

a. Unstrengthened buildings will suffer average damage that will cost about 10 percent of the total building replacement cost to repair.

b. Personnel under cover are afforded a high degree of protection from death or serious injury. Injuries that do occur will be mainly caused by broken glass and building debris.

c. Personnel in the open are not likely to be seriously injured by blast.

d. Corrugated asbestos siding will shatter.

e. Unreinforced concrete block or brick wall (3 to 5 cm) will be severely damaged/shattered.

f. Metal buildings will suffer severe buckling and some panels will be torn off.

g. Large and small glass windows will suffer severe frame failure, however, frame failure will not occur if the glass is thin and breaks easily.

h. Aircraft landing or taking off could lose control and crash.

i. Unsheltered aircraft will likely sustain minor damage due to blast but should remain airworthy.

This distance is required for medium traffic.

B.8 Scaled Factor 9.6

The expected results are:

a. Buildings which are unstrengthened can be expected to suffer damage to main structural members which will require repair. Repairs may cost more than 20 per cent of the replacement cost of the building. Strengthening of buildings to prevent damage and secondary hazards is feasible and not prohibitively expensive.

b. Personnel suffer temporary hearing loss; however, permanent ear damage is not likely. Other injuries from the direct effects of overpressure are unlikely.

c. There will be some personnel injuries caused by translation of the individual(s) involved.

d. Automobiles may suffer some damage to metal portions of the roof and body by blast. Windows facing the blast may be broken; however, the glass should not cause serious injuries to the occupants.

e. Aircraft will suffer some damage to appendages and sheet metal skin; however, they should be operational with only minor repair.

f. Cargo type ships will suffer minor damage from blast to deck houses and exposed electronic gear.

g. Wood frame structures will experience cracked studs and sheathing.

h. Injury from secondary blast effects such as building debris and impact with hard surfaces can be expected.

B.9 Scaled Factor 8.0

The expected results are:

a. Buildings which are unstrengthened can be expected to suffer serious damage which is likely to cost above 30 per cent of the total replacement cost to repair.

b. There is some possibility of delayed communication of the explosion as a result of fires or equipment failure at the susceptible site. Direct propagation of the explosion is not likely.

c. Cargo ships would suffer damage to decks and superstructure. In particular, doors and bulkheads on the weather-deck are likely to be buckled by overpressure.

d. Aircraft are expected to sustain considerable structural damage.

e. Metal buildings will have the siding and interior completely destroyed. Frame failure may occur if the siding has been reinforced or strengthened.

This distance is required for some process building distances and for light traffic.

B.10 Scaled Factor 7.2

The expected results are:

a. Provides high degree of protection against direct propagation of an explosion.

b. Some possibility that delayed communication of an explosion may occur from fires, or as a result of equipment failure at the susceptible site.

c. Damage to unstrengthened buildings will be of a serious nature. Repair is likely to cost 50 per cent or more of the total replacement cost.

d. Cargo ships would suffer some damage to doors and bulkheads on the weather-deck buckled by overpressure.

e. Aircraft can be expected to suffer considerable structural damage from blast. In some cases, this may be so severe as to necessitate salvage of the aircraft.

f. Unpressurized liquid storage tanks will be severely damaged.

g. Reinforced concrete walls will exhibit moderate cracking.

h. Reinforced concrete block or brick walls built between rigid supports will shatter or experience severe damage.

i. There is a 10 per cent chance of eardrum damage to personnel.

j. Transport vehicles will incur extensive, but no severe, body and glass damage consisting mainly of dishing of body panels and cracks in shatter resistant window glass.

B.11 Scaled Factor 4.4

The expected results are:

a. Heavy machinery (eg, generators, compressors, etc) will be completely displaced with moderate damage.

b. Unpressurized liquid storage tanks will collapse.

c. Reinforced concrete walls will suffer severe spalling and wall displacement.

d. Unreinforced concrete block or brick walls (3 to 5 cm) will collapse.

e. Wood frame structures will collapse.

f. Personnel will incur serious injury to eardrums and lungs or possible death due to the blast.

B.12 Scaled Factor 3.6

The expected results are:

a. Provides high degree of protection against direct propagation of an explosion when barricades are interspersed between the two explosives locations.

b. Explosions may subsequently occur in adjacent sites from fire spread by lobbed debris from blast site.

c. Unstrengthened buildings will suffer severe structural damage approaching total demolition.

d. Severe injuries or death to occupants of the susceptible site are to be expected from direct blast, building collapse, or translation.

e. Aircraft will be damaged by blast to the extent that they will be beyond economical repair.

f. Improperly designed barricades 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.

g. Heavy machinery (eg, generators, compressors, etc.) will be destroyed.

h. Vehicles and trailers will be destroyed.

i. Transport vehicles will be heavily damaged to the extent of total loss.

B.13 Scaled Factor 2.4

The expected results are:

a. Steel towers will be blown down.

b. Reinforced concrete walls will be completely destroyed.

c. Personnel will be killed by the direct action of the blast.

d. Vehicles will be overturned and crushed by the blast.

e. Aircraft will be destroyed.

B.14 Fragments/Debris

An important consideration in the analysis of the hazard associated with the accidental explosion is the effect of the projections generated by the explosion. These projections are known as primary or secondary projections depending on their origin.

Primary projections are formed as a result of the shattering of the explosive container. The container may be the casing of conventional ammunition, the kettles, hoppers or other metal containers used in the manufacture of explosives, the metal housing of rocket engines and similar items. These projections are usually small and travel initially at velocities of thousands of feet per second.

Secondary projections are formed as a result of high blast pressures on structural components and items in close proximity to the explosion and are generally called debris. These projections are somewhat larger in size than primary projections and travel initially at velocities of hundreds of feet per second. They consist of debris of earth-covered structural material and ejected material from the crater.

The minimum distances discussed in Parts 5 and 7 are a reflection of minimum distances for protection from fragments

B.15 Thermal Radiation

Detonation of an explosive typically results in the production of a visible flash of flame. Normally the radiation from this shortlived flame is of negligible hazard in comparison with blast and missile effects and may be ignored.

Propellants and pyrotechnic substances of Hazard Division 1.3 differ from detonating explosives of Hazard Division 1.1 in that unless heavily confined their reaction does not result in the generation of high pressure gases. The energy per unit mass of these explosives is comparable with that of a detonating explosive but, whereas the energy of a detonating explosive is released within a timescale of a few milliseconds, that from an unconfined propellant or pyrotechnic substance is released over a period measured in seconds or longer. This energy is released in the form of an intense flame and may cause hazard by thermal radiation and additionally by direct impingement of the flame.

Notes

Appendix C: Group Classification of Susceptible Sites

C.1 The general principles to be used in application of Quantity-Distances are to ensure the minimum practicable risk to personnel, equipment, structures and facilities. All structures and facilities which are not directly related to explosives should be sited at or beyond the Inhabited Building Distances. When this is not practicable, structures and facilities should be considered in accordance with the grouping provided below. The lists of facilities under each group are not complete, and they are given to provide general guidance only. For specific cases Explosives Branch reserves the right for final decision on classification of such susceptible sites.

C.2 Listing of Groups

C.2.1 Group 1

These buildings and facilities require Q-D sufficient to prevent the spread of fire from the building in question to a susceptible site. A minimum distance of 25 m should be used. Examples of Group 1 buildings are:

a. guard shelters;

b. MHE accommodation;

c. MHE charging facilities; and

d. stores for empty packages or other inert materials required at the explosives site.

C.2.2 Group 2

These buildings and facilities require Process Building Distances to ensure a reasonable degree of protection to the occupants from the effects of an explosion rather than protection of explosive stores from propagation. This is the minimum degree of protection to be provided to personnel from the effects of an explosion at another donor site. Light structures are likely to be severely damaged. Examples of Group 2 buildings are:

a. explosives process buildings or workshops (barricaded/unbarricaded);

b. explosives laboratories;

c. ammunition assembly buildings;

d. depot/facility fire stations (see also Group 5);

e. guard rooms in which those directly responsible for the security of the explosives area are housed when not on duty;

f. sub-offices with an occupancy of no more than 6 personnel during working hours; and

g. for new construction, packaging and shipping (transit) buildings in the explosives area.

C.2.3 Group 3

These buildings and facilities require Medium Traffic Route Distances to provide a higher level of protection than that given to Group 2 buildings. At Medium Traffic Route Distances personnel are only at risk from falling debris. Examples of Group 3 buildings and facilities are:

a. public parks;

b. recreational areas without structures;

c. parking area;

d. minor navigable waterways;

e. explosives facility and depot offices with an occupancy of between 7 and 20 personnel at any one time; and

f. railways of minor to medium importance

C.2.4 Group 4

These buildings and facilities require Heavy Traffic Route Distances. Examples of Group 4 buildings and facilities are:

a. main railway line;

b. highways and major roads;

c. major navigable waterways; and

d. non-vital stocks of fuel

C.2.5 Group 5

These buildings and facilities require Heavily Inhabited Building Distances. These distances should be applied to areas outside of the explosives area. Examples of Group 5 buildings and facilities are:

a. factory offices or administrative areas associated with an explosives area;

b. built up areas of inhabited buildings;

c. places of assembly;

d. non-explosives workshops including packaging refurbishment plants;

e. sports stadiums;

f. buildings used for the storage of radioactive materials;

g. canteens within the administrative area;

h. storehouses and shops which must not be placed at risk because of their vital nature or high intrinsic value;

i. structures and facilities in the administrative area of a depot which are important for the functioning of the depot, eg, fire stations, central heating plants, vehicle pools, gasoline storage and dispensing facilities, unprotected water supply and power installations; and

j. vital stocks of fuel (minimum 450 m)

C.2.6 Group 6

These buildings require a higher degree of protection than Group 5 buildings; Group 6 distance is twice the Inhabited Building Distance. Examples of Group 6 buildings and facilities are:

a. buildings of vulnerable construction;

b. buildings of national and historic importance.

c. large factories

d. multi-storey office or apartment buildings

e. public buildings and edifices of major value

f. large educational facilities

g. large hospitals

h. major traffic terminals (eg. railway stations, airports)

i. major public utilities (eg. gas, water, electricity)

j. major sports stadiums, and

l. exhibition areas and assembly halls.

Notes

Appendix D: Mixing and Aggregation Rules

D.1 Possible Combinations of Hazard Division and Compatibility Group

	Compatibility Group													
HD	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**N**	**S**	**A–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
1.1–1.6 Σ	1	3	4	4	3	4	4	2	3	2	3	1	1	35

This table is for information purposes. It is *not* to be used for mixing or aggregation. Combinations in blank squares do not exist

D.2 Mixing and Aggregation Rules for More Than One Hazard Division at *a Single Site*

When explosives of more than one Hazard Division are stored at a single site, the required Quantity-Distances or permissible Net Explosives Quantity limits shall be calculated as follows:

a. **Hazard Division 1.4.** When HD 1.4 is stored in the same site as any other HD, the HD 1.4 is ignored, subject to its compatibility, subject to differentiating between explosives that are or are not intrinsically HD 1.4 as described in Part 9.

b. **Hazard Division 1.21 with Hazard Division 1.22.** Treat the total as HD 1.21.

c. **Hazard Division 1.1 with Hazard Division 1.2.** Treat the total as HD 1.1, then treat the total as HD 1.2. The lowest Net Explosives Quantity or the greatest Quantity-Distance shall apply.

d. **Hazard Division 1.33 with Hazard Division 1.34.** Treat the total as HD 1.33.

e. **Hazard Division 1.1 with Hazard Division 1.3.** Treat the total as HD 1.1, then treat the total as HD 1.3. The lowest Net Explosives Quantity or greatest Quantity-Distance shall apply.

f. **Hazard Division 1.2 with Hazard Division 1.3:**

   1. Determine the Q-D for the amount of HD 1.2. Next determine the Q-D for the amount of HD 1.3. The required Q-D is the greater of these two distances.

   2. When explosives of HD 1.2 and 1.3 are kept in the same site, determine the permissible NEQ for each HD separately (do not aggregate). These two quantities may be stored together independently. (See also note 2 to the following table.)

g. **Hazard Division 1.1 with Hazard Division 1.2 and Hazard Division 1.3.** Treat the total as HD 1.1, HD 1.2 and HD 1.3 in turn. The lowest Net Explosives Quantity or greatest Quantity-Distance shall apply.

The above rules are summarized in the following table and notes.

HD	1.1	1.2	1.3	1.4	1.5 SUBSTANCES	1.6 ARTICLES
1.1	1.1	1.1	1.1	Note 1	1.1	1.1
1.2	1.1	1.2	Note 2	Note 1	1.1	Note 3
1.3	1.1	Note 2	1.3	Note 1	1.1	Note 3
1.4	Note 1	Note 1	Note 1	1.4	Note 1	Note 1
1.5 Subst.	1.1	1.1	1.1	Note 1	1.1	1.1
1.6 Artic.	1.1	Note 3	Note 3	Note 1	1.1	Note 3

Notes to Table

1. HD 1.4 may be stored with any other HD without aggregation, subject to Part 9.

2. Mixed HD 1.2 and 1.3 will usually behave as aggregated 1.2 or 1.3. However, there is a significant risk that, in certain circumstances, a mix of HD 1.2 and HD 1.3 will behave as an aggregated quantity of HD 1.1.

   If any of the following circumstances exists the mix must be aggregated as HD 1.1, unless relevant trials or analyses indicated otherwise:

   1) The presence of HD 1.2 shaped charges.

   2) Presence of propellants.

   3) High loading density storage of HD 1.3 in conditions of relatively heavy confinement.

   4) HD 1.2 articles with an individual NEQ > 5 kg.

   There may also be other circumstances, not yet identified, under which the mix should be aggregated as HD 1.1.

3. HD 1.1 unless demonstrated by testing or analogy to be otherwise.

D.3 Rules for Mixing of Compatibility Groups

D.3.1 Explosives Substances

Substances may be mixed in aboveground storage as shown in the following table, where

P = Mixing permitted

NP = Mixing not permitted

COMP.GROUP	A	C	D	G	L(2)	S
A	P	NP	NP	NP	NP	NP
C	NP	P[1]	P[1]	NP[3]	NP	P
D	NP	P[1]	P[1]	NP[3]	NP	P
G	NP	NP[3]	NP[3]	P[3]	NP	P
L(2)	NP	NP	NP	NP	NP[2]	NP
S	NP	P	P	P	NP	P

NOTES:

1 Mixing permitted provided substances have all passed UN Test Series 3. Storage of substances of any of Compatibility Groups C, D, or G which have failed UN Test Series 3 will require special consideration by an inspector.

2 Compatibility Group L substances must always be stored separately from all substances of other compatibility groups as well as from all other substances of Compatibility Group L.

3 The mixing of Compatibility Group G substances with other Compatibility Group G substances or compatibility groups may be permitted by an inspector.

D.3.2 Explosives Articles

Articles may be mixed in above ground storage as shown in the following table, where

P = Mixing permitted

NP = Mixing not permitted

C.G.	B	C	D	E	F	G	H	J	K	L[3]	S	N[6]
B	P	NP	P[1]	P[1]	P[1]	NP	NP	NP	NP	NP	P	NP
C	NP	P	P	P	NP[2]	NP[5]	NP	NP	NP	NP	P	P[6]
D	P[1]	P	P	P	NP[2]	NP[5]	NP	NP	NP	NP	P	P[6]
E	P[1]	P	P	P	NP[2]	NP[5]	NP	NP	NP	NP	P	P[6]
F	P[1]	NP[2]	NP[2]	NP[2]	P	NP[5]	NP	NP	NP	NP	P	NP
G	NP	NP[5]	NP[5]	NP[5]	NP[5]	P[5]	NP	NP	NP	NP	P	NP
H	NP	NP	NP	NP	NP	NP	P	NP	NP	NP	P	NP
J	NP	NP	NP	NP	NP	NP	NP	P	NP	NP	P	NP
K	NP	NP	NP	NP	NP	NP	NP	NP	P	NP	NP	NP
L[3]	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP[3]	NP	NP
S	P	P	P	P	P	P	P	P	NP	NP	P	P
N[6]	NP	P[6]	P[6]	P[6]	NP	NP	NP	NP	NP	NP	P	P

The numbers refer to the notes that follow.

Aboveground Storage of Explosive Articles

NOTES:

1 With the permission of an inspector, Compatibility Group B fuzes may be stored with the articles to which they will be assembled, provided that there are no more fuzes than articles but the NEQ must be aggregated and treated as Compatibility Group F.

2 Storage in the same building is permitted if effectively segregated so as to prevent propagation.

3 Compatibility Group L articles must always be stored separately from all articles of other compatibility groups as well as from all other articles of Compatibility Group L.

[4] Hazard Division 1.4 articles should be stored as per part 9, i.e., articles shall be classified for storage irrespective of packaging e.g., detonators classed 1.4 B or 1.4 S shall be stored as 1.1 B.

[5] Mixing of articles of Compatibility Groups G with articles of other compatibility groups is at the discretion of an inspector. Recreational fireworks should not be stored with other types of explosives including other CG G articles.

[6] Advice on storing CG N articles shall be obtained from an inspector.

Notes

Appendix E: Barricades

E.1 Functions of Barricades

An effective barricade arrests high velocity, low trajectory projections from an explosion which otherwise could cause direct propagation of the explosives at a susceptible site.

A vertical faced barricade close to a donor site also reduces the projection of burning packages, ammunition and debris.

A barricade may also provide limited protection against blast and flame arising from an external or internal explosion when the quantity of explosives is relatively small as it usually is in process buildings.

E.2 Influence of Barricades upon Q-D for HD 1.1

E.2.1 Inter-Magazine Distances

An effective barricade avoids the use of very large Inter-Magazine Distances around a site containing explosives of HD 1.1. This is a significant factor in the cost of a storage site. The reduced quantity-distances are given in Table 1.

E.2.2 Process Building Distances

An effective barricade avoids the use of large Process Building Distances from donor sites containing explosives of HD 1.1. A traverse or heavy wall around a process building considered as a susceptible site may provide some protection for personnel in the lee of the barricade.

E.2.3 Outside Quantity-Distances

Investigation of damage caused by blast in recorded accidents and trials shows that, in the case of HD 1.1, the difference between the OQ-Ds required for barricaded and unbarricaded buildings is too small to be taken into account.

E.3 Influence of Barricade upon Q-D for HD 1.2 or 1.3

A barricade, other than a door barricade, does not itself generally provide sufficiently effective protection against flame, radiant heat, projections and lobbed ammunition to justify a reduction of inter-magazine distances. An inspector should be consulted for guidance.

E.4 Geometry of Earth Barricades

Proper barricade geometry is necessary to reduce the risk that high velocity projections may escape above or around the ends of the barricade and so produce an explosion in an adjacent site. Since such projections do not move along perfectly linear trajectories, reasonable margins in barricade height and length must be provided beyond the minimum dimensions which block lines of sight.

The required height of the barricade is determined as follows:

For line AB on level terrain, point A is chosen as a reference on either of two stacks. If the stacks have different heights, point A is on the lower stack. Point A is at the top of that face of the chosen stack which is remote from the other stack. If the stacks are covered by protective roofs, point A may be at the top of the face of the chosen stack which is nearer to the other stack. Point B is on the top face of the other stack.

For line AB on sloping terrain, point A is on the stack whose top face is at the lower elevation. Point A is at the top of that face of the chosen stack which is remote from the other stack. If the stacks are covered by protective roofs, point A may be at the top of that face of the chosen stack which is nearer to the other stack. Point B is on the top face of the other stack.

Line AB must pass through at least 2.4 m of barricade material or undisturbed natural earth between the two stacks, whether or not they are adjacent.

For line AC (2 degree Rule) proceed as follows:

Point A is chosen as described above.

On level or sloping terrain, a second line AC is drawn at an angle of 2 degrees above line AB.

When stacks are separated by less than 300 m, line AC must pass through at least 1.0 m of barricade material or undisturbed natural earth.

The 2 degree Rule applies only where the distance between stacks is less than 300 m and the ground does not slope excessively. Where greater distances or marked slope is involved, advice should be sought from an inspector.

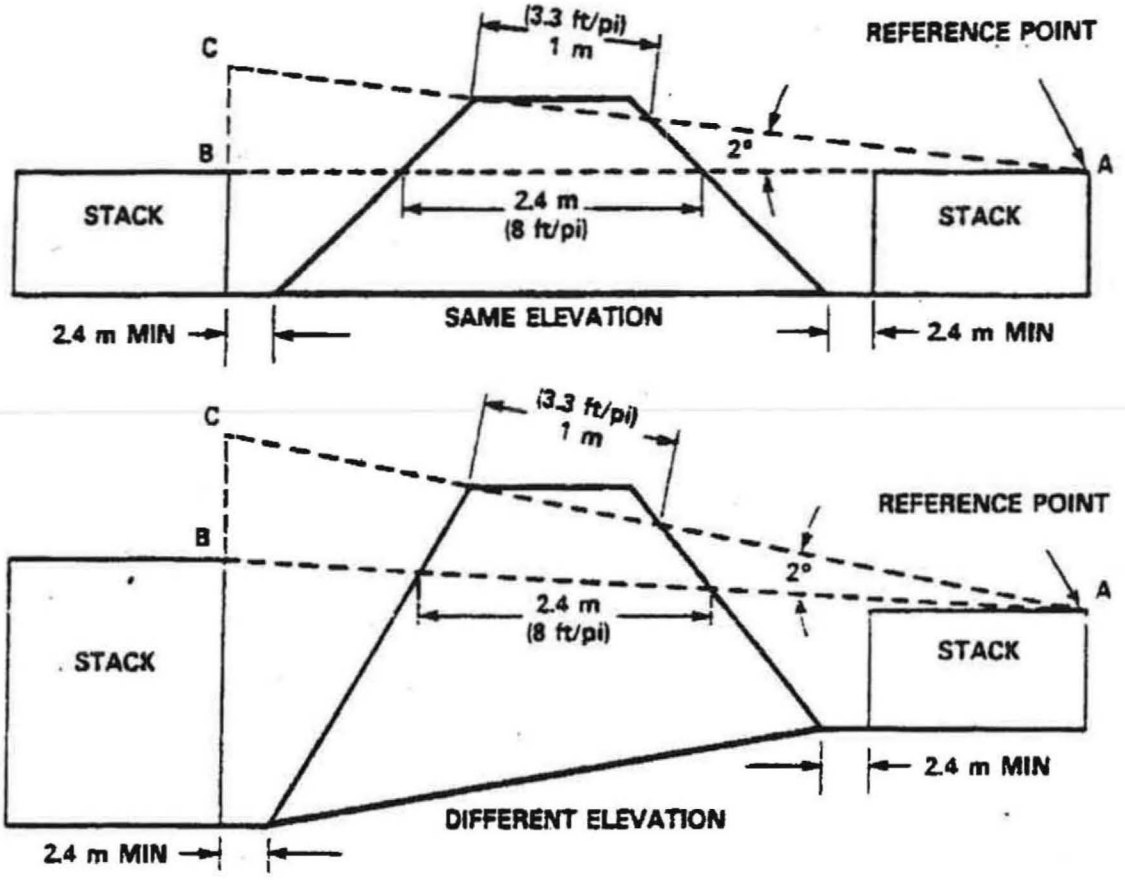
In the existing facilities where the 2 degree Rule cannot be applied without major reconstruction of barricades, advice should be sought from an inspector

The required length of the barricade is determined by extending the barricade, exclusive of the end slope, to 1.0 m beyond lines between the extremes of the two stacks of explosives under consideration. These lines must pass through at least 2.4 m of barricade material or undisturbed earth.

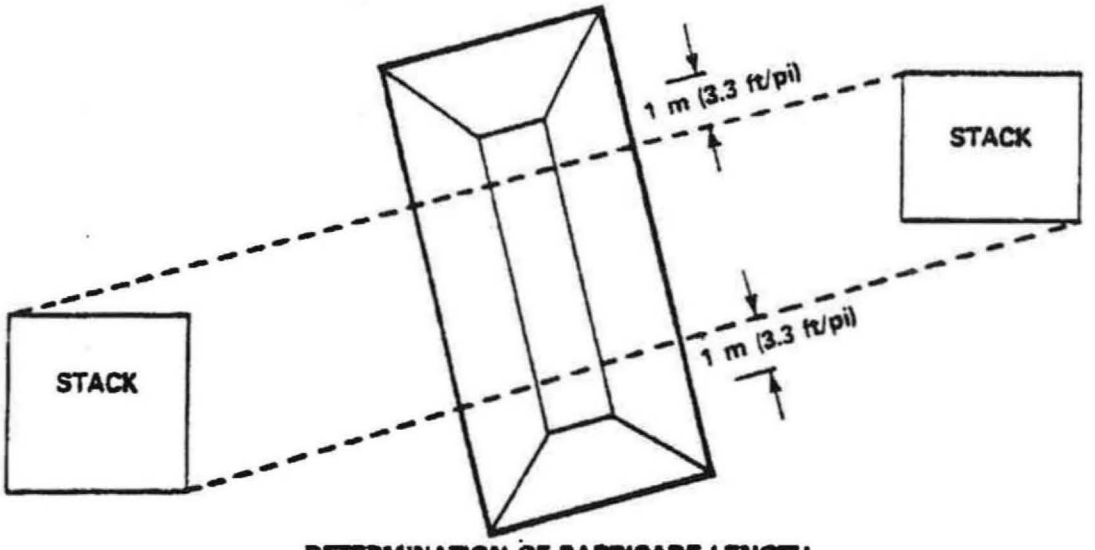
The distance from a stack to the foot of a barricade is a compromise. Each case is considered individually to achieve the optimum solution, taking account of the following factors:

A barricade close to a stack results in smaller dimensions for the barricade to intercept high velocity projections. However, on sloping terrain the minimum separation may not result in the smallest barricade.

A barricade further away from the stack results in easier access for maintenance and for vehicles, and the possibility to site the barricade outside the predicted crater when the donor site contains explosives which have mass explosion hazard (Hazard Division 1.1). The barricade shall be sited so that the crater does not undermine it more than one third of its thickness at ground level.



DETERMINATION OF BARRICADE HEIGHT — 2 DEGREE RULE



DETERMINATION OF BARRICADE LENGTH

The minimum distance from a stack or a building containing ammunition or explosives to the foot of the barricade shall be 2.4 m.

A good working estimate of the crater radius can be calculated from the formula:

Crater radius (m) = 1/2 (NEQ (kg))$^{1/3}$.

This radius is measured from the centre of the explosives. In certain soil conditions (saturated soil or clay), the crater may be larger than calculated from the above formula. In such conditions, consideration should be given to increasing the distance between magazines.

E.5 Material for Earth Barricades

The earth for barricades should be as prescribed below. When unreinforced concrete or solid brick is used in conjunction with earth, either of these materials may be taken as equivalent to four times its thickness of earth with regard to their ability to stop fragments. The concrete or brick may be used to support the earth or it may be those parts of the roof and walls of the building which intercept the high velocity projections.

Two precautions are necessary in the construction of earth barricades. One relates to the potential hazards to explosives and personnel at susceptible sites should the material be dispersed by an accidental explosion. The other relates to the precautions necessary to ensure the structural integrity of the earth barricades.

Because it is possible that the barricade material could be dispersed by an explosion, precautions shall be taken to reduce the hazards caused by large stones capable of causing initiation by impact upon explosives in adjacent storage sites. The selection of material and its use shall be governed by the following, which represent a reasonable compromise between undue hazards and excessive costs of construction:

Do not deliberately use rubble from demolished buildings.

Ensure that stones larger than 0.3 m in girth (about the size of a man's clenched fist) are removed during construction. Other harmful matter shall also be removed.

In climates where the ground becomes severely frozen, consideration should be given to the provision of an impermeable cover over the material or drainage to keep out excessive moisture.

The second precaution mentioned above, relating to structural integrity, applies in all cases. For this purpose, the material should be reasonably cohesive and free from excessive amounts of trash and detrimental organic matter. Compaction and surface preparation should be provided as necessary to maintain structural integrity and avoid erosion. Where it is impossible to use a cohesive material, for example, at a site in a sandy area, the earth-works should be finished with either a layer of cohesive soil or an artificial skin. On the other hand, solid wet clay should be avoided during construction since it is too cohesive and would result in an excessive debris hazard.

E.6 Walls as Barricades

External Walls of Buildings. A building without windows but with reinforced concrete walls of 45 cm thickness, 70 cm of solid brick or 70 cm of unreinforced concrete is acceptable as a barricaded building for stopping fragments from an explosion in an adjacent building or stack. These buildings are defined as heavy walled buildings. A 25 cm solid brick wall protected by a 45 cm solid brick wall barricade is prefer-

able to a single wall of about 70 cm of solid brick.

Substantial Dividing Walls within Buildings. Walls of not less than 30 cm of reinforced concrete, extending from floor to ceiling, can often be used to divide a building into individual cubicles. The function of each dividing wall is to prevent, or at least to substantially delay, transmission of an explosion between explosives on opposite sides of the wall. Explosives in Hazard Division 1.1 shall be stored not less than 1 m from the substantial dividing wall. The main advantage of this is that Quantity-Distances can then be based on the Net Explosives Quantity in one cubicle instead of on the total amount in the building. A second advantage is that an accidental explosion is less likely to render unserviceable all the stocks in the building. See TM5-1300 US Army "Structures to Resist the Effect of Accidental Explosives" for guidelines on constructing substantial dividing walls.

E.7 Barricade Material Equivalency Factors

The following earth equivalents are provided to assist in determining the contribution of the vertical facing material to the overall effectiveness of a vertical face barricade in stopping high velocity, low angle fragments and debris:

brick — 4 times,

unreinforced concrete — 4 times,

reinforced concrete — 6 times, and

steel — 24 times.

The barricade width may be reduced accordingly but the equivalent mass at the level of the top of the stack or eaves shall not be reduced below that of 2.4 m of earth.

E.8 Other Types of Barricades

Barricades may take any of the following forms provided that all parameters (eg, height, length and thickness) contained in this Appendix are met, and that the equivalent thickness of barricade material used is as detailed above.

Double Slope Barricade. An earth mound with both faces sloped at the natural angle of repose.

Single Slope Vertical Face (or Partial Vertical Face) Barricade. An earth mound with the outer face sloped at the natural angle and a vertical inner face suitably supported. Alternatively, the inner face may be partly vertical and partly sloped.

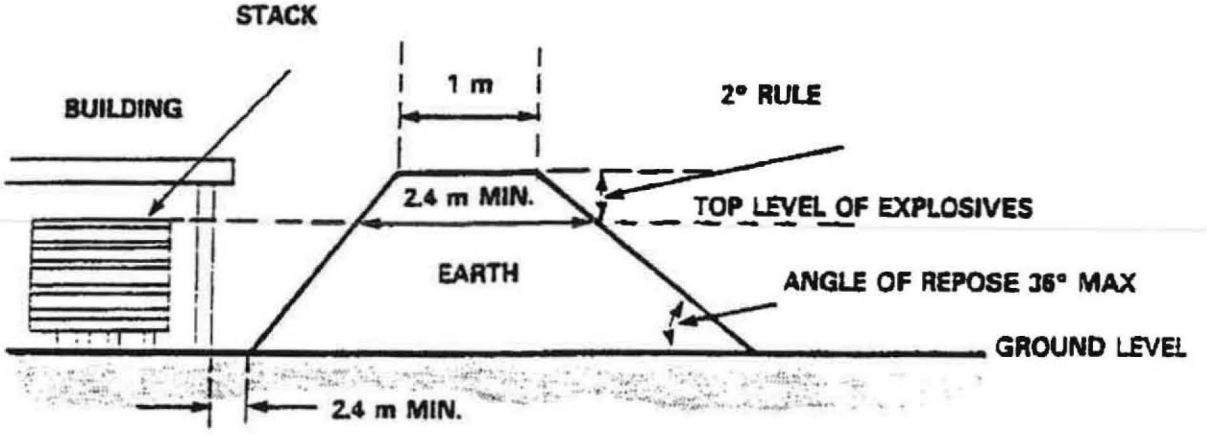
Steep Double Slope Barricade

Wall Barricade. A brick or concrete wall.

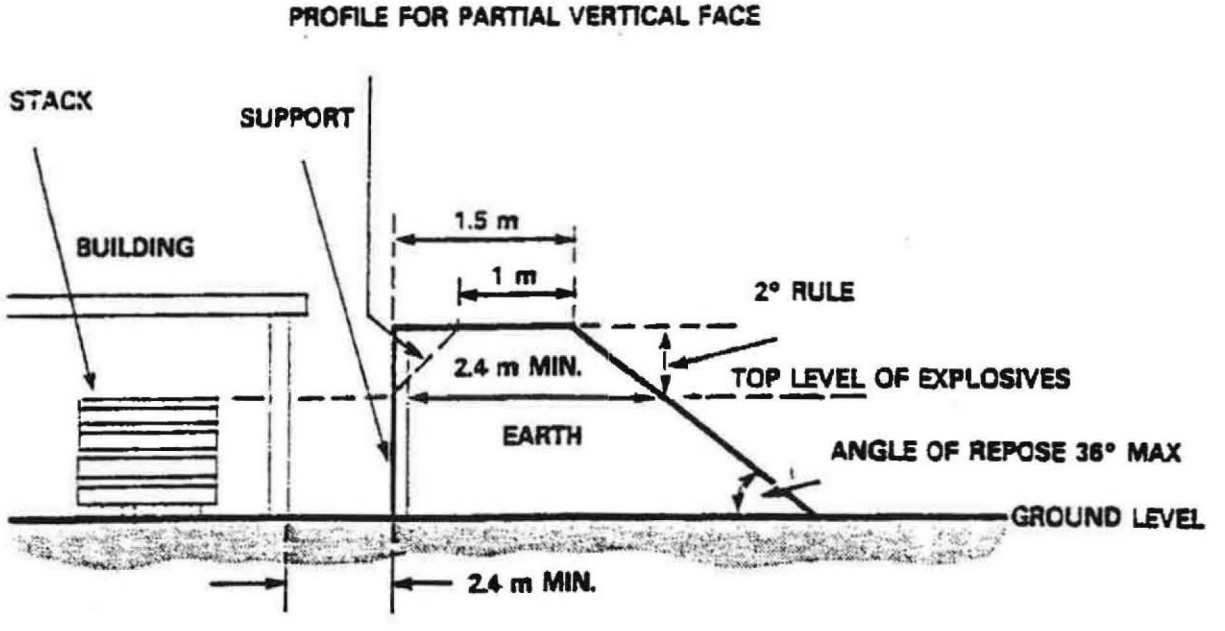
A natural feature of the land formation.

Thick vegetation (e.g., dense trees) should not normally be considered to be an effective barricade. Only an inspector may make this determination.

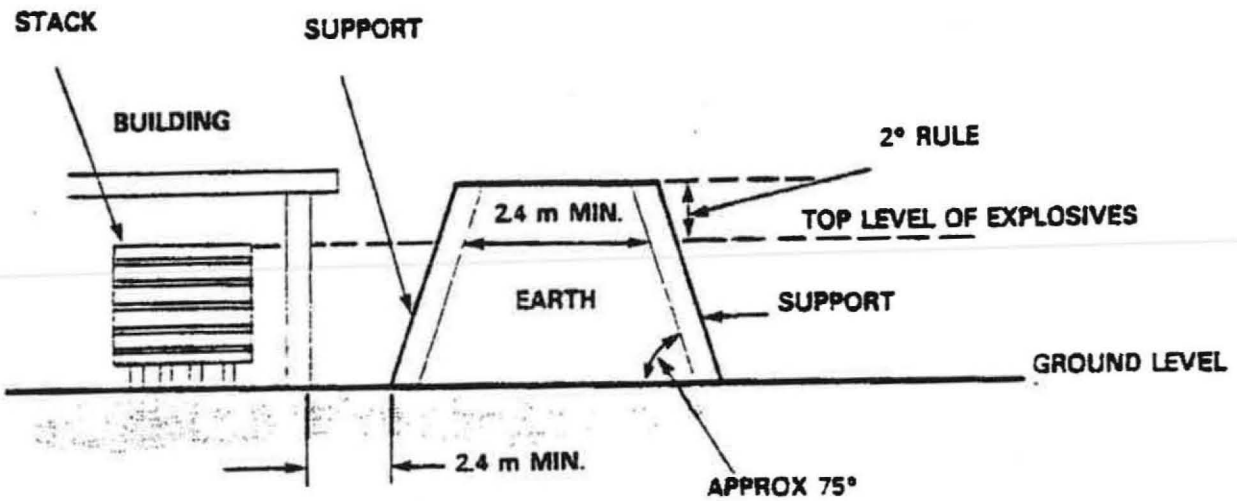
Double Slope Barricade



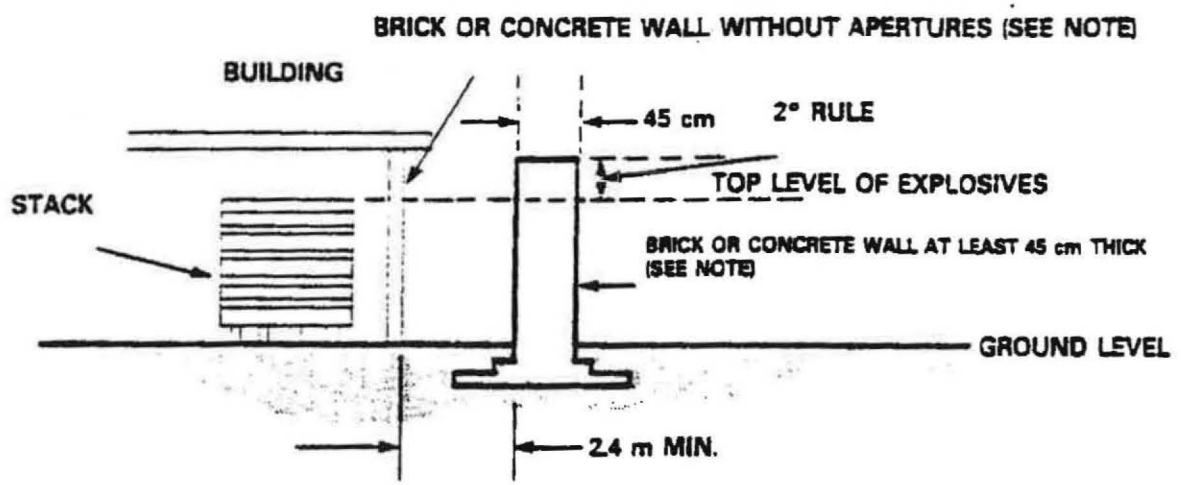
Single Slope Vertical Face (or Partial Vertical Face) Barricade



Steep Double Slope Barricade



Wall Barricade



NOTE

MINIMUM TOTAL THICKNESS OF THE BARRICADE AND BUILDING WALLS IS 45 cm REINFORCED CONCRETE, 70 cm UNREINFORCED CONCRETE OR 70 cm SOLID BRICK.

Notes

Appendix F: Determination of Quantity-Distance

F.1 General

Quantity-Distances required for HD 1.1 are given in Table 1, for HD 1.2 are given in Table 2 for HD 1.3 are given in Table 3 and for HD 1.4 G are given in the Table in Part 9. Q-Ds are, by definition, functions of quantity. It is, therefore, possible to determine the permissible NEQ of a HD given a fixed distance. It is also possible to determine the required separation distance given a fixed quantity of a HD.

F.2 Use of Q-D Tables

For an intermediate quantity between those given in the Q-D 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 explosive quantity limit for a given intermediate distance. Only an inspector may calculate the distances corresponding to an intermediate quantity using the distance functions presented in these guidelines. Values may be rounded up as per the following table:

Range of Values of Q-D	Rounding up to the nearest
2 - 100 m	1 m
100 - 500 m	5 m
500 - 1000 m	10 m
over 1000 m	20 m

F.3 Quantity Limits

Certain applications may require a lower limit than the minimum shown in the Tables. Only an inspector may make that determination. This also applies to quantities greater than the maximum shown in the tables.

F.4 Measuring Distances

Distances are measured from the nearest point of the donor site to the nearest point of the susceptible site. Distances are measured along a straight line without regard to barricades or topography.

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 the 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 instead of from the outside wall of the building.

F.5 Net Explosives Quantity

The total Net Explosives Quantity of explosives in a single donor site is generally used for the computation of Quantity-Distances.

Where two or more donor sites are not separated by the appropriate Inter-Magazine Distances, they are considered as a single site, which includes the structures and the area between them, and the aggregate Net Explosives Quantity is used for determining Quantity-Distances. Workshops, inhabited areas and traffic routes shall not be joined with magazines to form a single site unless it is otherwise authorized by an inspector.

F.6 Process of Determination of Quantity-Distances

Whether determining the location of a new donor site or establishing the permissible NEQ for an existing donor site, each site shall be assessed for its effect on the susceptible sites, both inside and outside of the explosives area.

For new construction, the site shall also be assessed as a susceptible site in order to determine its effect on the NEQ limits of the existing donor sites.

The following procedure is used in determining the permissible Net Explosive Quantity of a given Hazard Division at an existing donor site:

a. Establish the distances separating the donor site from each susceptible site.

b. Determine the appropriate pictographs for each donor site to the susceptible site.

c. Using the appropriate Hazard Division Q-D Table, determine the appropriate Quantity-Distance scale or critical distance by matching the column to a line for each donor site to susceptible site.

d. When a critical distance is indicated and the actual distance equals or exceeds this distance, the donor site may contain up to 250,000 kg. If the separation distance is less than the critical distance, that Hazard Division is not permitted at the donor site.

e. When a Quantity-Distance scale is indicated, determine the required Quantity-Distance by applying the actual distance between the donor site and the susceptible site to the appropriate Q-D Table. If a distance falls between two distances provided in the Tables, the lesser distance shall be used to determine the NEQ.

f. The most restrictive result is the Net Explosives Quantity limit for that Hazard Division.

When a specific Net Explosives Quantity of a given Hazard Division is to be stored at a new site, a similar procedure is followed to determine the required distances:

a. Determine the appropriate pictographs for each donor site to susceptible site.

b. Using the appropriate Hazard Division Q-D Table, determine the appropriate Quantity-Distance scale or critical distance by matching the column (donor site) to a line (susceptible site).

c. When a critical distance is indicated, the donor site to the susceptible site separation shall equal or exceed that distance or that Hazard Division may not be stored in the donor site under consideration.

d. When a Quantity-Distance scale is indicated, determine the required Quantity-Distance by using the specified Net Explosives Quantity to be stored. If the NEQ falls between two NEQs provided in the Q-D Tables, the greater NEQ shall be used to determine the distance.

e. The most restrictive distance, eg, the greater distance, shall be the minimum distance for the specified NEQ.

NOTE: For intermediate distances or quantities in the tables, an inspector may use the applicable formula to calculate quantity or distance.

F.7 Use of Quantity-Distance Calculation Worksheet

The following information is to be recorded in blocks 1-14. All information is required for factory licences. The regional inspector may waive blocks 8-13 for other types of licences.

Block

1. The name of the person, company or organization who has applied for the licence.
2. The licence number to be assigned (usually the last block to be filled in because a licence should not be issued until Q-D questions have been resolved).
3. The exact location of the magazine.
4. Indicate whether a site plan is attached. Site plans include sketches, topographical maps and aerial photos to confirm the distances supplied in the application by the applicant.
5. Indicate details such as proximity to fire department or nearest hydrant or source of water.
6. Indicate the type of magazine as detailed in the booklet Magazine Standards for Blasting Explosives and Detonators.
7. Insert the total internal dimensions (length, width and height).
8. Insert usable floor area (in square meters) and usable storage volume (in cubic meters).
9. Insert height at which stacking line is painted inside magazine. (Note that this is the height used in calculating the usable storage volume in Block 8).
10. If there is electrical supply to the magazine, indicate to what standard it has been installed.
11. If there is lightning protection, indicate the type.
12. If there is heating in the magazine, indicate the type.
13. Indicate the type of floor and if there are limits on it that would preclude making use of the full usable volume.
14. Insert details of any barricades around the magazine.

15. Insert the following:

    a. Below each applicable susceptible site pictograph, insert the number or name (eg. M1).

    b. There are three rows available for type of donor site. The two most common are already on the form. The third row is reserved for any unique donor site by drawing in the appropriate pictograph.

    c. At the intersection of the donor site row and susceptible site column, insert the distance (in meters) between the donor and susceptible site.

    d. The last two columns are used the show distances to sites such as a POL installation, radio transmitter, airfield, electrical installation.

16. Proceed as follows:

    a. In the spaces under each concerned susceptible site (for which distances are recorded in Block 15) and in the Hazard Division row, enter above the dashed line the appropriate Q-D Table column number, eg. D2 or a minimum distance, eg. 90m, derived from sheet 1 of the appropriate Q-D Table. Below the dashed line, enter permitted NEQ obtained from sheet 2 of the appropriate Q-D Table.

    b. For the last two columns, when applicable, POL, radio TX, airfield and electrical installation limits are derived from Part 6.

17. Enter for each HD the smallest permitted NEQ which is determined by comparing all filled in spaces in line with each HD in Block 16.

Notes

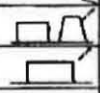
QUANTITY–DISTANCE CALCULATION WORKSHEET

1. Licencee (Name)			2. Licence No.
3. Location	4. Site Plan Attached YES / NO		5. Details of Fire Fighting

MAGAZINE DETAILS

6. Type	7. Internal Dimensions	8. Usable Space	9. Stacking Height
10. Electrical Standard	11. Type of Lighting Protection	12. Type of Heating	13. Type of Floor Including Load Limit

14. Barricade

15. Susceptible Site / Donor Site															POL RADIO TX.	AIRPORT ELECT INST.
																

16. Net Explosive Quantity

HD 1.1																
HD 1.2																
HD 1.3																

17. MAXIMUM NEQ (kg) PERMITTED BY QUANTITY DISTANCE					
HD 1.1	OR	HD 1.2	OR	HD 1.3	

18. Inspector's Signature

(Date) (Signature)

Record of Amendments to Canadian Quantity-Distance Principles

Amendment #	Date	Signature	Remarks, etc.

Errata

Please make the following corrections

1. pg 3-3 note under table change "seson" to "season"
2. pg 5-1 for column D7 change "Q½" to "$Q^{½}$"
3. pg 5-7 heading for right hand column in table change "of" to "or"
4. pg 8-3 Table 3 reverse the symbols in rows 8 and 9
5. pg F-4 para 15 d) change "the show" to "to show"
6. pg F-4 para 16 a) remove the word "dashed" in two places