



Defence
Safety Authority

DSA 03.OME Part 2 (JSP 482) - Defence Code of Practice (DCOP) and Guidance Notes for In-Service and Operational Safety Management of OME

Defence OME Safety Regulator

DOSR



DSA VISION

Protecting Defence personnel and operational capability through effective and independent HS&EP regulation, assurance, enforcement and investigation.

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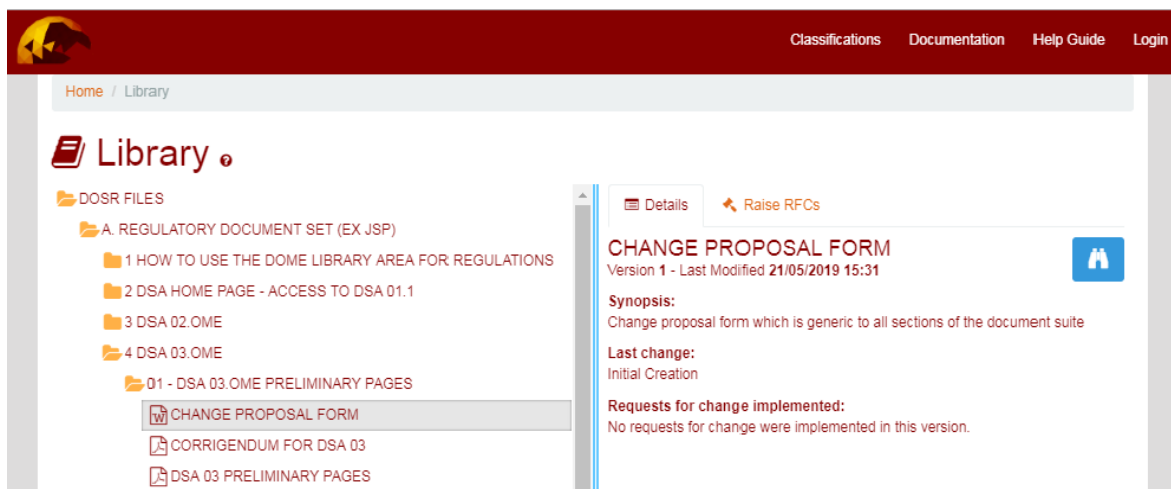


Figure 1. Change Proposal Form (Word version) Location

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1 SECTION ONE

1.1 Introduction

1.1.1 The storage, handling and transportation of military explosives are operations that present inherent risks to persons and property. The MOD therefore has a legal responsibility to ensure that its explosives present risks that are both tolerable and as low as reasonably practicable (ALARP) should an explosive event occur.

1.1.2 Based on assessment of the effects of such an event (e.g. blast and fragment radii), and predictions as to which specified levels of risk obtain in terms of injury or damage, the MOD Defence, Ordnance, Munitions and Explosives Regulator (DOSR) has developed tables of Net Explosive Quantity (NEQ) and associated recommended distances. These tables are known as Quantity Distance (QD) Tables and, together with other DOSR criteria for their use, form the foundation for MOD explosives licensing of Potential Explosion Sites (PES). The QD are based on trials and other data but are susceptible to uncertainty owing to the variability of the nature of explosions and the incompleteness of the trials data. QD are subject to continuing refinement, as further data becomes available.

1.1.3 This chapter is sub-divided into different sections as follows:

Section 1 (This section)	1	Common Criteria.
Section 2	2	Above Ground Storage.
Section 3	3	Marshalling Yards, Transit and Staging Facilities.
Section 4	4	Ports and Harbours.
Section 5	5	Military Airfields.
Section 6	6	Underground Storage.
Section 7	7	Mutually Hazardous and Other Non-Explosive's Buildings, Installations and Facilities.
Section 8	8	Authorised Quantities of Explosives.
Section 9	9	Demolition Grounds.

1.1.4 If a facility or circumstance is not covered in this chapter, or assistance in interpretation is required, or exceptional conditions prevail, advice is to be sought from the relevant IE. Ultimately, DSA DOSR CIE (MOD) staff may have to be approached for advice.

2 DEFINITIONS

2.1 Potential Explosion Site

2.1.1 A PES is any stock of explosives, however or wherever stored (building, stack, vehicle, railway wagon, berth, transit shed etc), the explosion of which will affect an Exposed Site.

2.2 Exposed Site

2.2.1 An ES is any facility, service or civilian, exposed to and thus hazarded by the effects of an explosion or fire at a PES. These facilities include:

- (1) Any stock of explosives, however or wherever stored.
- (2) Process Buildings and explosives workshops.
- (3) Inhabited buildings and places of assembly.
- (4) Public traffic routes, including roads, footpaths, railways, canals and civil aircraft facilities, etc.

- (5) Other Hazardous Installations, e.g. electrical sub-stations.

3 SUB - DIVISIONS FOR STORAGE

3.1 Introduction

3.1.1 Following NATO practice, DOSR has assessed the level of hazard from different types of explosives in HD 1.2 and HD 1.3 and placed more hazardous items and less hazardous items into different sub-groups (Storage sub-Divisions (SsD)) as described below.

3.2 Hazard Division 1.2

3.2.1 HD 1.2 is further divided into three Storage sub-Divisions (SsD) 1.2.1, 1.2.2 and 1.2.3..

NOTE: Due to legacy accounting systems the SsD is often displayed without the second "point", i.e. 1.22 or 1.34. For SsD 1.2.1 and 1.2.2 the selection is based on the range of fragments and lobbed explosives items that may be projected from a PES in an explosive event. Considerable testing has been conducted on several HE natures of HD 1.2, resulting in the sub-division between SsD 1.2.1 and 1.2.2 being based on the NEQ of the individual stores concerned.

- (1) The more hazardous items (SsD 1.2.1) are those with an individual HE content of 0.73 kg or above. It is important not to exaggerate the significance of this value. It has been derived from a specific break point in the database supporting the QD relationships and tables and the NEQ of the HE items tested.

- (2) The less hazardous items (SsD 1.2.2) are those with an individual HE content of less than 0.73 kg. This sub-division was previously known as HD 1.2* but use of this term has been discontinued.

3.2.2 A special storage subdivision, SsD 1.2.3, with its own unique set of quantity-distances, is applicable to munitions that have gained qualification as Insensitive Munitions (IM) and exhibit at most an explosive reaction in sympathetic reaction testing per STANAG 4396 and a burning reaction in bullet impact, slow heating and liquid fuel/external fire testing per STANAGs 4241, 4382 and 4240, respectively. Specific guidance on storage requirements and acceptable QD's can be found in ESTC Standard 15.

3.3 Hazard Division 1.3

3.3.1 For determining QDs, a distinction is made between the more hazardous items and those of lesser hazard, as follows:

- (1) SsD 1.3.3 contains the more hazardous items, generally bulk packed propellants, which produce a fireball with intense radiant heat, firebrands and some fragments. The firebrands may be only small glowing particles of packaging material, but sometimes they may be massive fiery pieces of burning propellant.

- (2) SsD 1.3.4 contains the less hazardous items that burn sporadically, with minor projections and firebrands but limited thermal effects. This sub-division was previously known as 1.3* but use of this term has been discontinued.

3.4 Recognition of Sub-Divisions

3.4.1 It is stressed that these sub-divisions are not recognised codes in the UN system of classification and must not appear on packaging labels etc. These sub-divisions are only to be used for assessing storage requirements.

4 MIXING RULES FOR HAZARD DIVISIONS (AGGREGATION)

4.1 Hazard Division Mixing Rules

4.1.1 Table 1 and accompanying notes detail the aggregation rules for use in storage situations. The rules for aggregation in transport are given in DSA03.DLSR Movement and Transport Safety Regulations, Dangerous Goods Manual (DGM). Currently, there are no military explosives in HD 1.5 or HD 1.6, and further information regarding storage of these HDs is to be obtained from DOSR through the appropriate IE. The mixing rules should be applied regardless of the relative quantities of the HDs involved:

(1) When explosives of HD 1.1, HD 1.2 and HD 1.3 are kept in the same PES, the aggregate quantity (i.e. the total quantity of HD 1.1, HD 1.2 and HD 1.3) is to be determined and considered as HD 1.1.

(2) When explosives of HD 1.4 are kept in the same PES as explosives of one or more other HD, the NEQ of the HD 1.4 may be ignored.

HAZARD DIVISION MIXING RULES FOR STORAGE									
HD/SsD	1.1	1.2.1	1.2.2	1.2.3	1.3.3	1.3.4	1.4	1.5	1.6
1.1	1.1	1.1	1.1	1.1	1.1	1.1	Para 4.1.1(3)	1.1	1.1
1.2.1	1.1	1.2.1	Para 4.1.2(1)	Para 4.1.2(1)	Para 4.1.2(2)	Para 4.1.2(2)	Para 4.1.1(3)	1.1	Para 4.1.2(3)
1.2.2	1.1	Para 4.1.2(1)	1.2.2	Para 4.1.2(1)	Para 4.1.2(2)	Para 4.1.2(2)	Para 4.1.1(3)	1.1	Para 4.1.2(3)
1.2.3	1.1	Para 4.1.2(1)	Para 4.1.2(1)	1.2.3	Para 4.1.2(2)	Para 4.1.2(2)	Para 4.1.1(3)	1.1	Para 4.1.2(3)
1.3.3	1.1	Para 4.1.2(2)	Para 4.1.2(2)	Para 4.1.2(2)	1.3.3	1.3.3	Para 4.1.1(3)	1.1	1.3.3
1.3.4	1.1	Para 4.1.2(2)	Para 4.1.2(2)	Para 4.1.2(2)	1.3.3	1.3.4	Para 4.1.1(3)	1.1	1.3.3
1.4	Para 4.1.1(3)	Para 4.1.1(3)	Para 4.1.1(3)	Para 4.1.1(3)	Para 4.1.1(3)	Para 4.1.1(3)	1.4	Para 4.1.1(3)	Para 4.1.1(3)
1.5	1.1	1.1	1.1	1.1	1.1	1.1	Para 4.1.1(3)	1.1	1.1
1.6	1.1	Para 4.1.2(3)	Para 4.1.2(3)	Para 4.1.2(3)	1.3.3	1.3.3	Para 4.1.1(3)	1.1	Para 4.1.2(4)

Table 1

4.1.2 The following specific QD rules apply to mixing of other HDs and SsDs:

(1) Mixing of SsD 1.2.1, 1.2.2 and 1.2.3:

(a) Required QD: When explosives of SsD 1.2.1 and 1.2.2 and 1.2.3 are kept in the same PES, determine the QD for SsD 1.2.1 only, taking no account of any SsD 1.2.2 or 1.2.3 present. Next determine the QD for SsD 1.2.2 only, taking no account of any SsD 1.2.1 or 1.2.3 present. Next determine the QD for SsD 1.2.3 only, taking no account of any SsD 1.2.1 or 1.2.2 present. The required QD is the greatest of the distances determined.

(b) Permissible NEQ: When explosives of SsD 1.2.1 and 1.2.2 and 1.2.3 are kept in the same PES they may be stored together without aggregation up to the permissible quantity for each SsD considered separately.

(2) Mixing of HD 1.2 and 1.3:

(a) Generally, it is the consensus within NATO that when HD 1.2 and HD 1.3 are stored together the aggregate quantity should be treated as HD 1.1. However, DOSR sponsored tests with 76 mm HESH Rounds, 81 mm Mortar Bombs and 120 mm Propelling Charges have demonstrated that, as a rule, HD 1.2 and HD 1.3 do not need to be aggregated as HD 1.1 but can be treated separately.

(b) Required QD: When explosives of HD 1.2 and HD 1.3 are kept in the same PES, determine the QD for HD 1.2 only. Next, determine the QD for HD 1.3 only i/a/w Table 1 above. The required QD is the greater of these two distances.

(c) Permissible NEQ: When explosives of HD 1.2 and HD 1.3 are kept in the same PES, they may be stored together without aggregation up to the permissible quantity for each HD considered separately taking account of the aggregation rules for SsD 1.2.1, 1.2.2 and 1.2.3.

(3) When HD 1.6 is stored with HD 1.2 it should be treated as SsD 1.2.3 with rules applied.

(4) Mixed storage of different natures of HD 1.6 articles should be treated as aggregates of HD 1.1 unless the mix can be classified as HD 1.6 through testing or by analogy to tested mixes. Advice should be sought from DOSR, through the responsible IE, before storage of such mixes is considered.

4.2 Exceptions to General Aggregation Rules

4.2.1 Provided there is a good technical case and that operational storage requirements cannot otherwise be met, IEs may request the following special assessment from DSA DOSR CIE(MOD) staff:

(1) In particular cases where tests or other data warrant it, explosives of HD 1.1 and SsD 1.2.2 may be stored together without aggregation.

(2) In particular cases where tests or other data warrant it, explosives of HD 1.1 and SsD 1.3.4 may be stored together without aggregation.

(3) There can be circumstances where HD 1.2 and HD 1.3 kept in the same site might be aggregated as HD 1.1. This may occur where explosives of HD 1.2 that form shaped charge jets are stored close to high energy type propellants of HD 1.3 in conditions of relatively heavy confinement. All such cases should be treated individually. It is not anticipated that an explosion of HD 1.2 would involve more than 5 kg of explosives at any point in time, and certainly never more than 50 kg. However, if individual HD 1.2 items have an NEQ greater than 5 kg, then aggregated quantities of such HD 1.2 munitions with HD 1.3 is to be treated as HD 1.1.

5 MEASUREMENT OF QD (INCLUDING UNIT RISK)

5.1 General

5.1.1 QD are to be accurately measured from the nearest point of the PES, or hard-standing of an open stack PES, to the nearest point of the ES or hard-standing of an open stack ES. Distances are measured along a straight line without regard for traverses or earth cover.

5.2 Unitization

5.2.1 Where the total NEQ in a PES (including a Process Building) is separated into stacks such that the maximum credible event is limited to the quantity in any one stack, distances may be measured from the outside of the wall adjacent to the controlling stack concerned to the nearest outside wall of the ES. If the separation to prevent practically instantaneous propagation is provided by one or more substantial dividing walls, then the QD may be measured from these walls instead of from the outside walls.

5.3 Intervening Structures

5.3.1 In general, the effect of intervening buildings and structures, other than traverses, is ignored when applying QD. In an exceptional case, such as a high building that has the same effect as a traverse, the situation must be specially assessed by DSA DOSR CIE (MOD) staff.

6 NET EXPLOSIVES QUANTITY

6.1 Introduction

6.1.1 Unless it has been determined by trials that the effective NEQ is significantly different from the actual NEQ, the total or aggregate NEQ of explosives in a single PES is used for the computation of QD. Where effective NEQs are applicable they are given in the DOSR DOME Database.

6.1.2 The NEQ does not include such substances as white phosphorus, chemical agents, smoke, incendiary compositions unless these substances contribute significantly to the dominant HD concerned. Any other energetic materials such as liquid fuels should be aggregated with the explosives NEQ unless it has been determined by testing that they do not contribute to the overall hazard. Where such substances have been shown to contribute to the dominant HD, the relevant effective NEQs can be found in the DOSR DOME Database.

6.2 TNT Equivalence

6.2.1 The distances quoted in the QD Tables for HD 1.1 are applicable to quantities of TNT. Where explosives having a significantly more powerful or less powerful effect than TNT are being considered, a 'TNT equivalent' may be used to determine the appropriate QD. TNT equivalence can vary significantly depending on the parameters used to measure the equivalence. DSA DOSR CIE (MOD) staff will advise on the appropriate equivalence to be used in any specific situation.

7 NOTES FOR QUANTITY-DISTANCE TABLES

7.1 Introduction

7.1.1 Net explosives quantities (NEQ) are in kilograms (kg), QD are in metres (m).

7.2 Determination of QD or Permissible Quantities

7.2.1 The location of PES with respect to each other and to other ES is based on the total NEQ in the individual PES unless this total NEQ is subdivided such that an incident involving any one of the smaller concentrations cannot produce a practically instantaneous explosion in adjacent stacks.

7.2.2 The QD required between each of two or more nearby storage sites or Process Buildings that contain explosives of one HD only are determined by considering each as a

PES. The NEQ permitted in the storage sites or Process Buildings is limited to the least amount allowed by the appropriate table for the distances separating the storage sites or Process Buildings concerned. The QD required from each of two or more nearby storage sites to contain given quantities of explosives of different HDs at different times are determined as follows:

- (1) Consider each building or stack, in turn, as a PES.
- (2) Refer to the table of each HD that can be stored in the building or stack considered as a PES.
- (3) Determine the QD for each HD as the minimum to be required from the building or stack.
- (4) Record the QD in terms of each HD in each instance as those to be required from the building or stack. Alternatively, calculate the permitted NEQ of each HD based upon the available distances.

7.3 Rounding of Quantity Distance

7.3.1 The values of QD in the QD Tables have been rounded up in accordance with Table 1, below. It is permitted to determine a QD using the distance function formulae at the foot of the appropriate column. A calculated distance rounded up to the nearest metre may be used in place of any value in the QD Tables. If an NEQ is back calculated from a distance, using the appropriate QD formula, the answer should be rounded down to the nearest kg.

ROUNDING OF QUANTITY DISTANCE	
9.1 Range of value of Quantity Distances (m)	9.2 Rounding up to the Nearest (m)
2 to <100	1
≥100 to <500	5
≥500 to <1000	10
≥1000	20

Table 2

7.4 General Instruction on the Use of QD Tables

7.4.1 The QD Tables contain information to determine suitable QD between sites except for a PES containing explosives of HD 1.4.

7.5 Hazard Division 1.1, 1.2 or 1.3

7.5.1 See the corresponding QD Table.

7.6 Hazard Division 1.4

7.6.1 Separation distances from explosives of HD 1.4 are not a function of the Net Explosives Quantity. Separation distances prescribed by fire regulations apply. Stacks or non-fire-resistant buildings must normally be separated by 10 m to prevent ignition by radiant heat.

7.7 Inert Ammunition

Separation distances from inert ammunition and other non-explosive items are determined in accordance with local prescriptions for fire protection and fire fighting, but must not normally be sited closer than 10 m.

8 EXPECTED EFFECTS, AND PERSONNEL AND FACILITIES ACCEPTABLE AT VARIOUS QUANTITY DISTANCES, FOR HD 1.1 IN ABOVE GROUND STORAGE

8.1 QD 44.4QP^{1/3}

8.1.1 Expected Effects – The expected effects are:

- (1) Un-strengthened normal structures are likely to suffer only superficial damage.
- (2) Certain types of vulnerable structures may collapse and cause injuries or death by crushing and falling debris.
- (3) When large panes of glass or other non-load bearing frangible materials, e.g. external cladding panels, are exposed to face a PES, 50% or more of these may be detached from the structure or broken by the blast.
- (4) Injuries and fatalities are very unlikely as a direct result of blast effects. Injuries that do occur will be caused principally by the impact on passers-by of falling, broken or detached panel or window materials. The risk of injury will often be reduced by minimising personnel exposure by, for example, placing gardens around the foot of buildings.

8.1.2 Personnel and Facilities Acceptable - This is the normal distance required for buildings of vulnerable construction and large facilities. Examples of such buildings are:

- (1) Large Facilities of Special Construction or Importance. Examples are:
 - (a) Large factories.
 - (b) Multi-storey office or apartment buildings.
 - (c) Public buildings and edifices of major value.
 - (d) Large educational facilities.
 - (e) Hospitals.
 - (f) Major transport centres e.g. railway stations, airports, etc.
 - (g) Major public utilities, e.g. water, gas and electric works.
- (2) Facilities of Vulnerable Construction Used for Mass Meetings. Examples are:
 - (a) Assembly halls and fairs.
 - (b) Exhibition areas.
 - (c) Sports stadia.
- (3) Built-up areas which are both large and intensely developed.

8.2 QD 22.2QP^{1/3}

8.2.1 General - The equivalent QD in respect of earth-covered buildings considered to be UK standard igloos are:

- (1) From the side: 19.0 QP^{1/3P}
- (2) From the rear: 15.5 QP^{1/3P}

8.2.2 Expected Effects - The expected effects are:

- (1) Un-strengthened buildings will suffer minor damage, particularly to parts such as windows, door frames and chimneys. Partial collapse may occur in buildings where structural integrity relies either on critical elements or the continuity of the structure.
- (2) Injuries and fatalities are very unlikely as a direct result of the blast effects. Injuries that do occur will be caused principally by glass breakage and flying/falling debris.

8.2.3 Personnel and Facilities Acceptable - This distance is known as the Inhabited Building Distance and is the minimum distance at which inhabited buildings not directly concerned with the functions of the explosives facility should be sited.

8.2.4 This QD is acceptable for the following types of ES:

- (1) Untraversed stacks of explosives.
- (2) Structures in the administration area of the facility with a considerable number of occupants, e.g. office buildings, non-explosives workshops, mess halls, changing areas with refreshment areas or showers.
- (3) Structures in the administration area of the facility which are important for the functioning of the installation, e.g., manned fire stations, manned heating plants, MT areas, unprotected water, gas and power supplies.
- (4) Inhabited buildings whether single buildings, communities or areas of scattered habitations.
- (5) Structures and facilities in which people assemble other than those at mentioned above.
- (6) Facilities serving the needs and safety of the general public such as water, gas and power supplies, radar installations and communications centres.
- (7) Important railways and public roads, e.g., main railway lines, motorways and major roads and navigable waterways.

8.3 QD 14.8QP^{1/3}

8.3.1 General - The equivalent QD in respect of earth-covered buildings considered to be UK standard igloos are:

- (1) From the side: 14.0 QP^{1/3P}
- (2) From the rear: 11.0 QP^{1/3P}

8.3.2 Expected Effects – The expected effects are:

- (1) Un-strengthened buildings will suffer average damage costing in the range of 10% of total replacement cost to repair.
- (2) Personnel under cover are afforded a high degree of protection from death or serious injury. Such injuries as do occur will be mainly caused by glass breakage and building debris.
- (3) Personnel in the open are not likely to be seriously injured by blast but some injuries are likely to be caused by fragments and debris depending on the structure of the PES, the NEQ involved and fragmentation characteristics.

8.3.3 Personnel and Facilities Acceptable - This distance is known as the Public Traffic Route Distance and is the minimum distance at which routes used by significant numbers of people for purposes unconnected with the explosives facility must be sited.

8.3.4 This degree of protection is acceptable for the following:

- (1) Structures and facilities within an administration area concerned with the explosives facility with a limited number of occupants.
- (2) Structures and facilities in which people assemble temporarily and which can be cleared quickly, e.g. sports fields, parking places, Small Arms ranges.
- (3) Railways, roads and navigable waterways of minor medium importance.

8.4 **QD 9.6QP^{1/3}**

8.4.1 Expected Effects – The expected effects are:

- (1) Buildings that are un-strengthened can be expected to suffer damage to main structural members that will require repair. Repairs may cost more than 20% of the replacement cost of the building. Strengthening of buildings to prevent damage and secondary hazards is feasible and not prohibitively expensive.
- (2) Cars may suffer some damage to metal portions of the roof and body by blast. Windows may be broken; however, the glass should not cause serious injury to the occupants.
- (3) Aircraft will suffer some damage to appendages and sheet metal skin.
- (4) Cargo type ships will suffer minor damage from blast to deck houses and electronic gear.
- (5) Personnel may suffer temporary hearing loss; however, permanent ear damage is not likely. There are likely to be some injuries caused by fragments, debris, or translation of the individual(s) involved.

8.4.2 Personnel and Facilities Acceptable - This must be the least distance at which unprotected duty personnel (e.g. troops, military and civilian maintenance and security personnel and crews of ships) should be permitted when their duties are not closely and specifically related to the PES. This degree of protection is acceptable for the following:

- (1) Open air recreation/sporting facilities used only by military personnel where structures, or dependants and the general public, are not involved.

- (2) Training areas for unprotected military personnel.
- (3) All military aircraft when the PES is not for the immediate service of the aircraft.

8.5 QD 8.0QP^{1/3}

8.5.1 General - The equivalent QD in respect of earth-covered buildings considered to be UK standard igloos are:

- (1) From the rear: 6.0 QP^{1/3P}

8.5.2 Expected Effects – The expected effects are:

- (1) Buildings which are un-strengthened can be expected to suffer damage which is likely to cost above 30% of the total replacement cost to repair.
- (2) Serious injuries to personnel, which may result in death, are likely to occur due to fragments, debris, firebrands or other objects.
- (3) There is some possibility of delayed communication of the explosion as a result of fires or equipment failure at the ES. Direct propagation of the explosion is not likely.
- (4) Cargo ships will suffer damage to decks and superstructure. Doors and bulkheads on the weather deck are likely to be buckled by the overpressure.
- (5) Aircraft are expected to sustain considerable structural damage.

8.5.3 Personnel and Facilities Acceptable - This distance is the minimum permissible distance between a PES and a Process Building. This degree of protection is acceptable for the following personnel and facilities:

- (1) Process Buildings in which the number of personnel present is kept to a minimum essential for the task.
- (2) Packing and shipping/transit buildings in the Explosives Area.
- (3) Minor transmission and communication lines.

8.6 QD 3.6QP^{1/3}

8.6.1 Expected Effects – The expected effects are:

- (1) Un-strengthened buildings will suffer structural damage approaching total demolition.
- (2) Severe injuries or death to occupants of the ES are to be expected from direct blast, building collapse, or translation.
- (3) Aircraft will be damaged, by both blast and fragments, to the extent that they will be beyond economical repair. If aircraft are loaded with explosives, delayed explosions are likely to result from subsequent fires.
- (4) A high degree of protection against direct propagation of an explosion is to be expected, provided direct attack by high velocity fragments is prevented, e.g. by a receptor traverse. Explosions may subsequently occur in adjacent PES from fire spread by lobbed debris or blast damage to an ES.

8.6.2 Personnel and Facilities Acceptable - This degree of protection is acceptable for the following personnel and facilities:

- (1) Temporary holding areas for vehicles containing explosives for Service production or maintenance facilities provided traverses are interposed both between the vehicle locations and other PES.
- (2) Unmanned auxiliary power facilities, transformers and other utilities that serve a PES and which are not vital and will not create a secondary hazard.

8.7 QD 2.4QP^{1/3}

8.7.1 Expected Effects – Un-strengthened buildings will suffer complete demolition.

8.7.2 Personnel and Facilities Acceptable - This degree of protection is acceptable for the following personnel and facilities:

- (1) Personnel performing storage and shipping functions in explosives areas may operate for short periods at adjacent PES. In large explosives areas however, management controls must be in place to reduce the length of time that unrelated operations are exposed to one another at distances less than $9.6QP^{1/3}$.

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