



UAE FIRE AND LIFE SAFETY CODE OF PRACTICE

2011 EDITION



Copyright © 2011, General Headquarters of Civil Defence, Ministry of Interior, United Arab Emirates

Copyright

Copyright © 2011

General Headquarters of Civil Defence

Ministry of Interior

United Arab Emirates

All Rights Reserved by General Headquarters of Civil Defence, Ministry of Interior, United Arab Emirates. No content, neither in part nor whole of the UAE Fire and Life safety Code of practice shall be copied, distributed, printed, sold or reproduced in any format. All the rights to reproduce, distribute and sell are reserved by General Headquarters of Civil Defence, Ministry of Interior, United Arab Emirates.

This copyright also prevents the Civil Defence Fire Code Council (CDFCC) members claiming credit for the UAE Fire and Life Safety Code of Practice in any form without prior permission from the Civil Defence Fire Code Council (CDFCC). Civil Defence Fire Code Council (CDFCC) members are also prevented from sharing the information regarding code development issues, code conflict issues, code adoption issues with anybody other than the Civil Defence Fire Code Council (CDFCC).

[Click here to continue](#)

***This book is dedicated to all those unsung heroes of the World
who have lost their altruistic lives during Fire Fighting and Fire Rescue.
The pain and suffering in those last moments of their struggle
lingers on in the lives of their families and loved ones to
remind us the value of Fire Safety.***

[Click here to continue.](#)



- Acceptable pipes for Fire water systems
- Beam detector spacing
- Building Classifications
- Building Height, area requirements
- Chemical Gas Comparisons
- Cinema, Theatre seating
- Civil Defence Vehicle Access
- Civil Defence Website
- Classes of fire
- Common path
- Curtainwall systems
- Dead Ends
- Dry riser Schematic
- Exit Sign Locations
- Fire rating of Buildings
- Fire rating of Corridors
- Fire rating of Doors
- Fire rating of exterior walls
- Fire Sizes of various occupancies
- Foam sprinkler design criteria
- Heat detector spacing
- Hydrant spacing
- Hydrants Required?
- I am a Consultant
- I am a Contractor
- I am a Decor Contractor
- I am a LPG Contractor
- Inert Gas Comparisons
- Low hazard materials and activities
- LPG Tank arrangement on roof
- LPG Cylinder arrangements
- LPG Cylinders usage
- LPG Tank (Aboveground) Separation
- LPG Tank (Rooftop) Separation
- LPG Tank (Underground) Separation
- Material Testing
- Multiple pump schematic
- My building Corridor needs smoke extraction?
- My building needs Sprinkler?
- My building Staircase needs pressurization?
- My Factory needs Smoke management?
- My Factory needs Sprinkler?
- My Warehouse needs Smoke management?
- My Warehouse needs Sprinkler?
- Occupant Loads
- Portable Extinguisher Types & locations
- Smoke detector spacing
- Sprinkler spacing
- Sprinklers for refrigerated spaces
- Sprinklers Pipesizes
- Stair specifications
- Suppression Required?
- Travel Distances
- Water Spray Schematic
- Wet riser Schematic
- When is single staircase allowed?



CONTENTS	PAGE NO.
I. PREFACE	23
II. ACKNOWLEDGEMENT	24
III. INTENTION	26
IV. APPLICATION	27
V. COMMITMENT TO BEST PRACTICE	28
VI. FIRE CODE COUNCIL	30
VII. ROLE OF FIRE CODE COUNCIL	31
VIII. CODE REVIEW AND AMENDMENT	32
IX. REGISTER OF CODE SIGNATORIES	33
X. LICENSING AND ACCREDITATION	34
XI. RECOGNIZED INTERNATIONAL TESTING LABORATORIES	35
XII. QUALIFIED AND COMPETENT PERSON	37
XIII. CLASSIFICATION OF OCCUPANCIES	38
XIV. HAZARD EVALUATION	42
XV. ACKNOWLEDGEMENT OF INTERNATIONAL CODES AND STANDARDS	43
CHAPTER 1. CONSTRUCTION AND FIRE COMPARTMENTALIZATION	44
CHAPTER 2. FIRE SERVICE VEHICLE AND PERSONNEL ACCESSIBILITY	105
CHAPTER 3. MEANS OF EGRESS	133
CHAPTER 4. PORTABLE FIRE EXTINGUISHERS	215
CHAPTER 5. EXIT SIGNS	221
CHAPTER 6. EMERGENCY AND EXIT LIGHTING	228
CHAPTER 7. EMERGENCY VOICE EVACUATION AND COMMUNICATION SYSTEM	236
CHAPTER 8. FIRE DETECTION AND ALARM SYSTEM	243
CHAPTER 9. FIRE PROTECTION SYSTEM	298
CHAPTER 10. MECHANICAL VENTILATION AND SMOKE CONTROL SYSTEMS	487
CHAPTER 11. FIRE SAFETY GUIDELINE FOR LIQUEFIED PETROLEUM GAS (LPG) INSTALLATIONS	565
CHAPTER 12. FIRE & SAFETY CODES DURING CONSTRUCTION AND MAINTENANCE	594
CHAPTER 13. FIRE SAFETY REQUIREMENT FOR MULTI-TENANT (TERRACE TYPE) WAREHOUSE AND FACTORIES	632
CHAPTER 14. SUBSTATION REQUIREMENTS	642
CHAPTER 15. ACCESSIBILITY GUIDELINES FOR DISABLED	652
CHAPTER 16. SPECIFICATION FOR LIFE SAFETY ALARM MONITORING	657
CHAPTER 17. GUIDELINES FOR CONDUCTING RISK ASSESSMENT (RA) STUDIES	673
CHAPTER 18. SPECIAL STRUCTURES AND OCCUPANCIES	681
CHAPTER 19. REQUIREMENTS FOR SUBMISSION OF DRAWINGS	681
FREQUENTLY ASKED QUESTIONS	697
MOST POPULAR SEARCH TOPICS	



CONTENTS	PAGE NO.
I. PREFACE	23
II. ACKNOWLEDGEMENT	24
III. INTENTION	26
IV. APPLICATION	27
V. COMMITMENT TO BEST PRACTICE	28
VI. FIRE CODE COUNCIL	30
VII. ROLE OF FIRE CODE COUNCIL	31
VIII. CODE REVIEW AND AMENDMENT	32
IX. REGISTER OF CODE SIGNATORIES	33
X. LICENSING AND ACCREDITATION	34
XI. RECOGNIZED INTERNATIONAL TESTING LABORATORIES	35
XII. QUALIFIED AND COMPETENT PERSON	37
XIII. CLASSIFICATION OF OCCUPANCIES	38
XIV. HAZARD EVALUATION	42
XV. ACKNOWLEDGEMENT OF INTERNATIONAL CODES AND STANDARDS	43
CHAPTER 1. CONSTRUCTION AND FIRE COMPARTMENTALIZATION	44
1. General	47
2. Table 1.1: Required Fire Resistance–Rated Separations for Separated Occupancies	48
3. Space Beneath Platforms (Raised platforms).	50
4. Fire Resistance Rating Requirements for Structural Elements	50
5. Exterior Walls	50
6. Table 1.2: Fire Rating for Exterior Walls (hr)	51
7. Horizontal Separation	51
8. Imaginary Line	51
9. Openings	53
10. Table 1.3: Minimum Fire Protection Ratings for Exterior Opening Protection	53
11. Table 1.4:	54
Maximum allowable area of unprotected openings (percentage of exterior walls) for Assembly, Educational, Day-care, Health care, Ambulatory Health Care, Detention and correctional, Residential, Residential board and care, Business, Industrial and Low Hazard Storage.	
12. Table 1.5:	55
Maximum Allowable Area of Unprotected Openings (percentage of exterior wall) for Mercantile, Industrial and Storage with Ordinary Hazard and Industrial and Storage with High Hazard.	
13. Height and Area Requirements	56
Table 1.6: Allowable Building Height and Area	
14. Table 1.7:	58
Occupancy, Area, Height and Occupant Load limitation for provision of automatic sprinklers	
15. Mixed Occupancies.	60
16. Underground Buildings.	60
17. Fire Separation and Protection of Various Rooms	60
17.1. Emergency Command Centre	60
17.2. Fire Pump Rooms	61



17.3. Kitchen	61
17.4. Separation of theatre, cinema or concert hall from other parts of the building	63
17.5. Hotel Bedrooms	64
17.6. Labor Accommodation	64
17.7. Motor Vehicle Workshop	64
17.8. Spray Painting Room	64
17.9. Coldroom	65
18. Rooms requiring External wall	66
19. Separation between tenancy for terraced units	66
20. Fire-Resistive Materials and Construction	66
20.1. Fire Resistance–Rated Construction.	66
20.2. Minimum Fire Protection Rating.	66
20.3. Table 1.9: Fire separation and protection for the various rooms.	68
20.4. Table 1.10:	69
Minimum Fire Protection Ratings for Opening Protectives in	
Fire Resistance–Rated Assemblies	
Table 1.10a: Fire Rating of Corridors and Internal Walls based on Occupancies	69
20.5. Fire Door Closers.	70
20.6. Fire Door Assemblies and Fire Window Assemblies.	70
20.7. Fire Door Assemblies.	70
21. Fire Stopping	71
21.4. Definitions	72
21.4.1. Firestopping	72
Firestop System	72
21.4.2. Barrier	72
21.4.3. Through-penetration	72
21.4.4. Membrane-penetration	72
21.4.5. Fire Resistive Joint	72
21.4.6. Perimeter Barrier	72
21.4.7. Dynamic Joint	73
21.4.8. Static Joint	73
21.4.9. 'F' Rating	73
21.4.10. 'T' Rating	73
21.4.11. 'L' Rating	73
21.4.12. Tested and Listed System	73
21.4.13. Engineering Judgment	74
21.5. Classification of Firestop systems	74
21.5.1. Through penetration firestop system	74
21.5.2. Membrane-penetration	74
21.5.3. Fire resistive joint systems	75
21.5.4. Perimeter fire barriers / External Curtainwall system	75
21.6. Design & Selection of Firestop systems	76
21.6.1. Products	76
21.6.2. Submittal	76
21.6.3. Quality assurance	77
21.7. Delivery, storage, and handling	77
21.8. Examination & preparation	77
21.9. Project conditions (environmental limitations)	78
21.10. Installation	78



21.10.1. Installer qualification	78
21.10.2. Installation – ‘Through penetration firestop systems’	78
21.10.3. Installation – ‘Fire resistive joint systems’	79
21.10.4. Installation – ‘Curtainwall / Perimeter fire barrier systems’	79
21.11. Coordination	79
21.12. Identification	80
21.13. Inspection	80
21.13.1. Through penetration firestop systems	80
21.13.2. Fire resistive joint systems and Curtainwall/ Perimeter fire barriers	80
21.14. Field Quality Control	80
21.15. Maintenance & Management	81
22. Ducts and Air-Transfer Openings	81
22.1. Fire Damper Requirements	81
Table 1.11. Fire Damper rating	81
22.2. Installation	83
22.3. Access and Identification	83
22.4. Fire Damper Actuation Device.	84
23. Smoke Barriers	84
24. Smoke barrier Penetrations	85
25. Smoke Damper Exceptions	86
26. Vertical Openings	87
27. Communicating Space	88
28. Atrium	89
29. Convenience Openings	91
30. Service Openings	92
31. Elevator Hoistway	93
32. Mezzanine	93
32.2. Area Limitations.	94
32.3. Openness	94
33. Concealed Spaces	96
33.1. Draft Stops	96
33.2. Combustibles in Concealed Spaces	96
34. Interior Wall and Ceiling Finish Requirements	96
34.3. Use of Interior Finishes.	97
Table 1.12. Interior Finish Classification Limitations	97
35. Interior Wall or Ceiling Finish Testing and Classification	98
35.3. Class A Interior Wall and Ceiling Finish	98
35.4. Class B Interior Wall and Ceiling Finish	98
35.5. Class C Interior Wall and Ceiling Finish	98
36. Specific Materials	99
36.1. Textile Wall or Ceiling Materials	99
36.2. Expanded Vinyl Wall or Ceiling Coverings	100
36.3. Cellular or Foamed Plastic	100
36.4. Light-Transmitting Plastics	101
36.5. Metal Ceiling and Wall Panels	101
36.6. Trim and Incidental Finish	101
36.7. Bulletin Boards and Posters	101
37. Interior Floor Finish Testing and Classification	101
37.4. Class I Interior Floor Finish	102



37.5. Class II Interior Floor Finish.	102
38. Interior Finish in relation to Automatic Sprinklers	102
39. Material Approval	102
40. Further Reference	102
CHAPTER 2. FIRE SERVICE VEHICLE AND PERSONNEL ACCESSIBILITY	105
1. Definitions	106
1.1. Breeching inlet	106
1.2. Fire Service access level	106
1.3. Fire Access Roadway	106
1.4. Fire Accessway	106
1.5. Landing Valve	106
1.6. Hose Reel or Hose Rack	106
1.7. Standpipe	106
2. General	107
3. Access Level	107
4. Access to Buildings with Standpipes or Risers	107
5. Public Fire Hydrants (By UAE Municipality)	107
6. Private Fire Hydrant	108
7. Pipe for hydrant water supply.	111
Table 2.1: Manufacturing Standards for Underground Pipe	113
8. Steel Pipe.	114
9. Pipe Type and Class.	114
10. Working Pressure.	114
11. Master Streams.	114
Table 2.2: Fittings Materials and Dimensions	115
12. Protection Against Damage	115
Table 2.3 : Civil Defence Vehicle Access specifications	118
13. Accessway for Fire Fighting Appliances	118
Table 2.4: Extent of fire engine access for non-industrial and non-storage occupancies (without sprinklers)	120
Table 2.5: Extent of fire engine access for non-industrial and non-storage occupancies (with sprinklers)	121
Table 2.6: Extent of fire engine access for industrial and storage occupancies (without sprinklers)	123
Table 2.7: Extent of fire engine access for industrial and storage occupancies (with sprinklers)	123
14. Access Roadways	127
Table 2.8: Access roadways and route specifications.	127
15. Fire Fighter Access within the building	127
15.1. Fire Lift	127
15.2. Homing of lifts	128
15.3. Alternative Homing Floor	128
15.4. Fire Fighting Stairs	129
15.5. Fire Fighting Lobby	129
15.6. Location of Landing valves	130
15.7. Emergency Command Centre	130



16. Material Approval	131
17. Further Reference	132
CHAPTER 3. MEANS OF EGRESS	133
1. Definition	136
1.1 Means of Egress	136
2. General	136
3. The Exit Access	136
3.2 Doors	136
3.3 Measurement of Door width	137
3.4 Measurement of Clear width	138
3.5 Minimum Door Width	139
3.6 Floor Level at Door	140
3.7 Swing and Force	140
3.8 Locks, Latches and Alarm Devices	140
3.9 Access Controlled Doors	142
3.10 Self-Closing Devices	142
3.11 Powered Doors	142
3.12 Revolving Doors	142
3.13 Doors in Folding Partitions	142
3.14 Fire Rating Requirements for Doors	143
Table 3.1A. Fire rating requirements for doors at various locations	144
4. Exit Access Corridors	144
4.2 Separation and protection of Exit Access Corridors	144
4.3 Ramps	146
Table 3.1. Ramp specifications	147
5. Exits	147
5.2 Exit Stairs	147
Table 3.2. Exit Stair specifications	148
5.2.2 Measurement of Headroom	148
Table 3.3. Headroom specifications	149
5.2.3 Minimum Stair Width measurement	149
5.2.4 Landings	149
5.2.5 Tread and Landing Surfaces	149
5.2.6 Separation and Protection of Inside Stairs	150
5.2.7 Separation and Protection of Outside Stairs	153
5.2.8 Protection of Openings	155
5.2.9 Special Provisions for Outside Stairs	156
5.2.10 Scissor or Interlocked Stairs	156
5.2.11 Spiral Stairs	157
5.2.12 Fire Escape Ladders	157
5.2.13 Handrails	158
5.2.14 Handrail Details	158
5.2.15 Guards	160
5.2.16 Marking of Stairs	160
5.2.17 Floor Diagrams	161
5.2.18 Stair Pressurization	161

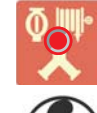
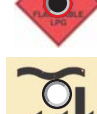
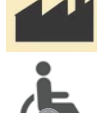


5.2.19	Smoke Proof Enclosure	164
5.2.20	Horizontal Exit	166
5.2.21	Bridges and Balconies	167
5.2.22	Elevators	167
5.2.23	Elevator Lobby	168
6.	Exit Discharge	168
6.2	Exit Passageway	168
6.2.6	Construction	169
6.3	Area of Refuge	169
6.4	Discharge through Areas on Level of Exit Discharge	170
6.5	Arrangement and Marking of Exit Discharge	170
7.	Number of Exits	171
7.4	Remoteness between two exits.	172
	Table 3.4. Number of Exits	171
8.	Walking Surfaces	174
	Table 3.5: Specifications of Walking Surface in Means of Egress	174
9.	Interior Finish in Means of Egress	174
10.	Measurement of Means of Egress	174
11.	Arrangement of Means of Egress	175
11.4	Travel Distance to Exits	175
11.5	Measurement of Travel Distance to Exits	175
11.6	Capacity of Exit Discharge	176
11.6.2	Exits Serving More than One Story	176
11.6.3	Egress Capacity from a Point of Convergence	176
11.6.4	Egress Capacity from Balconies and Mezzanines	177
11.6.5	Egress Capacity for Corridor	178
11.6.6	Egress Capacity for single exit access	179
11.6.7	Egress Capacity for more than one exit access	179
11.6.8	Egress Capacity for street floor exit	179
11.7	Obstructions at the exit or Impediments to Egress	179
11.8	Table 3.6A: Requirements for Arrangement of Means of Egress (Common path, Dead ends, Travel Distances, Exit Discharge capacities)	181
	Table 3.6B: Requirement for Arrangement of Means of Egress (Minimum corridor width, Room Size requiring 2 exits, intervening rooms)	186
12.	Single Exit Staircase Requirements	194
12.1	Apartment Building	194
12.2	Business	200
13.	Requirements for Assembly Occupancies and Places of Public Interest	203
13.1	General	203
13.2	Occupant load	203
13.3	Waiting Spaces.	203
13.4	Outdoor Facilities.	203
13.5	Means of Egress.	204
13.5.1	Doors	204
13.6	Number and width of exit facilities	204
	Table 3.7. Number and Width of Exits	204
13.7	Assembly Occupancy with Fixed Seating: (Theatres, Cinemas, Auditoriums, Concert Halls etc)	205
13.7.1	Aisles and Gangways	205



Table 3.8. Seating arrangements	206	
13.8 Exit Component	207	
13.9 Exits from a theatre, cinema or a concert hall	209	
13.10 Seats Requirements	209	
13.11 Internal Furnishings	210	
13.12 Standard for Interior wall and ceiling finishing.	210	
13.13 Standards for Floor Finishing	210	
13.14 Standard for Decoration and Scenery	211	
14. Labour Accommodation	211	
14.2 Size	211	
15. Material Approval	214	
16. Further References	214	
 CHAPTER 4. PORTABLE FIRE EXTINGUISHERS	 215	
1. Definition	216	
1.1. Portable Extinguisher	216	
Table 4.1: Classes of Fires	216	
2. Application	216	
Table 4.2: Applicable Types of Fire Extinguishers	217	
3. Table 4.3: Selection and Location of Portable Fire Extinguishers	218	
4. Installation of Portable Fire Extinguishers	219	
5. Inspection and Maintenance of Portable Fire Extinguishers	219	
6. Training of Portable Fire Extinguishers' Operation	220	
7. Material Approval	220	
8. Further References	220	
 CHAPTER 5. EXIT SIGNS	 221	
1. Exit and Directional Signs	222	
2. Exit Access	223	
3. Floor Proximity Exit Signs.	223	
4. Floor Proximity Egress Path Marking.	223	
5. Visibility	224	
6. Mounting Location.	224	
7. Directional Signs	224	
8. Sign Legend	225	
9. Power Source	225	
10. Externally Illuminated Signs	225	
11. Size and Location of Directional Indicator	225	
12. Level of Illumination	226	
13. Internally Illuminated Signs	226	
14. Photoluminescent Signs	226	
15. No Exit Sign	226	
16. Elevator Signs	227	
17. Material Approval	227	



18. Further References	227	
CHAPTER 6. EMERGENCY AND EXIT LIGHTING	228	
1. General	229	
2. Emergency Lighting for Corridors and Lobbies	229	
3. Emergency Lighting for Occupied Areas	229	
4. Performance of System	230	
5. Emergency lighting for fire fighting facilities	231	
6. Secondary Source of Power Supply	231	
7. Design Stages	233	
8. Material Approval	235	
9. Further References	235	
CHAPTER 7. EMERGENCY VOICE EVACUATION AND COMMUNICATION SYSTEM	236	
1. General	237	
2. Definition	237	
3. Requirements for Emergency Voice Evacuation and Communication System	237	
4. Automatic Response.	238	
5. Voice Evacuation Messages.	238	
6. Tones.	239	
7. Controls.	239	
8. Relocation and Partial Evacuation.	239	
9. Circuits	240	
10. Evacuation Signal Zoning.	240	
11. Two-Way Communication Service.	241	
12. Material Approval	241	
13. Further references	242	
CHAPTER 8. FIRE DETECTION AND ALARM SYSTEM	243	
1. General	245	
2. Definitions and Terminology	245	
3. System Design	249	
3.1. General	249	
3.2. Detection Zones	249	
3.3. Alarm Zones	250	
3.4. Manufacturer Specifications	251	
3.5. Manual Call Points	251	
4. Requirements for Smoke and Heat Detectors.	252	
4.1. Recessed Mounting.	252	
4.2. Detector Coverage.	252	
5. Heat Detectors.	253	
5.1. General	253	
Table 8.1: Colour coding for Heat Detectors	254	

5.2. Location.	254
5.3. Temperature.	254
5.4. Spacing.	255
5.5. Solid Joist Construction.	257
5.6. Beam Construction.	257
5.7. Sloping Ceilings.	257
5.8. High Ceilings.	259
Table 8.2: Ceiling Height and spacing reduction factors	259
6. Spot type Smoke Detectors.	259
6.1. General	259
6.5. Location and Spacing.	260
7. Air Sampling–Type Smoke Detector.	263
7.1. General	263
7.2. Location and Spacing.	264
8. Optical/Projected Beam–Type Smoke Detectors.	265
9. Raised Floors and Suspended Ceilings.	267
10. Partitions.	267
11. Heating, Ventilating, and Air Conditioning (HVAC).	267
12. Spot-Type Detectors	268
13. High-Rack Storage.	268
14. High Air Movement Areas.	268
14.1. General.	268
14.2. Location.	268
14.3. Spacing.	269
14.4. HVAC Mechanical Rooms	269
15. Video Image Smoke Detection.	271
16. Other Detectors	271
Table 8.3: Smoke Detector spacing based on air movement	271
17. Sprinkler Waterflow Alarm-Initiating Devices.	272
18. Detection of the Operation of Other Automatic Extinguishing Systems.	272
19. Supervisory Signal-Initiating Devices.	272
19.1. Control Valve Supervisory Signal-Initiating Device.	272
20. Pressure Supervisory Signal-Initiating Device.	273
21. Water Level Supervisory Signal-Initiating Device.	273
22. Smoke Detectors for Control of Smoke Spread.	274
22.1. Classifications.	274
22.2. Purposes.	274
22.3. Application.	274
23. Smoke Detection for the Air Duct System.	274
23.1. Supply Air System.	274
23.2. Return Air System.	274
24. Location and Installation of Detectors in Air Duct Systems.	275
25. Smoke Detectors for Door Release Service.	277
26. Building Fire Alarm Systems.	281
26.2. System Requirements.	281
26.3. Combination Systems	282
26.4. Alarm Signal Initiation — Detection Devices	283
26.5. Alarm Signal Initiation — Sprinkler Systems.	283
26.6. Supervisory Signal Initiation — Sprinkler Systems.	284



26.7. Alarm Signal Initiation — Fire Suppression Systems Other Than Sprinklers.	284
26.8. Supervisory Signal Initiation — Fire Suppression Systems (Non Sprinklers)	284
26.9. Signal Initiation — Fire Pump.	284
26.10. Fire Alarm and Supervisory Signal Initiation :Releasing Service Control Units.	284
26.11. Trouble Signal Initiation.	285
26.12. Fire Alarm and Mass Notification System Notification Outputs.	285
26.13. Notification Appliances in Exit Stair Enclosures, Exit Passageways, and Elevator Cars.	285
26.14. Notification Zones.	285
26.15. Circuits for Addressable Notification Appliances.	285
27. Suppression System Actuation.	286
28. Elevator Recall for Fire Fighters' Service.	286
29. Visual Warning.	287
30. Elevator Shutdown.	287
31. HVAC Systems.	288
32. Door Release Service.	288
33. Door Unlocking Devices.	288
34. Public Mode Audible Requirements.	289
35. Private Mode Audible Requirements.	289
36. Sleeping Area Requirements.	289
37. Location of Audible Notification Appliances for a Building or Structure.	290
38. Location of Audible Notification Appliances for Wide Area Signalling.	290
Table 8.4: Average ambient sound level according to location	291
39. Visible Characteristics — Public Mode.	292
39.1. Light, Color, and Pulse Characteristics.	292
39.2. Appliance Location.	292
39.3. Spacing in Rooms.	292
Table 8.5: Room spacing for wall mounted visible appliances	293
Table 8.6: Room spacing for ceiling mounted visible appliances	295
39.10. Spacing in Corridors.	296
40. Material Approval	297
41. Further References	297

CHAPTER 9. FIRE PROTECTION SYSTEM 298

1. General	303
2. Definitions	303
3. Application	308
3.1. Building Classification and Application of Fire Protection Systems	308
3.2. Non-industrial and Non-storage occupancies	308
3.3. Industrial occupancies	308
3.4. Storage occupancies	309
Table 9.1. Building Classification and Application of Fire Protection Systems	310
Table 9.2. Auxiliary Rooms and Acceptable Fire Protection Systems	313
Table 9.3. Location and Selection of Fire Protection Systems for Industrial Occupancies	314
Table 9.4. Location and Selection of Fire Protection Systems for Storage Occupancies	320
4. Design Requirements	322
4.1. Dry Riser Systems	322



4.2.	Fire Hose Station locations	322
4.3.	Flow & Pressure Requirements	322
4.4.	Fire water demand & Hydraulic Calculations	322
4.5.	Pipe Sizes	323
4.6.	Fire Pump set	323
4.7.	Fire Water tanks	323
4.8.	Civil Defence Breeching Inlets	323
4.9.	Wet Riser Systems	324
4.10.	Flow & Pressure Requirements	328
4.11.	Zoning of Wet riser system	330
4.12.	Fire Water Demand	330
4.13.	Combined System Water Demand	334
4.14.	Hydraulic Calculations	334
4.15.	Pipe Sizes	334
4.16.	Fire Pump Sets	335
4.17.	Fire Water tanks	335
4.18.	Test Risers and Drains	336
4.19.	Civil Defence Breeching Inlets	337
4.20.	Location & Protection of Wet riser Pipe	337
5.	Sprinkler System	338
5.1.	General	338
5.2.	Types of Sprinkler Systems	338
5.3.	Wet Sprinkler System	338
5.4.	Dry Pipe Sprinkler System	339
5.5.	Pre-Action Sprinkler system	340
5.6.	Types of Sprinkler Heads	341
5.7.	Types of Sprinkler Heads based on discharge pattern	341
5.8.	Types of Sprinkler Heads based on coverage	341
5.9.	Types of Sprinkler Head based on sensing element	341
5.10.	Sprinklers Operating Temperature	342
	Table 9.5. Sprinkler Temperature rating and color coding	342
5.11.	Sprinkler Operating Response	342
5.12.	Sprinkler Thread, Orifice & K-Factor	343
5.13.	Sprinkler Zone Limitations	343
5.14.	Sprinkler Operating Pressure	343
5.15.	Sprinkler Design Density & Water Supply Requirements	344
5.16.	Density / AMAO Method	344
5.17.	Room Design Method	344
5.18.	Combined Sprinkler & Wet Riser system Water Demand	344
5.19.	Hydraulic Calculations	345
5.20.	Pipe Sizes	345
	Table 9.6. Number of Sprinkler Heads allowed per pipe sizes	346
6.	Certification of Fire Pumps	346
7.	Fire pump location and arrangement	347
7.8.	Fire Pump for Hydrants	348
8.	Inspectors Test & Drains	348
8.1.	Inspectors Test	348
8.2.	Drains	348
9.	Classification of Fire Hazards for Sprinkler Design	350



9.2. Light Hazard	350
9.3. Ordinary Hazard	350
9.4. Extra High Hazard	350
9.5. Special / Storage Hazard	351
10. Sprinkler System Design Requirements	353
11. Sprinkler System Design Requirements for all occupancies other than Storage Occupancies.	354
Table 9.7. Sprinkler Design requirements for all occupancies other than Storage occupancies	355
12. Special Design Consideration for Atria	365
13. Sprinkler System Design Requirements for Storage Occupancies	365
13.1. General	365
13.2. Preferred K-factors of sprinkler heads for Storage occupancies	366
13.3. Table 9.8. Preferred K-factors of Sprinkler Heads for Storage Occupancies	366
14. Design criteria for Storage Occupancies	366
Table 9.9. Control Mode Design requirements for idle wooden pallets stored indoor	367
Table 9.10. Large Drop Design requirements for idle wooden pallets stored indoor	367
14.3. Idle Plastic pallets	368
14.4. Class I, II, III and IV Commodities, Stored Palletized, solid piled or on shelves	368
Table 9.11. Specific Application (K-16.8) for idle wooden pallets stored indoor	370
Table 9.12. Specific Application (K-19.6) for idle wooden pallets stored indoor	370
Table 9.13. ESFR Design requirements for idle wooden pallets stored indoor	371
Table 9.14. ESFR Design requirements for plastic pallets stored indoor	372
Table 9.15. Class I-IV Commodities stored up to 3.7m	373
Table 9.16. Class I-IV Commodities stored at 3.7m – 6.1m	374
Table 9.17. Class I-IV Commodities stored at 6.1m – 6.7m	375
Table 9.18. Class I-IV Commodities stored at 6.7m – 7.6m	376
14.5. Large drop and Nominal K-factor Design for palletized or solid piled Commodities	377
14.6. ESFR Sprinkler System for palletized or solid piled commodities	377
14.7. Class I, II, III & IV Commodities Stored in Single, Double or Multiple Racks	378
14.8. In-Rack Sprinkler Location for Rack Storages of Class I Through Class IV Commodities Stored Up to 7.6 m in Height.	378
Table 9.19. Large Drop design for solid piled commodities, plastic and rubber stored up to 7.6m	380
Table 9.20. ESFR Design for solid piled Class I-IV Commodities	381
Table 9.21. Large Drop design for Class I-IV Commodities stored in racks up to 7.6m	382
Table 9.22. ESFR design for Class I-IV Commodities stored in racks up to 7.6m	383
Table 9.23. Large Drop design for Class I-IV Commodities stored in racks over 7.6m	384
Table 9.24. ESFR design for Class I-IV Commodities stored in racks over 7.6m	385
14.9. Group A Plastic	386
14.13. Tires	386
14.14. Rolled Paper	386
14.15. Single, Double or Multiple row Rack Storage of Class I,II, III and IV Commodities	386
Table 9.25. Group A Plastic stored up to 3.7m	388
Table 9.26. ESFR Design for solid piled or palletized Plastic and Rubber	389
Table 9.27. Tires stored up to 3.7m	390
Table 9.28. Rolled Paper stored up to 3.7m	390



Table 9.29. Single or Double row Racks storage of 3.7m – 6.1m	391
Table 9.30. Single or Double row Racks storage of 6.1m – 6.7m	392
Table 9.31. Single or Double row Racks storage of 6.7m – 7.6m	393
Table 9.32. Multiple row Racks storage of 3.7m – 7.6m	395
Table 9.33: Multiple Row Racks, Rack Depth Over 16 ft (4.9 m) or Aisles Narrower Than 8 ft (2.4 m)	396
15. Refrigerated Spaces (Cold Room Application)	398
15.1. General	398
15.2. Low Air Pressure Alarm	398
15.3. Air or Nitrogen Supply	398
15.4. Control Valve	398
15.5. Check Valve	398
15.6. Air or Nitrogen Supply Piping	399
15.7. Nitrogen Supply	399
16. Piping Requirements	400
16.1. Above Ground Piping	400
16.2. Above Ground Pipe Fittings	400
16.3. Under Ground Pipes & Fittings	400
17. Isolation / Section or floor Control valves	401
18. Check Valves	401
19. Alarm Check Valve (ACV) Assembly	403
20. Control Valves	405
21. Supervision.	406
22. Pressure Gauges	406
23. Pressure-Reducing Valves	406
24. Section or Floor Zone Control Valve (ZCV) Assembly	407
25. Sprinkler Heads Installation	408
25.1. General	408
25.2. Upright Sprinkler Heads	409
25.4. Pendent Sprinkler Heads	411
Table 9.34. Distance of standard upright sprinklers to obstruction	411
25.6 Recessed / Concealed Pendent Sprinkler Heads	413
Table 9.35. Distance of standard pendant sprinklers to obstruction	413
Table 9.36. Distance of standard concealed sprinklers to obstruction	416
25.8 Sidewall Sprinkler Heads	416
Table 9.37. Distance of standard sidewall sprinklers to obstruction	418
Table 9.38. Distance of standard sidewall sprinklers to obstruction along wall	420
26. Obstruction from structural members, pipe, columns and fixtures for upright and pendent sprinklers	420
27. Suspended or Floor-Mounted Vertical Obstructions for upright or pendent sprinklers	421
Table 9.39: Distance to avoid obstruction for upright and pendent sprinklers	421
28. Obstructions that Prevent Sprinkler Discharge from Reaching the Hazard	422
29. Obstructions to Sprinkler Discharge Pattern Development for sidewall sprinklers	422
30. Suspended or Floor-Mounted Vertical Obstructions for sidewall sprinklers	423
Table 9.40: Distance to avoid obstruction for upright and pendent sprinklers	423
31. Distance Below Ceilings.	423
Table 9.41. Minimum spacing between sprinklers to Heat source	425
32. Location & Protection of Sprinkler Riser Pipe	425
33. Stock of Spare Sprinklers	426



Table 9.43. Minimum spacing of hanger supports	426
34. Civil Defence Breaching Inlets for Sprinkler System	426
35. Support of Sprinkler Piping	427
36. Pipe Expansion Joints	428
37. Water Hammering Arrestors	428
38. Installation of Sign Boards	428
39. Installation Workmanship	428
40. Inspection, Testing & Commissioning	428
40.1. Inspection	428
40.2. Testing & Commissioning	429
41. Maintenance	431
42. Water Spray System	431
42.1 Introduction	431
42.2 Characteristics of Water Spray System	432
42.3 Application of Water Spray System	432
42.4 General Design Requirements and Procedure	433
42.5 Piping and Installation	436
43. Water Mist Specifications	438
43.1. Introduction	438
43.2. How does water mist function	438
43.3. Advantages & Benefits	438
43.4. System Types	439
43.5. Nozzle Types	440
43.6. Pumps & Pressure Skid Modules	440
43.7. Filters & Strainers	443
43.8. Pressure Gauges	443
43.9. Section Valves	443
43.10. Manual Ball Valves	444
43.11. Pressure Switches	444
43.12. Fire Detections Systems	444
43.13. Project Designs & Hydraulics	444
43.14. Design and O&M Manuals	444
43.15. Commissioning Certificates	444
43.16. Water Mist Applications	445
43.17. Design Considerations	445
43.18. Standards	446
44. Foam Extinguishing Systems	446
44.1 Introduction	446
44.2 Different Types of Foams and Their Applications	447
44.3 Foam Proportioning	448
44.4 Characteristics and Limitations	451
44.5 Design Criteria	452
44.6 Piping and Installation	453
Table 9.44. Design Criteria for Fixed Foam outlets, surface and subsurface	454
Table 9.45. Design Criteria for Foam Water Sprinklers	455
45. Gas Suppression	456
45.1 Introduction	456
45.2 Definitions	456
45.3 Gas Extinguishing Systems	457



45.4	Agent Storage Bank	458
45.5	Cylinder Valves	459
45.6	Nozzles	469
45.7	Area Valves	460
45.8	Pipe and Fittings	460
45.9	Room Integrity and Air Tightness Requirements	461
45.10	Inert Gases	464
	Table 9.47. Various Inert Gas comparisons	466
	Table 9.48: KB factor for solid materials and facilities	472
45.11	Chemical Gases	473
	Table 9.49. Various Chemical Gas comparisons	474
45.12	Fire Prevention Systems	475
45.13	Health & Safety Aspects of Gas Extinguishing Systems and Fire Prevention Systems	479
46.	Dry Chemical Suppression	481
47.	Wet Chemical Suppression Systems	483
48.	Material Approval	486
49.	Further References	486
CHAPTER 10. MECHANICAL VENTILATION AND SMOKE CONTROL SYSTEMS		487
1.	Definitions	489
2.	Air-Conditioning and Ventilation Systems	490
2.1	General Requirements for Equipment	490
3.	Air-Handling Unit Rooms	491
3.1	Air-Handling Unit Rooms Used as Plenum Space	491
3.2	Air-Handling Unit Rooms That Have Air Ducts That Open Directly into a Shaft.	491
4.	Outside Air Intakes	491
5.	Air Cleaners and Air Filters	492
6.	Fans	492
7.	Air Ducts	492
8.	Ventilation Ducts	495
9.	Plenum	497
10.	Fire Dampers	498
11.	Smoke Dampers	499
12.	Smoke Detection for Automatic Control	500
13.	Plenum Material	501
14.	Corridor Air Systems	501
15.	Exits	501
16.	Smoke free enclosure and fire fighting lobbies	502
17.	Engine driven fire pump and generator room and emergency command centre	503
18.	Rooms involving use of Flammable and Explosive Substances	506
19.	Acceptance testing	507
20.	Building Smoke Ventilation System	507
20.1	Smoke Ventilation Of Commercial Cooking Operations	507
21.	Industrial Building & Storage Smoke Ventilation	510
21.1	Sprinklered Buildings	510
21.2	Nonsprinklered Buildings	510



22. Assembly Occupancy Building Smoke Ventilation	511
23. Smoke Control System	511
23.1 Exit Stair Enclosures	511
23.2 Flow velocity	511
23.3 Leakage and relief	512
23.4 Pressure Distribution	512
24. Elevators.	525
25. Ventilation Requirements for Internal Corridors	526
Table 10.1. Smoke Control System requirement criteria for various types of buildings	527
26. Malls and Atriums	535
27. Fire Engineering Analysis	535
28. Underground buildings	537
28.2 Basement Smoke Control System	537
28.4 Smoke Vents	538
28.7 Smoke Purging System	538
29. Engineered Smoke Control System	539
29.4 Fire Sizes	539
Table 10.2. Fire size for various occupancies	539
29.5 Capacity of Smoke ventilation systems	540
29.6 Clean Layer	541
29.7 Smoke Reservoir	541
29.9 Removal of smoke from circulation or atrium	542
29.10 Discharge of smoke into circulation or atrium spaces	544
29.12 Stagnant Regions	545
29.14 Maximum smoke flow/smoke layer temperature	546
29.21 Perforated ceiling	547
29.22 Emergency Power supply	547
29.23 Mode of Activation	547
29.24 Manual activation	548
29.26 Shutdown of all other HVAC systems	548
29.28 Stand Fans or Multiple Fans	549
29.29 Protected Circuits	549
29.31 Fire rating of Ducts	549
30. Smoke Control System for Auditorium (Used or Intended for Cinema, Concert Hall, Performance Theatre)	552
31. Enclosed Car Parking	552
32. Open Carpark	554
33. Ductless Jet Fans System in Car Parks	555
33.1 Objectives	555
33.2 Scope	555
33.3 Design Considerations	555
33.4 Zoning of car park	555
33.5 Jet fans system	555
34. Wiring arrangement of jet fans	557
35. Provision of supply air for jet fan systems	558
36. Exhaust fan design for jet fan system	558
37. Fire resistance of jet fans system	559
38. Verification of Jet Fans System Designs	559



39. Acceptance criteria for jet fan system	560
40. CFD fire modelling input parameters for jet fan system	560
41. Jet fan velocity profile	561
42. Operations and Maintenance Manual for jet fan systems	562
43. Commissioning Test for jet fan system	562
44. Material Approval	563
45. Further References	564

CHAPTER 11. FIRE SAFETY GUIDELINE FOR LIQUEFIED PETROLEUM GAS (LPG) INSTALLATIONS 565

1. Scope	566
2. General Requirements for LPG Cylinder Installations	566
3. LPG Cylinder Installation Requirements	567
3.1. Main Considerations for Use of LPG	567
3.2. Codes of Practice & Standards	567
3.3. Fire Stopping	567
3.4. Pressure	568
3.5. Fire Extinguisher	568
3.6. Warning Sign / Notice	568
4. Requirements for Outdoor LPG Cylinder Installation	568
4.1. Locating of LPG Cylinders	568
4.2. Protection to LPG Cylinder Installation	569
4.3. Safety Provisions	569
4.4. Allowable Quantities	570
5. Requirements for Indoor LPG Cylinder Installation	570
5.1. General	570
5.2. Safety Provisions	571
5.3. LPG Cylinder installation in separate compartment	572
5.4. Allowable Quantity	572
5.5. Compartment	572
5.6. Ventilation	572
5.7. Location	573
5.8. Safety	573
6. Fire Safety Guidelines for Roof Top central LPG Container Installations	574
6.1. General Description	574
6.2. System Design Requirements	574
6.3. Safe Distances and Allowable Quantities	575
Table 11.1. Minimum Roof Top tank separation distances	575
6.4. Piping and Connections	576
6.5. Pipe Material	576
6.6. System Shut- Off Configuration	577
6.7. Protection and Fire Fighting Requirement.	577
6.8. LPG Storage Tank	578
7. Fire Safety Guidelines for Aboveground central LPG Container Installations	578
Table 11.2. Minimum aboveground tank separation distances	578
8. Fire Safety Guidelines for Underground central LPG Container Installations	579
Table 11.3. Minimum underground tank separation distances	579



ANNEX A - STANDARDS AND SPECIFICATIONS FOR LPG CYLINDER INSTALLATIONS	580
ANNEX B - VARIOUS DISTANCES FOR OUTDOOR LPG INSTALLATIONS	588
ANNEX C INDOOR LPG CYLINDER INSTALLATION IN SEPARATE COMPARTMENT	590
ANNEX D - WARNING SIGN / NOTICE	592
ANNEX E –ROOFTOP LPG INSTALLATION	593
CHAPTER 12. FIRE & SAFETY CODES DURING CONSTRUCTION AND MAINTENANCE	594
1. Policy	597
2. General	597
3. Fire Protection Plan	597
4. Fire Safety Program	598
5. Owner's Responsibility for Fire Protection.	598
5.2. Premises identification	598
5.3. Program Manager Responsibilities.	598
5.4. Site Security.	599
5.5. Smoking.	599
5.6. Waste Disposal.	600
6. Temporary Construction, Equipment and Storage	600
6.2. Temporary Offices and Sheds.	600
Table 12.1. Separation distances between buildings in construction site	600
6.3. Temporary Enclosures.	601
6.4. Equipment.	601
6.5. Construction Materials	601
7. Processes and Hazards	602
7.1. Hot Work.	602
7.2. Welding, Cutting, Brazing and other Hot work & open flame or smoke producing operations	602
7.3. Thermit Welding.	602
7.4. Pre-Site Inspection	603
7.5. Fire Watch	603
7.6. Post-work Inspection	603
8. Flammable and Combustible Liquids and Flammable Gases.	603
8.1. Storage.	603
8.2. Handling of Flammable and Combustible Liquids at Point of Final Use.	604
9. Explosive Materials.	605
10. Other Combustible Materials.	605
10.1. Storage	605
10.2. Combustible Debris	605
10.3. Oily Rags	605
11. Compressed Gases	605
11.1. Protection of Gas Containers	605
11.2. Separation	606
11.3. Marking	606
12. Liquefied Petroleum Gas (LP-Gas)	606
12.10. Occupied Buildings	607
13. Special Equipment	607
13.1. Motorized Equipment	607



13.2. Temporary Heating Equipment.	607
13.3. Asphalt and Tar Kettles	608
14. Electrical Devices	608
14.5. Temporary Wiring.	609
14.6. Lighting.	609
15. Fire Protection	610
15.1. Installation, Testing, and Maintenance.	610
15.2. Hydrants.	610
15.3. Standpipes.	610
15.4. Standpipe Installations in Buildings Under Construction.	611
15.5. Fire Extinguishers	612
15.6. Area Separation Walls	612
15.7. Fire Sprinkler Systems	612
15.8. Water Supply.	613
15.9. Fire Alarm System	613
16. Telephone & Communication	614
16.1. Fire Alarm Reporting.	614
17. Civil Defence Access & Parking	614
18. Means of Egress Components	615
18.1. Means of Egress.	615
18.2. Minimum number of exits	615
18.3. Stairs.	616
18.4. Hoists and Elevators.	616
19. Assembly Points	616
20. Vehicle Parking.	616
21. Safeguarding Construction and Alteration Operations	617
21.1. Scaffolding, Shoring, and Forms.	617
21.2. Construction Material and Equipment Storage.	617
21.3. Permanent Heating Equipment.	617
21.4. Gas.	617
21.5. Building Separation Walls.	618
21.6. Fire Protection During Construction.	618
22. Safeguarding Roofing Operations	618
22.1. Asphalt and Tar Kettles.	618
22.2. Single-Ply and Torch-Applied Roofing Systems.	619
22.3. Openings, Penetrations, and Flashings.	619
22.4. Flame Contact Protection.	620
22.5. Personal Protection.	620
22.6. Equipment.	620
22.7. Equipment Inspection.	621
22.8. Fuel Gas Cylinders.	621
22.9. Frost Buildup.	621
22.10. Fire Extinguishers for Roofing Operations.	621
22.11. Fuel for Roofing Operations.	622
23. Safeguarding Demolition Operations	622
23.1. General.	622
23.2. Special Precautions.	622
23.3. Smoking.	622
23.4. Demolition Using Explosives.	622



23.5. Gas.	623
23.6. Fire Cutoffs.	623
23.7. Fire Protection During Demolition.	623
23.8. Sprinkler Control Valves.	623
23.9. Standpipes.	623
23.10. Fire Extinguisher.	624
24. Safeguarding Underground Operations	624
24.1. General.	624
24.2. Security.	624
24.3. Water Supply.	624
24.4. Emergency Procedures.	625
24.5. Drills.	625
24.6. Fire Detection and Protection Systems.	625
24.7. Fire Communications Systems.	626
24.8. Electrical.	627
24.9. Hazardous Operations and Procedures.	627
24.10. Flammable and Combustible Liquids.	628
24.11. Storage.	628
24.12. Equipment.	629
24.13. Ventilation.	629
25. Requirements for Site Offices (Manufactured Homes/Offices)	629
25.2. Manufactured Home Site Fire Safety Requirements.	629
25.3. Marking of Underground Utility Lines.	630
25.4. Manufactured Home Installations.	630
25.5. Fire Detection and Protection Systems.	630
26. Fire Safety and Evacuation Plan for Building Under Construction or Renovation	630
27. Material Approval	631
28. Further References	631
CHAPTER 13. FIRE SAFETY REQUIREMENT FOR MULTI-TENANT (TERRACE TYPE) WAREHOUSE AND FACTORIES	632
1. Scope	633
2. Definition	633
3. Compartment	633
4. Sprinkler Protection and Fire Fighting Systems.	634
5. Storage Height Control	634
6. Smoke Control	635
6.2. Smoke Vents	635
6.3. Smoke Purging System	635
6.4. Engineered Smoke Control	635
LIST A (Not exhaustive) - Low hazard Commodities, Materials and related Activities Exempted from Sprinkler with regards to Table 13.1	636
7. Material Approval	637
8. Further Reference	637
TABLE 13A.1 - SIZE OF FIRE COMPARTMENT	638
TABLE 13A.2 – SMOKE MANAGEMENT REQUIREMENT	638
TABLE 13A.3 – DISTANCE FROM SMOKE VENT	638



Figure 13A.1: General warehouse not requiring sprinkler	639
Figure 13A.2: General warehouse requiring sprinkler	640
Figure 13A.3: General warehouse with unconfirmed type of storage or to be rented out	641
CHAPTER 14. SUBSTATION REQUIREMENTS	642
1. General	643
2. Construction	643
4.12. Outdoor Oil insulated transformer and Equipment	644
Table 14.1. Minimum separation distances for outdoor transformers	644
4.13. Indoor Oil insulated transformer or Equipment	646
3. Fire Access	646
4. Means of Egress	646
5. Doors	647
6. Portable Fire Extinguishers	647
Table 14.2. Portable Fire Extinguishers for substations	647
7. Exit Signs	647
8. Emergency and Exit Lighting	648
9. Fire Detection and Fire Protection System	648
Table 14.3. Acceptable Fire detection & Protection Systems for substations	648
10. Ventilation and Smoke Control System	650
11. Material Approval	651
12. Further References	651
CHAPTER 15. ACCESSIBILITY GUIDELINES FOR DISABLED	652
1. Purpose	653
2. Scope	653
3. Applicability and Adoption	653
4. Referenced Codes and Standards	654
5. Permitting and Inspection	654
6. General Exceptions	654
7. Minimum Requirements and Provisions	655
CHAPTER 16. SPECIFICATION FOR LIFE SAFETY ALARM MONITORING	657
1. Category 1	658
2. Category 2	660
3. Category 3	662
4. Category 4	665
5. Category 5	668
6. Material Approval	672



CHAPTER 17. GUIDELINES FOR CONDUCTING RISK ASSESSMENT (RA) STUDIES	673	
1. General Requirements	674	
2. Outline of Risk Assessment Study Report	675	
Table 17.1 – Working Methods of Hazard Assessment	676	
3. Specific Fire Protection Requirements to be Addressed	676	
4. Guideline Notes	677	
Table 17.2 - Fire & Explosion Index (F&EI) System Material Factor (MF)	678	
4.8 General Hazards (GH)	678	
4.9 Specific Hazards (SH)	678	
4.10 Fire and Explosion Index (F&EI)	679	
4.11 Toxicity Number	679	
4.12 Penalty Factor	679	
4.13 Toxicity Index (TI)	680	
CHAPTER 18. SPECIAL STRUCTURES AND OCCUPANCIES	681	
1. General	682	
18.1. Table 18.1 Construction, Life Safety, Fire Systems requirements for Special structures	683	
18.1.1. Membrane Structures	683	
18.1.2. Metro Rail and Tram Systems	684	
18.1.3. Modular Houses and Offices	687	
18.1.4. Road Tunnels	688	
18.1.5. Robotic/ Automatic Car Parking Structures	689	
18.1.6. Special Amusement Structures	690	
18.1.7. Tents	691	
2. Material Approval	692	
3. Further References	692	
CHAPTER 19. REQUIREMENTS FOR SUBMISSION OF DRAWINGS	693	
1. Policy	694	
2. Requirements for Consultants	694	
3. Consultant's Standard Plans	694	
4. Requirements for Décor Companies	696	
5. Décor Company's Standard Plans	696	
6. Requirements for Contracting Companies	697	
7. Contracting Company's Standard Shop Drawings	697	
8. Requirements for LPG and GAS Suppression System Contracting Companies	698	
9. LPG and Gas Based Fire Suppression System Contracting Company's Standard Shop Drawings	698	
10. Civil Defence Standard Legends	699	
APPENDIX: 10. CIVIL DEFENCE STANDARD LEGENDS	700	
10.1. ARCHITECTURE	700	
10.2. FIRE DETECTION & ALARM SYSTEM	702	
10.3. VOICE EVACUATION SYSTEM	703	
10.4. EMERGENCY LIGHTING & EXIT SIGN SYSTEM	704	
10.5. SMOKE CONTROL & PRESSURIZATION SYSTEM	705	
10.6. WATER BASED FIRE FIGHTING SYSTEM	706	
10.7. PORTABLE FIRE EXTINGUISHERS	708	
10.8. GAS BASED FIRE FIGHTING SYSTEM	708	
10.9. LPG SYSTEM	708	
FREQUENTLY ASKED QUESTIONS	709	



I. Preface

Don't let your dreams go up in smoke - practice fire safety.

~Author Unknown

Driven by the visions of UAE President, His Highness Khalifa Bin Zayed Bin Sultan Al Nahyan and UAE Vice President, Prime Minister of UAE and Ruler of Dubai, His Highness Sheik Mohammad Bin Rashid Al Maktoum, United Arab Emirates has raced against time in its rapid development and prosperity for the past years. There has been vast realization of world class landmark projects all over UAE such as super high rise buildings, transportation network, amusement parks, industrial facilities, warehouses, places of public interest and many more prospective developments. UAE now presents itself as a central hub for commercial, industrial, residential and tourism developments involving high density of population and activities. The dreams and aspiration of UAE government and the community thus calls for high level expertise of planning, architectural, engineering and construction work which unconditionally must collaborate with a high standard of Life and Fire Safety to ensure the protection of precious life and property.

Unfortunately, tragic lessons were learnt from recent building and structural fires. The aftermath was devastating, resulting in the damage to assets and loss of lives. Fires in a building with inadequate fire protection features can present severe problems and create complexity in a fire fighting operation. This inevitably causes deficiency in the protection of occupants from fire and smoke during the egress or evacuation.

The fire professionals, consultants and contractors have been adopting mostly on standards from the NFPA (National Fire Protection Association) with regards to the life safety design, building construction, fire protection, fire fighting, fire alarm and smoke ventilation systems. However, UAE requires a Code of practice that suits the local trend and concept as well as the fire fighting operational needs.

This UAE Fire and Life Safety Code of Practice is the outcome of discussion between Civil Defence Engineers, Fire Safety professionals, Practitioners and Consultants. Matured international standards such as NFPA, BS, EN, VDS, ISO etc were referred to in the study of fire safety requirements which are feasible and necessary to address the fire hazards in various types of occupancies. Civil Defence Operational issues are also considered in the process of developing this code.

Civil Defence is thankful to all those who contributed directly or indirectly in bringing this first edition of UAE Fire and Life Safety Code of Practice to life.

In presenting this UAE Fire and Life Safety Code of Practice, Civil Defence underscores its aim to promote professional relationship with Fire professionals, clients and the community. Along with ensuring the protection of life, assets and environment from Fire and other emergencies, Civil Defence also anticipates a beginning of a new chapter in Fire and Life Safety professionalism in UAE.



II. Acknowledgement

Civil Defence Directorate

Director: Major General Rashid Thani Al Matrooshi
Commander in Chief of Civil Defence

Deputy Director General: Brigadier Abdul Aziz Khamis

Civil Defence Fire Safety and Prevention Section Representatives

Chairman: Major Jamal Ahmed Ibrahim
Director of Preventive Safety

Head, engineering plans & projects: Sara Ahmed Ahmadi

Raghdaa Nashed	B. E., Civil Engineer, Structural Design.
Aidil Bin Arshad	B. E., (Hons) Mechanical, Certificate in Fire Engineering.
Tahir Hassan Taher	Diploma in Construction., Advanced Diploma in Fire Fighting & Rescue (Singapore)
Pramod Y. Challa	B. E., Instrumentation.

Civil Defence Operation Department Representatives

Ashraf Amro	Eng. Safety Engineering (Master Equivalent)
Fatima M. Dawood	Cambridge International Diploma in Management HPL (Strategic Marketing)

Civil Defence Legal Office

Kamal Eldeen Abdou M.	Legal Advisor, Dubai Civil Defence

Fire Engineering Consultants

Barry R. Bell	BscEE MscFSE PE (MIFPO MNSFPE MNSPE MICC MIFMA).
John Huish	B.E., (Hons) MIFireE.
Arun C	B.E. Fire Engineering, CFPS.

Industrial Fire Protection Practitioners (Reviews and Comments)

Alexandre Benoit	M.E., Mechanical.
Amir Toma	B.E., Mechanical, Power Section, Certificate in Fire Protection Engineering.
D. Paul	B.E., Mechanical. MBA.
M. P. Babu	B. E., Electrical.
Mohamed Fiaz	B. E., Mechatronics.



Rajendran Ekambaram	BE., Mechanical, PGBMM.
Raja Sajad Hussain	B.E., Electronic and Communications, Post Graduate Diploma in Fire Protection Engineering.
Sajid Raza	B.E., (Hons) Mechanical, UL STP, FCIA Standards Committee, FM DRI.
Samir Siddiqui	B.E., Electronics and Communication.
Thomas Schaedlich	B.Sc. Electrical Engineering.
Zainul Abedeen	B.Sc. Engineering, Mechanical.

This list represents the Civil Defence Fire Code Council (CDFCC) membership at the time of final compilation of this First edition of the UAE Fire and Life Safety Code of practice. The committee comprises of professional practitioners with appropriate qualification and experience in a variety of engineering and scientific disciplines.

Civil Defence Fire Code Council (CDFCC) membership is subject to change at the discretion of the Civil Defence. Membership on a committee shall not constitute any form of endorsement by the Civil Defence.

Committee Scope

The Civil Defence Fire Code Council (CDFCC) shall have primary responsibility for the continuous development of a Fire Protection & Prevention Code of Practice that includes administrative provisions, to be used with the UAE Fire and Life Safety Code of practice for the planning, installation, operation, and maintenance of buildings, structures, and premises for the purpose of providing protection to life and property from fire and explosion.

This includes development of requirements for, and maintenance of, systems and equipment for fire control and extinguishment as well as Safety to life of occupants of buildings and structures.

Civil Defence Fire Code Council (CDFCC) members are prevented from claiming credit for the UAE Fire and Life Safety Code of Practice in any form without prior permission from the Civil Defence Fire Code Council (CDFCC). Civil Defence Fire Code Council (CDFCC) members are also prevented from sharing the information regarding code development issues, code conflict issues, code adoption issues with anybody other than the Civil Defence Fire Code Council (CDFCC).



III. Intention

It is the policy of Civil Defence to impose measures to minimize the risk of Fire and to ensure the Safety of life and property. The purpose of this code is to prescribe minimum guidelines for determining Design, Construction, Modification & Installation of Buildings, Structures, Occupancies, Fire detection systems, Fire protection systems, Fire Prevention Systems and Life Safety concerns to achieve safe societies. The property Owners, Designers, Consultants, Décor companies, Contracting companies, Suppliers, Installation companies and Maintenance companies are obliged to follow the minimum requirements of these codes and regulations.



IV. Application

This UAE FIRE AND LIFE SAFETY CODE OF PRACTICE, henceforth referred as 'Civil Defence Fire Code' recommends the Civil Defence' minimum requirements for Life Safety and Fire Safety Design and Installation. Where, the parties have to go through multiple organizations for the approval or where in-house codes and regulations govern the Life safety and Fire safety requirements or whenever the conflicts arise between requirements of different departments, the minimum requirements of UAE FIRE AND LIFE SAFETY CODE OF PRACTICE shall surpass all other requirements unless other requirements are higher than the UAE FIRE AND LIFE SAFETY CODE PRACTICE.

All the Personnel, Companies, Materials, Equipment and Accessories in the UAE's Life Safety and Fire Safety systems and installations shall be Listed, Approved and Registered by the Civil Defence.

The provisions of this code apply to Fire Safety, Life Safety and Civil Defence Access of all Occupancies and Multiple, Separated or Mixed Occupancies located in High Depth, Low Depth Underground buildings, Lowrise, Midrise and Highrise buildings.

In multiple or mixed occupancies, relevant Civil Defence code requirements for different occupancies are applicable along with the provisions of predominant occupancy.



V. Commitment to Best Practice

1. Commitment to Best Practice

Approved Fire Safety Consultants and Approved Contractors shall strive for best practice in relation to:

- Compliance with relevant codes and standards
- Compliance with relevant acts and regulations
- High level of quality of work
- Environmental management and Sustainability
- Occupational health and safety

2. Environmental Management & Sustainability

So far, as we know it, there is only one habitable planet, Earth and we are the inhabitants at present. It is our duty to respect, cherish and protect its environment, resources and beauty so that the future generations do not regret inheriting this planet from us.

Civil Defence urges every individual, consultants, contractors and organizations to commit themselves to the best possible practices in sustaining Earth's habitable environment through Environmental Management and Sustainability when it comes to Fire Protection.

Before 1987, Halon was the highly effective Fire extinguishing agent throughout the industry. But due to its 'Ozone Depleting' character, after the *Montreal Protocol*, Halon (HCFCs) was agreed to be phased out of the general industry usage except for certain specialised applications in marine and aviation industry. As a replacement for Halon, Fire Protection industry has new technologies, new extinguishing agents and systems. Today, after *Kyoto Protocol*, there are raising concerns of using some of those replacement extinguishing agents such as HFCs and PFCs because of their 'Global Warming' characters.

However, Civil Defence takes the environmental concerns a step further to caution the industry regarding available new technologies and extinguishing agents, not only regarding 'Ozone Depletion' but also with other factors such as 'Global Warming' and 'Water Conservation'. Civil Defence would adhere to any future protocols, research results and justifications which prohibit the usage of any technology and extinguishing agents which have adverse affects on environment, human health and sustainability of this planet. Hence, it is owner's, Consultant's, Contractor's and Supplier's responsibility to update themselves with latest international and local stand on new technologies and extinguishing agents and their impact on environmental concerns.

3. Water Conservation

The UAE's first ever national 'Water Conservation' law will be implemented in the coming months. The law will layout the regulations for water usage and management. Where water



is the most appropriate and widely used Fire extinguishing medium for most of the applications, water is also a very scarce asset in this part of the world and a very expensive venture in desalination. Hence, Civil Defence takes the initiative towards Water Conservation through promoting the technologies and systems that restrict the wastage of water in Fire Protection. Water Mist System and Water Fog Systems are such examples where an affective Fire Protection is achieved using less water discharge than the conventional Fire Water Systems. Adopting Auto zone check valves instead of conventional Alarm test valves will also enable inspectors to conduct the flow tests without discharging water.

4. Occupational Health and Safety

Civil Defence aims at the promotion and maintenance of the highest degree of physical, mental and social well-being of workers and users of the buildings in all occupations. Safe workplaces provide the consistency and reliability needed to build a community and grow a business. Workplaces with active safety and health leadership have fewer injuries, and have more satisfied and productive employees. Safe workplaces not only save life, they promote successful and vibrant lives.

The protection of workers in their workplace from various health risks involves implementation of an occupational environment adapted to worker's physiological and psychological capabilities along with empowering workers with good Health and Safety practices.

Civil Defence, thus calls for all organizations, consultants, contractors and individuals to recognise their role in establishing awareness of the environment, correct practices, consequence of actions and consideration for others to make 'Occupational Health and Safety' a way of life in UAE.



VI. Fire Code Council

The Civil Defence Fire Code Council (CDFCC) will be established to supervise and involve in the administration of the Code.

The selected Board of Committee is made up of:

- Executive Director (Director General Civil Defence).
- Chairman (Director, Fire Safety & Prevention Section, Civil Defence)
- Members from industry with Fire Protection and Fire Alarm Systems experience.
- Members from industry with Fire Fighting Operation and Fire Fighting Systems experience.
- Members from industry with Life Safety Design and Emergency Management experience.



VII. Role of Fire Code Council

The Civil Defence Fire Code Council (CDFCC) is responsible for reviewing the administration of the Code. To achieve this, the Committee must:

- Conduct a review of the Code at least once every 12 months.
- Submit all proposed amendments to the Board for approval.
- Develop and implement a strategy to increase consumer and industry awareness of the Code.
- Provide technical support to the public domain to ensure correct application of the code.
- Oversee the administration and implementation of proposals for change from the public domain.
- Collate data of proposals and comments received and their outcomes.
- Prepare annual report and data based on consolidated analysis on code compliance during the current year.



VIII. Code Review and Amendment

Review

Civil Defence Fire Code Council (CDFCC) is responsible for the review, evaluation and administration of the Code. In conducting its review, where appropriate, the committee may consult with any group or members affected by the Code. The review committee shall make recommendations to the Board for consideration.

Amendment

The Board may at any time resolve to amend the Code. Once an amendment to the Code has been made, the Board will ensure that each member of Civil Defence Fire Code Council (CDFCC) promptly receives notice of the amendment; and the amendment is adequately publicised so that consumers and other organisations may be made aware of the amendment.



IX. Register of Code Signatories

Annual Requirements

To be registered with Civil Defence as an Approved Fire Safety Consultant and an Approved Fire Safety Contractor, the Fire safety Consultants and Fire Safety Contractors shall also register with the Civil Defence Fire Code Council (CDFCC). This enables them to have official access to the Civil Defence Fire Code and participate in proposal and reviews. The Fire Safety Consultant and Fire Safety Contractors must sign the Code of Practice Declaration with their annual membership renewal.

Removal from Register

Cessation of membership, either voluntary, or through suspension, or failure to provide a current signed Code of Practice Declaration with membership renewal, will result in removal from the membership listing and the Civil Defence Fire Code Council (CDFCC) listing.



X. Licensing, Accreditation and Competent Persons

Civil Defence will administer the licensing and accreditation of fire practitioners (fire consultants and fire contractors) and professionals working in their disciplines.



XI. Recognized Certification and/or Testing Laboratories

The use of Fire Safety and Emergency System products in the UAE is regulated by an approvals process in which an approved certification body, informed by inspection and testing, provides product certification.

The different certification systems covered in ISO Guide 67 are tabulated below. But the one which has been adopted by Civil Defence is system 5.

Procedure (Carried out by the certification body)	ISO Guide 67 common system types						
	1a	1b	2	3	4	5 (Adopted System)	6
Selection (sampling), as applicable	✓	✓	✓	✓	✓	✓	✗
Determination of characteristics, as applicable by:							
a) Testing	✓	✓	✓	✓	✓	✓	✓
b) Inspection	✓	✓	✓	✓	✓	✓	✓
c) Design appraisal	✓	✓	✓	✓	✓	✓	✓
d) Assessment of services	✓	✓	✓	✓	✓	✓	✓
Review (evaluation)	✓	✓	✓	✓	✓	✓	✓
Decision on certification	✓	✓	✓	✓	✓	✓	✓
Licensing (attestation)	✗	✓	✓	✓	✓	✓	✓
Ongoing surveillance, as applicable by:							
a) Testing of samples selected from the open market	✗	✗	✓	✗	✓	✓	✗
b) Inspection of samples selected from the open market	✗	✗	✓	✗	✓	✓	✗
c) Testing of samples selected from the factory	✗	✗	✗	✓	✓	✓	✗
d) Inspection of samples selected from the factory	✗	✗	✗	✓	✓	✓	✗
e) Quality system audits combined with random tests or inspections	✗	✗	✗	✗	✗	✓	✓
f) Assessment of the production process or service	✗	✗	✗	✓	✓	✓	✓

Table on the Dubai Civil Defence' website 'Recognized Certification and/or Testing Laboratories' lists the Local and International Approved Certification and/or Testing Laboratories, contact details and the scope of the companies.



However, this list is not exhaustive and should any details regarding any certification body not included, please send your query to faq@dcd.gov.ae

It is the responsibility of Consultants and Contractors to check the ‘accreditations and scope’ validity of the companies mentioned in the list from time to time through the companies’ websites or through the websites of accreditation issuers of these companies.



XII. Qualified and Competent Persons

Companies shall employ appropriately qualified and competent persons to undertake the work. Qualification shall be determined in accordance with the Written and Oral tests conducted by the Civil Defence.



XIII. CLASSIFICATION OF OCCUPANCIES AND BUILDINGS

Definitions

1. Underground Buildings and Structures

A structure or portion of a structure in which the floor level is below the level of exit discharge.

2. Lowdepth Underground Buildings and Structures

A structure or a building with up to two basements or up to 7 m below the level of exit discharge.

3. Highdepth Underground Buildings and Structures

A structure or a building with more than two basements or more than 7 m below the level of exit discharge.

4. Lowrise Buildings

The occupancies or Multiple and Mixed occupancies, facilities, buildings and structures having occupiable or usable floors at or up to 15 Meters from the lowest grade or lowest level of Fire Service Access into that occupancy is categorized as Lowrise Building.

5. Midrise Buildings

The occupancies or Multiple and Mixed occupancies, facilities, buildings and structures having occupiable or usable floors between 15 Meters to 23 Meters from the lowest grade or lowest level of Fire Service Access into that occupancy is categorized as Midrise Building.

6. Highrise Buildings

The occupancies or Multiple and Mixed occupancies, facilities, buildings and structures having occupiable or usable floors more than 23 Meters above the lowest grade or lowest level of Fire Service Access into that occupancy is categorized as Highrise Building.

7. Multiple or Mixed Occupancies

A building, structure or facility where more than one classes of occupancies exist is noted as Multiple or Mixed occupancy. Occupancies are often mixed and intermingled with one type of occupancy located and associated with other classes of occupancies, facilities, buildings and structures without a definite Fire Barrier such as Offices located in Showrooms, Shopping Centers, Souks, industrial facilities or hospitals. Similarly assembly occupancy such as Mall or amusement park intermingled with mercantile occupancies. A storage occupancy such as warehouse can house offices, thus qualifying as Mixed Occupancy. Or industrial complex like manufacturing units can have associated Storage occupancies. A residential building having



shops, showrooms and other mercantile occupancies at the ground floor without Fire Barrier are considered as multiple occupancy.

Where multiple or mixed occupancies exist, each portion of the building is classified according to its use and the Civil Defence Fire code application in such occupancies is based on the most stringent requirements.

8. Separated Multiple Occupancies

A building, structure or facility which houses multiple occupancies as in 'Mixed Occupancies' but with definite Fire Barriers, distinctive separate Exit Access and Exits, 'separating' the different classes of occupancies from each other. (Chapter 1. Construction and Compartmentalization deals with details on Fire Barrier and separation requirements)

9. Business, Offices

An occupancy or the facility, building, structure used for commercial or non-commercial transaction of business, information, professional, law and governing matters such as the following.

- 9.1. General Business Offices
- 9.2. Government and Ministry Offices
- 9.3. Banking and Financial Offices
- 9.4. Engineer's Consulting Offices
- 9.5. Consultation Offices
- 9.6. Doctor's Consulting Offices
- 9.7. Lawyer's Consulting Offices
- 9.8. Corporate Offices
- 9.9. Typing, Translation & Visa processing Offices
- 9.10. Tours & Travel Offices
- 9.11. Money exchange & transfer Offices
- 9.12. Beautician's Offices
- 9.13. Marketing and Sales Offices
- 9.14. Business development Offices
- 9.15. Media Offices

10. Educational

An educational occupancy is a facility, structure or building used for educational purposes where academic activities are held for 6 hours or more such as Academies, Kindergarten Schools, Nurseries, Institutions and Course offering establishments.

11. Assembly

An occupancy used for a gathering of 50 or more persons for deliberation, worship, entertainment, eating, drinking, amusement, awaiting transportation, or similar uses. Special amusement building, regardless of occupant load, is considered as assembly occupancy.



12. Mercantile

An occupancy used for the display and sale of merchandise.

13. Healthcare, Hospitals, Clinics

An occupancy used for purposes of medical or other treatment or care of four or more persons where such occupants are mostly incapable of self-preservation due to age, physical or mental disability, or because of security measures not under the occupants' control.

14. Day-care

An occupancy, in which four or more clients receive care, maintenance and supervision by other than their relatives or legal guardians for less than 24 hours per day.

15. Detention and Correctional

An occupancy used to house one or more persons under varied degrees of restraint or security where such occupants are mostly incapable of self-preservation because of security measures not under the occupants' control.

16. Labor and Staff accommodation

Labor accommodation is an occupancy where Lodging is provided for group of workers or laborers involved in projects, construction work and manufacturing etc.

Staff accommodation is an occupancy where group Lodging is provided for company, office or sales staff.

17. Industrial, Workshops, Factories

An occupancy in which products are manufactured or in which processing, assembling, mixing, packaging, finishing, decorating, or repair operations are conducted.

18. Storage, Warehouse

An occupancy used primarily for the storage or sheltering of goods, merchandise, products and vehicles. The plant nursery building is also included in this category because of the nature of storage.



19. Residential

An occupancy where housing for families is provided such as Villas, Group of Villas, Residential apartments with multiple dwelling units and bungalows.

20. Hotel

An occupancy where a building or group of buildings under one management provide sleeping and lodging facilities with or without meals for transients.

21. Animal Housing

An occupancy where area of a building or structure, including interior and adjacent exterior spaces, where animals are fed, rested, worked, exercised, treated, exhibited, or used for production such as Veterinary Clinics, Zoos and Animal care centers.

22. Special Structures and Occupancies

Refer to **Chapter 18. Special Structures and Occupancies** for Special Membrane Structures, Tents, Robotic car parking, Metro and Tram Stations, Road Tunnels, Modular Housing and Offices, Special Amusement Structures.



XIV. HAZARD EVALUATION

Hazard Content and Hazard evaluation for the occupancies differ based on the material involved and its burning characteristics. The owner, Consultants and Contractors should submit details such as occupancy description, operations and processes involved and Material usage in their occupancy for Civil Defence approval.

For life safety purposes, Hazard evaluation of occupancies is categorized into Low Hazard, Ordinary Hazard and High Hazard Occupancies. For Fire Protection purposes, Hazards are categorized into Light, Ordinary, High and Extra High Hazards. Therefore Fire detection, protection and Suppression Systems will need to be designed to address the various categories of hazards effectively.

Most of the Occupancies are basically categorized as ORDINARY HAZARD where materials such as Paper, Records, Books, Computers, Carpet, Household Plastic, Home Appliances, Electronic & Electrical Office Equipment, Hospital Equipment, Furniture, Wood, Bedding and upholstery, and Parking areas are likely to burn with moderate rapidity or to give off a considerable volume of smoke.

Occupancies also house other associated Hazard which falls into High Hazard category such as Battery Storage, Flammable liquids such as Diesel in Generators, Laboratories, Cleaning Solvents in Storage rooms, and Fuel Gas in Kitchens and Pantries. Industrial and Storage occupancies usually form an Extra High Hazard with storage of rapidly burning and dense smoke generating materials such as Plastic, Tyres, Highly Flammable liquids and gases, Combustible dust, processes and operations involving high temperatures and flames.

Multiple or Mixed occupancies are combinations of various Hazard Content and Hazard categories. Accordingly the code application in such occupancies is based on the most stringent requirements.



XV. ACKNOWLEDGEMENT OF REFERENCED INTERNATIONAL CODES AND STANDARDS.

The following list acknowledges the various editions of International ‘Referenced’ Codes and Standards.

GCC Code of Practice

National Fire Protection Association (NFPA)

International Code Council (ICC)

British Standards (BS)

European Standards (EN)

Singapore Fire Code

‘Code of Practice for the Management of Dangerous Goods in the Emirates’ issued by Dubai Municipality

At the end of each chapter the specific referenced codes and standards are acknowledged.



CHAPTER 1.

CONSTRUCTION AND FIRE COMPARTMENTALIZATION

1. General

- 1.1.** Each occupancy shall not exceed the area limitations or be located at a height greater than that permitted for such occupancy and the type of construction being used.
- 1.2.** Where minor accessory usages do not occupy more than 25 percent of the area of any floor of a building, the principal use of the building shall determine the occupancy classification.
- 1.3.** In high-rise occupancies, the most restrictive, applicable, high-rise building provisions and fire protection system requirements shall apply to all portions of the building.
- 1.4.** Where separated occupancies are provided, each part of the building comprising a distinct occupancy, as described in this chapter, shall be completely separated from other occupancies by fire-resistive assemblies, as specified in [Table 1.1](#) below.
- 1.5.** *Note: The fire resistance ratings specified in Table 1.1 are permitted to be reduced by 1 hour, but in no case to less than 1 hour of fire resistance, where the building is protected with supervised automatic sprinkler system.*

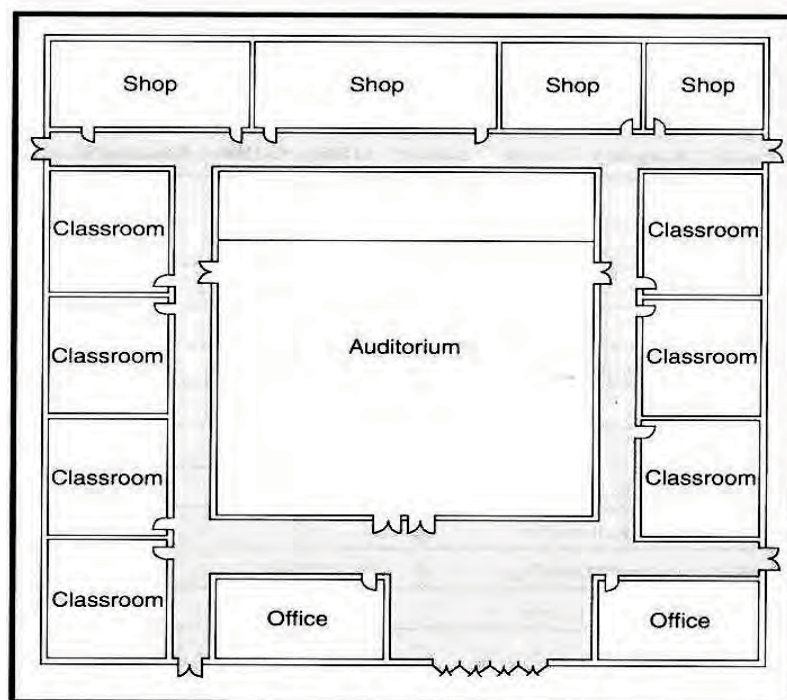


Figure 1.1: An example of a Multiple occupancy protected as mixed occupancy



2. Table1.1: Required Fire Resistance-Rated Separations for Separated Occupancies

OCCUPANCY	Assembly with Less than or equal to O.L. 300	Assembly with O.L. 300 to 1000	Assembly with more than O.L. 1000	Assembly with O.L. 300 to 1000	Assembly with more than O.L. 1000	Educational	Day Care with more than 12 Clients	Day-Care Homes	Health Care	Ambulatory Health Care	Detention and Correctional	One-and-Two Family Dwelling	Lodging or Rooming Houses
Assembly with Less than or equal to O.L. 300				0	0	2	2	2	2!	2	2!	2	2
Assembly with O.L. 300 to 1000			0			2	2	2	2!	2	2!	2	2
Assembly with more than O.L. 1000						2	2	2	2!	2	2!	2	2
Educational							2	2	2!	2	2!	2	2
Day Care with more than 12 Clients								1	2!	2	2!	2	2
Day-Care Homes									2!	2	2!	2	2
Health Care										2!	2!	2!	2!
Ambulatory Health Care											2!	2	2
Detention and Correctional												2!	2!
One- and Two-Family Dwellings													1
Lodging or Rooming Houses													

Legend: ! The 1-hour reduction due to the presence of sprinklers (As mentioned in clause 1.5) is not permitted.
O.L. Occupant Load



OCCUPANCY	Hotels and Dormitories	Apartment Buildings	Board and care, Small	Board and care, Large	Mercantile	Mercantile, Covered Mall	Mercantile, Bulk Retail	Business	Industrial, Low Hazard	Industrial	Storage, Low Hazard	Storage
Assembly with Less than or equal to O.L. 300	2	2	2	2	2	2	3	1	2	3	2	
Assembly with O.L. 300 to 1000	2	2	2	2	2	2	3	2	2	3	2	
Assembly with more than O.L. 1000	2	2	2	2	2	2	3	2	2	3	2	
Educational	2	2	2	2	2	2	3	2	3	3	2	
Day Care with more than 12 Clients	2	2	2	2	2	2	3	2	3	3	2	
Day-Care Homes	2	2	2	2	2	2	3	2	3	3	2	
Health Care	2!	2!	2!	2!	2	2!	3	2!	2!	3	2!	
Ambulatory Health Care	2	2	2	2	2	2	3	1	2	3	2	
Detention and Correctional	2!	2!	2!	2!	2	2!	3	3	2!	3	2!	
One- and Two-Family Dwellings	2	2	1	2	2	2	3	2	2	3	2	
Lodging or Rooming Houses	2	2	2	2	2	2	3	2	2	3	2	
Hotels and Dormitories (including staff accommodation)		2	2	2	2	2	3	2	2	3	2	
Apartment Buildings			2	2	2	2	3	2	2	3	2	
Board and Care, Small				1	2	2	3	2	3	3	2	
Board and Care, Large					2	2	3	2	3	3	2	
Mercantile						0	3	2	2	2	2	
Mercantile, Covered Mall							3	2	3	3	2	
Mercantile, Bulk Retail								2	3	3	2	
Business									2	2	2	
Industrial, Low Hazard										0	1	
Industrial											1	
Storage, Low Hazard												
Storage												

Legend: ! The 1-hour reduction due to the presence of sprinklers (As mentioned in clause 1.5) is not permitted.

O.L. Occupant Load

- 2.1. Occupancy separations shall be vertical, horizontal, or both or, when necessary, of such other form as required to provide complete separation between occupancy divisions in the building.
- 2.2. Where the occupancy separation is horizontal, structural members supporting the separation shall be protected by an equivalent fire-resistive construction.
- 2.3. The type of construction required for the building shall be determined in accordance with [Table 1.6](#).

3. Space Beneath Platforms (Raised platforms).

- 3.1. When the space beneath any permanent platform is used for storage or any purpose other than equipment, wiring, or plumbing, the floor construction shall have a fire resistance rating of not less than 1 hour.

4. Fire Resistance Rating Requirements for Structural Elements

- 4.1. Structural elements, floors, and bearing walls shall have a fire resistance rating not less than the fire resistance rating required for the structural element, bearing or non-bearing wall, floor, or roof they support.
- 4.2. Structural elements, such as girders, beams, trusses, and spandrels, that have direct connections to columns carrying gravity loads, and that are essential to the stability of the building as a whole, shall have a fire resistance rating not less than that of the columns to which they are connected.
- 4.3. Structural elements required having a fire resistance rating and that support more than two floors, one floor and roof, a bearing wall, or a non-bearing wall more than two stories high shall be individually protected on all sides for their full length with materials providing the required fire resistance rating.
- 4.4. Fire-resistive materials covering columns required to have a fire resistance rating, where exposed to impact damage by moving vehicles, handling of merchandise, or by other means, shall be protected from damage.

5. Exterior Walls

- 5.1. Exterior walls shall have a fire resistance rating based on [Table 1.2](#) and [Table 1.6](#), whichever is greater.



6. Table 1.2: Fire Rating for Exterior Walls (hr)

OCCUPANCY	Horizontal separation (m)				Other protective measures
	0 to 1.5	More than 1.5 to 3	More than 3 to 9	More than 9	
Assembly, educational, day care, health care, ambulatory health care, detention and correctional, residential, residential board and care, business, industrial, and low hazard storage	1	1	0	0	As per Table 1.4
Mercantile and industrial and storage occupancies with ordinary hazards	2	1	0	0	As per Table 1.5
Industrial and storage occupancies with high hazards	3	2	1	0	As per Table 1.5

7. Horizontal Separation

7.1. Horizontal separation shall be measured at a 90-degree angle to the exterior wall.

8. Imaginary Line

8.1. Where two or more buildings are located on the same lot, the horizontal separation shall be measured from the exterior wall to an imaginary line or notional boundary drawn between the exterior walls of the adjacent buildings. See [Figure 1.2](#) for illustrations.

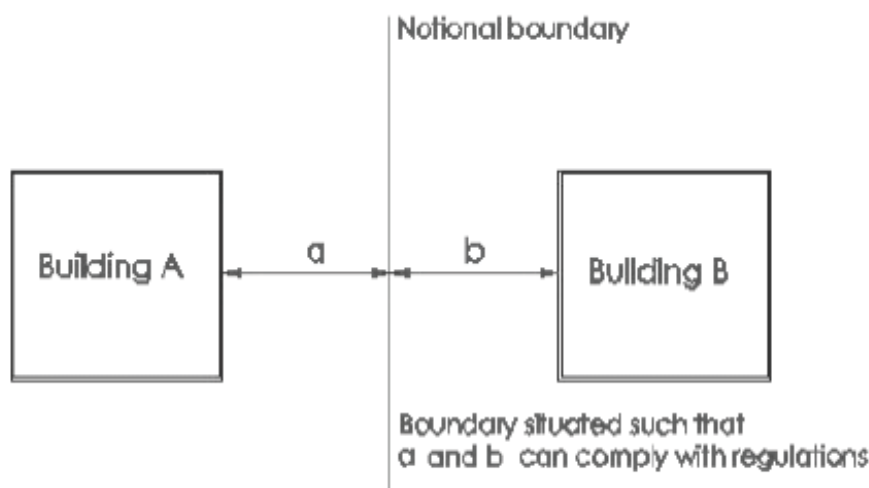


Figure 1.2: Imaginary line or Notional Boundary between two buildings.



- 8.2.** The imaginary line shall be placed at a distance from the facing exterior wall of the adjacent building that is equal to the horizontal separation applicable for that wall based on its fire resistance rating and protection of openings.
- 8.3.** Where the exterior wall is an irregular vertical shape, the following criteria shall be met:
- 8.3.1.** The horizontal separation shall be determined by measuring from a vertical plane that is located so that no portion of the exterior wall is between such vertical plane and the line to which the horizontal separation is measured.
- 8.3.2.** The area of openings shall be determined from the projection of the openings in the exterior wall onto the vertical plane. See [Figure 1.3](#).

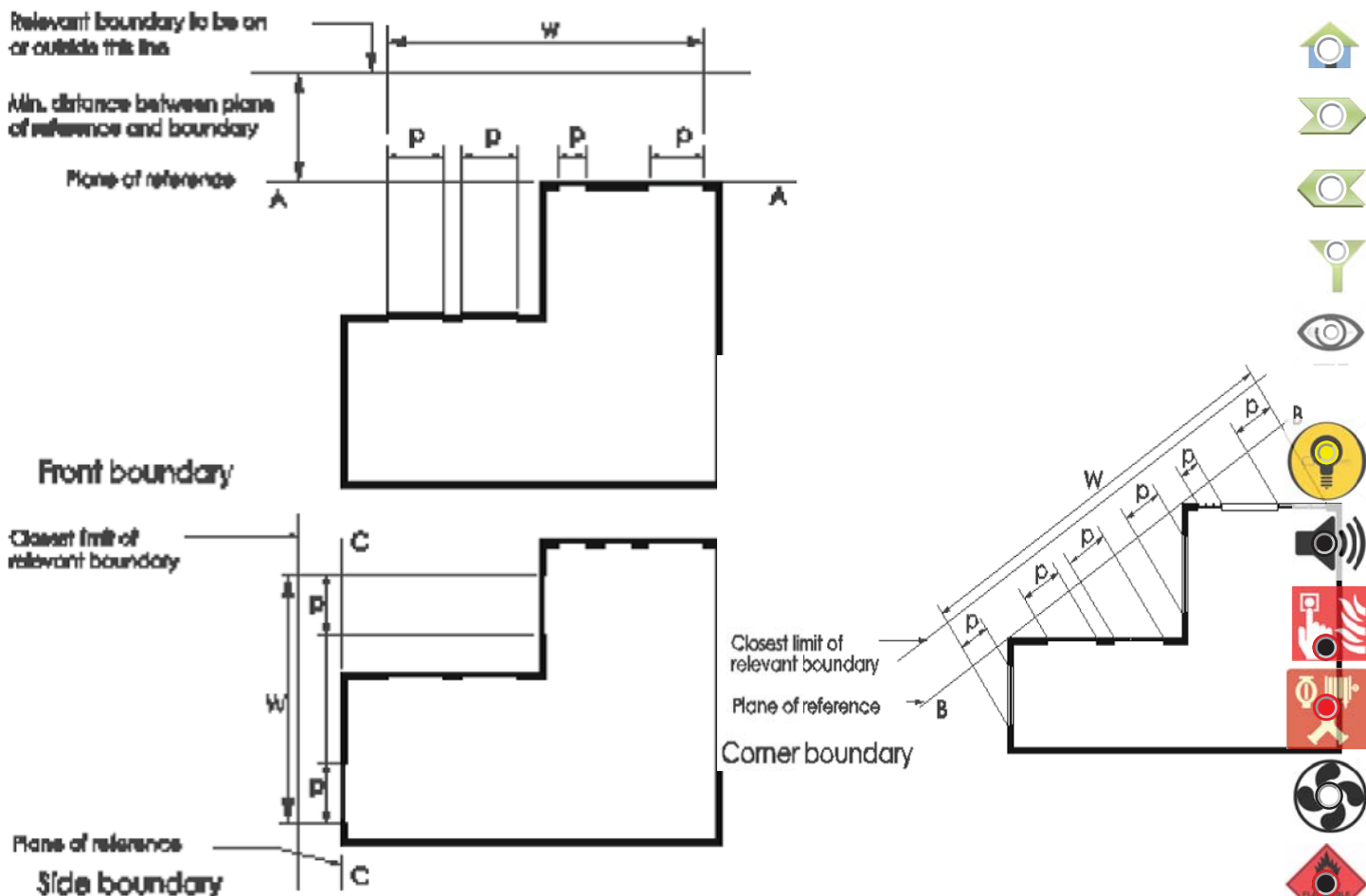


Figure 1.3: Projection of openings onto plane of reference for irregular external wall

9. Openings

- 9.1.** Where an exterior wall is required to have a fire resistance rating as determined by [Table 1.2](#), the area of openings in exterior walls shall not exceed that permitted by [Table 1.4](#) or [Table 1.5](#).
- 9.2.** The area of unprotected openings in an exterior wall shall be the aggregate of unprotected openings expressed as a percentage of the area of the exterior wall.
- 9.3.** The area of an exterior wall shall be calculated as the length, edge to edge, of the exterior wall multiplied by the measurement from the finished ground level to the uppermost ceiling.
- 9.4.** The area of unprotected openings permitted by [Table 1.4](#) and [Table 1.5](#) shall be permitted to be doubled under either of the following conditions.
- 9.4.1.** Where the building is protected throughout with an approved, electrically supervised automatic sprinkler system.
 - 9.4.2.** Where the openings are protected with a fire window, fire door, fire shutters assembly or other listed opening protective having the required fire protection rating in accordance with [Table 1.3](#).

10. Table 1.3: Minimum Fire Protection Ratings for Exterior Opening Protection

Wall Fire Resistance Rating (hr)	Exterior opening Fire Protection Rating (hr)
2	1½
1	¾



11. Table 1.4:

Maximum allowable area of unprotected openings (percentage of exterior walls) for Assembly, Educational, Day-care, Health care, Ambulatory Health Care, Detention and correctional, Residential, Residential board and care, Business, Industrial and Low Hazard Storage.

Horizontal separation to boundary or notional boundary (m)	Maximum Area of Exposing Building (m ²)																		
	9	14	19	23	28	37	47	55	65	74	84	93	140	185	230	325	465	930	≥
	Maximum allowable area of unprotected openings (% of area of exposing wall)																		
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1.2	9	8	8	8	8	7	7	7	7	7	7	7	7	7	7	7	7	7	
1.5	12	11	10	9	9	9	8	8	8	8	8	8	7	7	7	7	7	7	
1.8	18	15	13	12	11	10	10	9	9	9	9	8	8	8	8	7	7	7	
2.1	25	20	17	15	14	12	11	11	10	10	10	9	9	8	8	8	8	7	
2.4	33	25	21	19	17	15	14	13	12	11	11	11	10	9	9	8	8	7	
2.7	43	32	27	23	21	18	16	15	14	13	12	12	11	10	9	9	8	8	
3.0	55	40	33	28	25	21	19	17	16	15	14	13	12	11	10	9	9	8	
>3.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	



12. Table 1.5:

Maximum Allowable Area of Unprotected Openings (percentage of exterior wall) for Mercantile, Industrial and Storage with Ordinary Hazard and Industrial and Storage with High Hazard.

Horizontal separation to boundary or notional boundary (m)	Maximum Area of Exposing Building (m ²)																		Maximum allowable area of unprotected openings (% of area of exposing wall)																	
	9	14	19	23	28	37	47	55	65	74	84	93	140	185	230	325	465	930																		
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																	
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																	
1.2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4																	
1.5	6	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4																	
1.8	9	7	7	6	6	5	5	5	5	4	4	4	4	4	4	4	4	4	4																	
2.1	12	10	8	8	7	6	6	5	5	5	5	5	4	4	4	4	4	4	4																	
2.4	17	13	11	9	9	7	7	6	6	6	5	5	5	4	4	4	4	4	4																	
2.7	21	16	13	12	10	9	8	7	7	7	6	6	5	5	5	4	4	4	4																	
3.0	27	20	16	14	12	11	9	8	8	7	7	7	6	5	5	5	4	4	4																	
4.5	69	48	38	31	27	21	18	16	14	13	12	12	9	8	7	6	6	5	4																	
6	100	91	70	57	48	38	31	27	24	22	20	18	16	12	10	9	7	6	5																	
7.5		100	100	91	77	59	48	41	36	32	29	27	20	16	14	11	9	7	5																	
9				100	100	86	59	56	52	46	42	38	27	22	18	15	12	8	6																	
>9						100	100	100	100	100	100	100	100	100	100	100	100	100	100																	

13. Height and Area Requirements

Table 1.6: Allowable Building Height and Area

Building height	Type A < 23m	Type B < 55m	Type C < 128m	Type D > 128m	Elements of structure
	Assembly < 300 OL				Exterior bearing walls, Interior bearing walls, Columns, Beams, Girders, Trusses, Arches, floor and roof.
Fire resistance (Hr)	1	2	3	4	
Max floor area (m²)	1440	UL	UL	UL	
	Assembly > 300 - < 1000 OL				For Type D and Type C buildings, fire resistance rating of Interior bearing walls and Columns supporting 1 floor, roof only can be reduced by1 hour
Fire resistance (Hr)	1	2	3	4	
Max floor area (m²)	1440	UL	UL	UL	
	Assembly > 1000 OL				For Type D and Type C buildings fire resistance rating of Beams, Girders, Trusses, Arches supporting 1 floor, roof only will be required to be 2 hours.
Fire resistance (Hr)	1	2	3	4	
Max floor area (m²)	1440	UL	UL	UL	
	Business				For Type D and Type C buildings fire resistance rating of Beams, Girders, Trusses, Arches supporting 1 floor, roof only will be required to be 2 hours.
Fire resistance (Hr)	1	2	3	4	
Max floor area (m²)	3485	UL	UL	UL	
	Board & care				For Type D and Type C buildings fire resistance rating of Beams, Girders, Trusses, Arches supporting 1 floor, roof only will be required to be 2 hours.
Fire resistance (Hr)	1	2	3	4	
Max floor area (m²)	1765	5110	UL	UL	
	Day care				For Type D and Type C buildings fire resistance rating of floor, roof can be reduced by 2 hours
Fire resistance (Hr)	1	2	3	4	
Max floor area (m²)	2460	5620	UL	UL	
	Detention				For Type D and Type C buildings fire resistance rating of floor, roof can be reduced by 2 hours
Fire resistance (Hr)	1	2	3	4	
Max floor area (m²)	1395	UL	UL	UL	
	Education				For Type B buildings fire resistance rating of roof and exterior, interior bearing walls, columns, Beams, Girders, Trusses and arches supporting roof only, fire resistance rating can be reduced by 1 hour
Fire resistance (Hr)	1	2	3	4	
Max floor area (m²)	2460	UL	UL	UL	
	Health care				For Type B buildings fire resistance rating of roof and exterior, interior bearing walls, columns, Beams, Girders, Trusses and arches supporting roof only, fire resistance rating can be reduced by 1 hour
Fire resistance (Hr)	1	2	3	4	
Max floor area (m²)	1395	UL	UL	UL	
	Health care ambulatory				For Type B buildings fire resistance rating of roof and exterior, interior bearing walls, columns, Beams, Girders, Trusses and arches supporting roof only, fire resistance rating can be reduced by 1 hour
Fire resistance (Hr)	1	2	3	4	
Max floor area (m²)	3485	UL	UL	UL	
	Industrial low & ordinary hazard				For Type B buildings fire resistance rating of roof and exterior, interior bearing walls, columns, Beams, Girders, Trusses and arches supporting roof only, fire resistance rating can be reduced by 1 hour
Fire resistance (Hr)	1	2	3	4	
Max floor area (m²)	2320	UL	UL	UL	
	Mercantile				For Type B buildings fire resistance rating of roof and exterior, interior bearing walls, columns, Beams, Girders, Trusses and arches supporting roof only, fire resistance rating can be reduced by 1 hour
Fire resistance (Hr)	1	2	3	4	
Max floor area (m²)	2000	UL	UL	UL	
	Residential				For Type B buildings fire resistance rating of roof and exterior, interior bearing walls, columns, Beams, Girders, Trusses and arches supporting roof only, fire resistance rating can be reduced by 1 hour
Fire resistance (Hr)	1	2	3	4	
Max floor area (m²)	2230	UL	UL	UL	
Storage low & ordinary hazard					
Fire resistance (Hr)	1	2	3	4	
Max floor area (m²)	2415	4460	UL	UL	



Note:

1. *UL = Unlimited.*
2. *For fully sprinklered buildings other than mercantile, industrial and storage occupancy Type D construction can be reduced to Type C and Type C construction can be reduced to Type B.*
3. *For fully sprinklered buildings other than mercantile, industrial and storage occupancy less than 36 meters in height Type B construction can be reduced to Type A.*



14. Table 1.7: Occupancy, Area, Height and Occupant Load limitation for provision of automatic sprinklers**Note:**

This table should be considered only for provision of Sprinkler Systems. For further details regarding provision of Wet Risers, Dry Risers etc refer to table 9.1, 9.2, 9.3 and 9.4 of Chapter 9. FIRE PROTECTION SYSTEMS

OCCUPANCY TYPE	Should be provided fully with Automatic Sprinklers, if any one of the conditions mentioned below exists			
	Total Floor area (m ²) / Usage	Area of single largest compartment (m ²)	Number of stories/ Height	Number of occupants
14.1. Assembly Bars with Live Entertainment, Dance Halls, Discotheques, Nightclubs, Assembly with festival seating.				Fire resistance
14.2. Animal Housing	If more than 2230 m ²	-	If More than 3 stories or 15 m above grade (i.e If Midrise Building)	-
14.3. Educational	If more than 1860 m ²	-	If More than 3 stories or 15 m above grade (i.e If Midrise Building) or with a basement	-
14.4. Day Care	Unconditional	(Should be provided fully with supervised automatic sprinkler system)		
14.5. Health Care	Unconditional	(Should be provided fully with supervised automatic sprinkler system)		
14.6. Ambulatory Health Care	Unconditional	(Should be provided fully with supervised automatic sprinkler system)		
14.7. Detention and Correctional	Unconditional	(Should be provided fully with supervised automatic pre-action sprinkler system)		
14.8. One and Two Family Dwelling (Villas)	If more than 1115 m ²	If Basement is more than 900 m ²	If more than 23 m in height (including basement)	-
14.9. Lodging or Rooming	-	-	If > 3 stories or 15 m above	-

OCCUPANCY TYPE	Should be provided fully with Automatic Sprinklers, if any one of the conditions mentioned below exists			
	Total Floor area (m ²) / Usage	Area of single largest compartment (m ²)	Number of stories/ Height	Fire resistance
House			grade (i.e If Midrise Building)	
14.10. Hotels and Dormitory	Unconditional (Should be provided fully with supervised automatic sprinkler system)			
14.11. Apartment Buildings	-	-	If More than 23 m in height, If Exit door not open direct to external, If No direct access to external staircase serving more than 2 units per floor, If No direct access to internal staircase serving more than 1 unit	If less than 1 hour rating for corridors.
14.12. Residential Board and Care	Unconditional (Should be provided fully with supervised automatic sprinkler system)			
14.13. Mercantile	If more than 1115 m ²	-	If > 3 stories or 15 m above grade (i.e If Midrise Building)	If less than 1 hour fire rating for corridors
14.14. Business		If more than 900 m ²	If more than 23 m in height (i.e If Highrise Building)	If less than 1 hour fire rating for corridors
14.15. Industrial, Single Tenant with Low Hazard Activity as per chapter 13, List A.	If more than 2230 m ²	If more than 900 m ²	If > 3 stories or 15 m above grade (i.e If Midrise Building)	-
14.16. Storage, Single Tenant, with Low Hazard Materials as per chapter 13, List A.	If more than 2230 m ²	If more than 900 m ²	If > 3 stories or 15 m above grade (i.e If Midrise Building)	-
14.17. Staff Accommodation	-	-	If > 3 stories or 15 m above grade (i.e If Midrise Building)	-
14.18. Labor Accommodation	-	If more than 1860 m ²	If > 3 stories or 15 m above grade (i.e If Midrise Building)	-

15. Mixed Occupancies.

- 15.1.** Buildings with mixed occupancies shall have their required type of construction determined by applying the most restrictive type of construction to the entire building. Refer to [Clause 1.2](#).

16. Underground Buildings.

- 16.1.** All structural members up to and including the floor of the lowest level of discharge of underground buildings more than 7000 mm below or more than two level below the lowest level of exit discharge (i.e. All Highdepth Underground Buildings or Structures) shall be at least 2 hours fire rated construction. No part of a basement storey shall be used for the bulk storage of highly inflammable liquids or substances of an explosive nature.

17. Fire Separation and Protection of Various Rooms

17.1. Emergency Command Centre

- 17.1.1.** The Emergency command centre shall be separated from other parts of the same building by compartment walls and floors having fire resistance of at least 1 hour with fire suppression system. Minimum size shall be 8.9 m².

17.2. Fire Pump Rooms

- 17.2.1.** Fire pumps shall be located on the ground floor or below grade level with protected dedicated access from the fire engine access level.
- 17.2.2.** Where multiple pump sets are required in a Highrise building, Intermediate Fire Pumps and Water tanks shall be located at 90 m intervals from the First Fire Pump located as mentioned in 17.2.1.

Note:

- i. **The intention of above requirements is to prohibit the down-feeding of water into the Fire Water Systems.**
 - ii. **Thus above requirements call for appropriate design and allocations of *Service Floors* in a building with multiple Fire Pump sets, where 90 m interval between intermediate Fire Pumps can be established.**
- 17.2.3.** Fire pump room shall have 2 hours fire rated compartment in non-sprinklered buildings.



17.3. Kitchen

- 17.3.1.** In an eating establishment where a kitchen is required for the preparation of food and/or where 'open flame' cooking appliances are used, the kitchen shall be separated from other parts of the same building by compartment wall and floor having fire resistance of at least 1 hour.
- 17.3.2.** For open kitchens, where roller shutters separate food serving area, such shutters shall be of 30 minutes fire rating. See [Figure 1.4, 1.5, 1.6](#) and [1.7](#).
- 17.3.3.** Doors shall have fire resistance of half an hour and fitted with automatic self-closing device.
- 17.3.4.** Where the flue or duct passes through the compartment wall or floor, the flue or duct shall be encased by non-combustible construction and no damper shall be permitted to be installed in such flue or duct.
- 17.3.5.** Separation requirement for kitchen could be exempted when all the cooking facilities in the kitchen are fitted with an approved extinguishing system such as Kitchen hood suppression.
- 17.3.6.** Separation requirement for kitchen could be exempted when an eating establishment is separated from other parts of the same building by walls and floors having fire resistance of at least 1 hour and doors having fire resistance of at least half an hour.
- 17.3.7.** For a non-sprinkler protected building, the floor area of the kitchen compartment shall not exceed 150 m².
- 17.3.8.** LPG cylinders provided for the 'open flame' cooking activities are not allowed to be located at the basement.
- 17.3.9.** The compartment where 'open flame' cooking activities are carried out shall not comprise more than one storey.



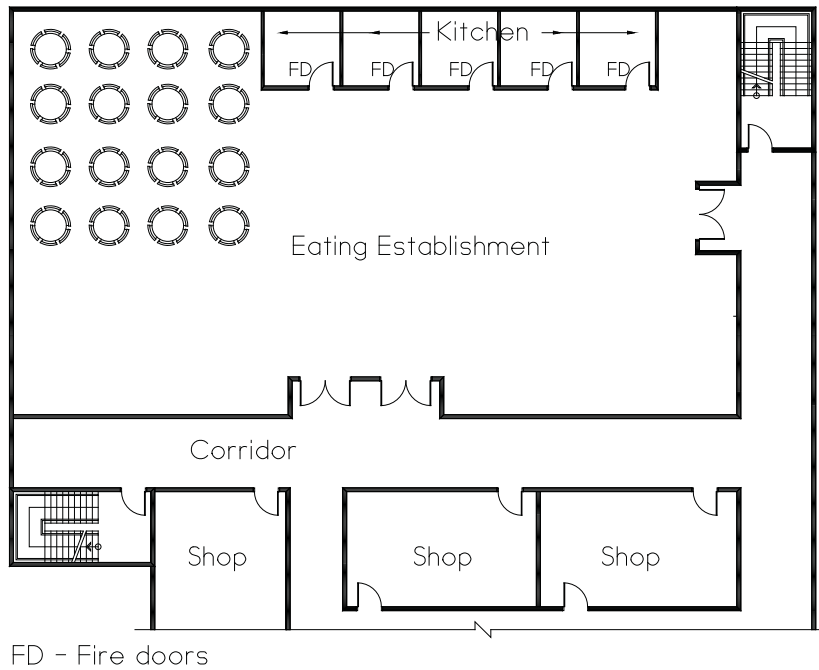


Figure 1.4: Kitchen without extinguishing system separated from other areas

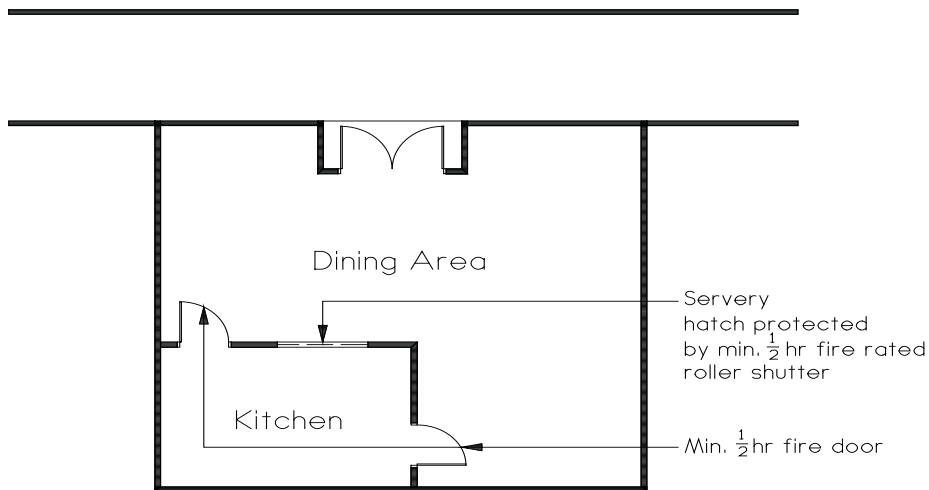


Figure 1.5: Kitchen without extinguishing system separated from dining area.



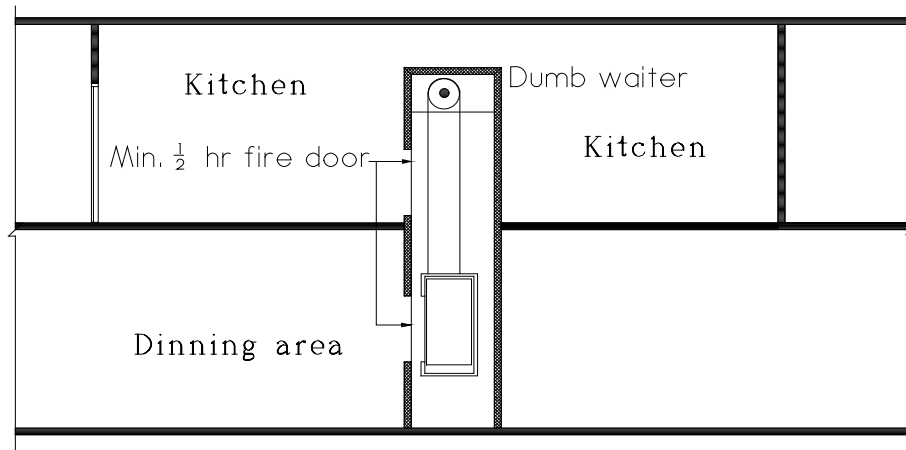


Figure 1.6: Separation between kitchen and dumb waiter.

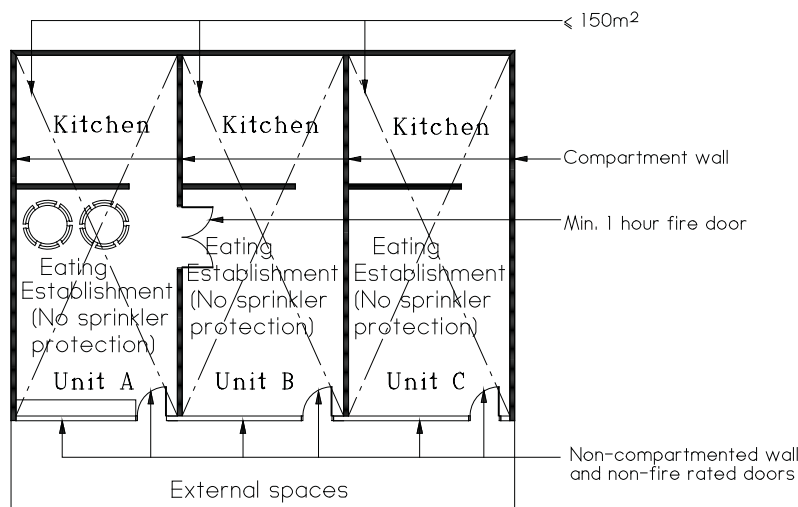


Figure 1.7: Control of area for kitchen in buildings with no sprinklers.

17.4. Separation of theatre, cinema or concert hall from other parts of the building

17.4.1. A theatre, cinema or concert hall shall be separated from other parts of the same building, which is of a different purpose group, by compartment walls and floors having a fire resistance of at least 2-hour. If the building is protected by an automatic sprinkler system, the fire resistance rating of the compartment walls or floors can be reduced to 1-hour.



17.4.2. Where openings are provided for access between the theatre, cinema or concert hall and any other part of the same building of a different purpose group, the openings shall either be protected by fire doors having the necessary fire resistance rating as the enclosing walls or floors, or be provided with lobby which complies with the following requirements. Refer to **Table 1.10**.

17.4.3. The lobby is enclosed by walls having fire resistance of at least one hour, is naturally or mechanically ventilated.

17.4.4. All doors to the lobby shall each have fire resistance of not less than half an hour and fitted with automatic self-closing device.

17.5. Hotel Bedrooms

17.5.1. Each hotel bedroom shall be compartmented from adjoining rooms and other parts of the same building by construction having fire resistance rating of at least 1 hour.

17.6. Labor Accommodation

17.6.1. Each labor accommodation bedroom shall be compartmented from adjoining rooms and other parts of the same building by construction having fire resistance rating of at least 1-hour.

17.6.2. Kitchens are only allowed on the ground floor and shall be enclosed with minimum 1-hour fire rated compartment wall, including ½-hour fire rated door. Kitchen shall be separated by 1 hour fire rating and a protected corridor away from the dormitory sleeping area on the ground floor.

17.7. Motor Vehicle Workshop

17.7.1. A motor vehicle workshop shall be separated from any other part of the same building by compartment walls and floors having fire resistance of not less than 2 hours.

17.8. Spray Painting Room

17.8.1. Areas in which spray painting or other allied processes are performed or carried out, shall be separated from other parts of the same building by compartment walls and floors having fire resistance of not less than 2 hours. Spray painting booths shall have built in vapor extraction system.

17.8.2. Where a spray painting room or booth is protected by an automatic Fire Suppression system, the fire compartment to the room or booth can be reduced from 2 hours to 1 hour. See **Figure 1.8**.



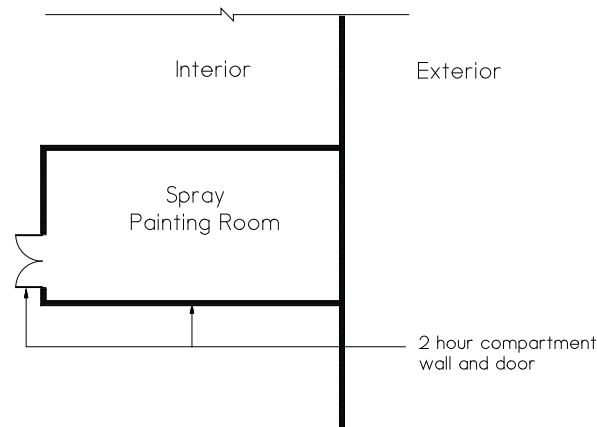


Figure 1.8: Separation between Spray Painting room and other areas.

17.9. Cold room

- 17.9.1.** Where a cold room has a floor area exceeding 20 m², a separate outer layer of non-combustible construction, including the door, having minimum 1-hour fire resistance rating (with sprinkler), shall be provided to compartmentalize the cold room enclosure from other areas. See [Figure 1.9](#).
- 17.9.2.** Provision of the fire resisting outer layer enclosure, including the fire door to the cold room would not be required if the cold room has a floor area not exceeding 20 m² and is sprinkler protected. The storage materials shall not include highly flammable chemicals.
- 17.9.3.** Cold room lesser than 20 m² provided with at least one hour fire rating compartment, need not be provided with sprinklers provided that the storage shall not include flammable materials.

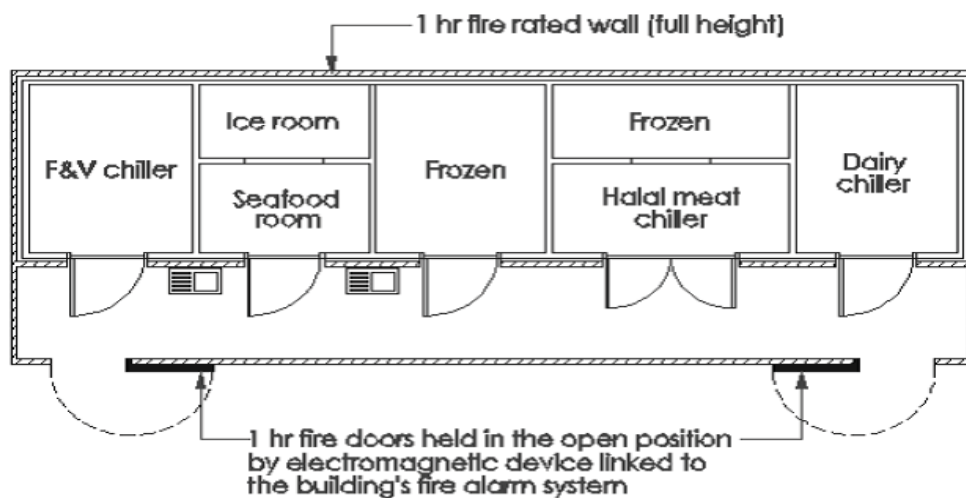


Figure 1.9: Fire compartment for cold room exceeding 20 m²



18. Rooms requiring External wall

- 18.1.** Rooms housing transformer containing flammable liquid and generator rooms, flammable storage and processes shall be located against an external wall. Where louvers for ventilation are used on internal walls for ventilation, fire shutters shall be provided to maintain same rating of the internal wall.

19. Separation between tenancy for terraced units

- 19.1.** Fire compartmentalization between individual tenancy units within terraced buildings (Multitenant Warehouse and Factories) shall be provided. The entire enclosure of each of these units shall be fire compartmented with walls and floors of minimum one-hour fire resistance rating or more depending on the type of occupancies mentioned in this code. (See Chapter 13 A. FIRE SAFETY FOR MULTI TENANT WAREHOUSE AND FACTORY)

20. Fire-Resistive Materials and Construction

20.1. Fire Resistance–Rated Construction.

- 20.1.1.** Construction assemblies required to be fire resistance–rated floors or roofs, or a combination of floors or roofs and ceilings, shall be fire barriers having a fire resistance rating set forth in [Table 1.1](#), [1.6](#), [1.9](#), [1.10](#) and [1.10a](#), which ever greater.
- 20.1.2.** Ceilings shall form continuous fire-resistive membranes but shall be permitted to have steel, ferrous, or copper conduits; electrical outlet boxes; pipes; tubes; combustion vents; exhaust vents; concrete; or masonry penetrating items where the annular space is protected to prevent the free passage of flame and the products of combustion where the aggregate area of ceiling penetrations is not more than 64,520 mm² for any 9.3 m² of ceiling.
- 20.1.3.** Where 1-hour fire resistance–rated construction is required for floor or floor-ceiling assemblies, the fire-resistive protection shall be permitted to be omitted from the underside of the floor in the crawl space area at grade and from the attic area of the ceiling where the roof forms the upper surface of the attic.
- 20.1.4.** Duct systems that penetrate the ceiling membrane of a fire resistance–rated floor-ceiling or roof-ceiling assembly shall be protected with fire rated enclosure.

20.2. Minimum Fire Protection Rating.

- 20.2.1.** Opening protection shall have a minimum fire protection rating as specified in [Table 1.10](#). See [Figure 1.10](#) for illustrations.



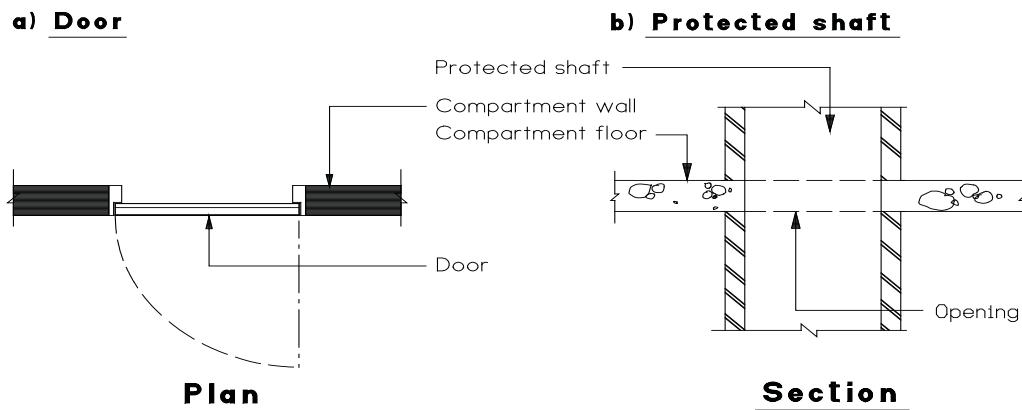


Figure 1.10: Examples of opening protection



20.3. Table 1.9: Fire separation and protection for the various rooms.

USAGE	WITH SPRINKLER PROTECTION OR OTHER SUPPRESSION SYSTEM	WITHOUT SPRINKLER PROTECTION OR OTHER SUPPRESSION SYSTEM
A/C Plant room	As per Building construction type	As per Building construction type
AHU room	As per Building construction type	As per Building construction type
Boiler Room (oil fired)	1 hr rating	2 hr rating
Central Bulk Laundries >9.3m ²	1 hr rating	2 hr rating
Cold room >20m ²	1 hr rating	Not allowed
Cold room ≤20m ²	0 (No storage of flammable material)	1 (No storage of flammable material)
Communication Nerve Centre	As per Building construction type	As per Building construction type
Control rooms	As per Building construction type	As per Building construction type
Data Centre	As per Building construction type	As per Building construction type
Electric Lift motor room	As per Building construction type	As per Building construction type
Electrical room	As per Building construction type	As per Building construction type
Emergency Command Centre	1 hr rating	2 hr rating
Emergency lighting battery room	1hr rating	2 hr rating
Essential fan room	As per Building construction type	As per Building construction type
Fire pump room	1hr rating	2 hr rating
Generator room	1 hr rating	2 hr rating
Gift or retail shops	0 hr rating	1 hr rating
Guest Laundry room <9.3m ²	0 hr rating	1 hr rating
Guest Laundry room >9.3m ²	1 hr rating	2 hr rating
High voltage switch room	As per Building construction type	As per Building construction type
Hydraulic lift motor room	As per Building construction type	As per Building construction type
Kitchen	1hr rating (if no kitchen suppression system is provided)	1 hr rating and limited to 150 m ²
Laboratories using flammable or combustible liquid	1 hr rating	2 hr rating
Usage	With Sprinkler Protection or other suppression system	Without Sprinkler Protection or other suppression system
Locker rooms	0 hr rating	1 hr rating
Low voltage switch room	As per Building construction type	As per Building construction type
Maintenance workshop	1 hr rating	2 hr rating
MDF Room	As per Building construction type	As per Building construction type
Oil Tank room	1 hr rating	2 hr rating
PABX room	As per Building construction type	As per Building construction type
Padded cells	1 hr rating	2 hr rating
Paint shops	1 hr rating	2 hr rating
Soiled linen rooms	1 hr rating	2 hr rating
Spray painting room	1 (with vapor extract)	2 (with vapor extract)
Sprinkler/Wet riser tank room	As per Building construction type	As per Building construction type
Storage rooms <9.3m ²	0 hr rating	1 hr rating
Storage rooms >9.3m ²	1 hr rating	2 hr rating
Transformer room (oil type)	1 hr rating	2 hr rating
Trash collection room	1 hr rating	2 hr rating



20.4. Table 1.10:

Minimum Fire Protection Ratings for Opening Protection in Fire Resistance-Rated Assemblies (reference shall also be made to clause 3.14 of Chapter 3)

COMPONENT	FIRE RESISTANCE RATING	FIRE PROTECTION RATING	
	Walls and Partitions (hrs)	Fire Door Assemblies (hrs)	Fire Window Assemblies
Elevator hoist ways	2	1½	Windows Not allowed
	1	1	
Vertical shafts, stairways, services refuse chutes.	2	1½	Windows Not allowed
	1	1	
HC (High Challenge) Fire walls and Fire Walls	4	2	Windows Not allowed
	3	3	
	2	1½	
Fire barrier	4	3	Windows Not allowed
	3	3	Windows Not allowed
	2	1½	Windows Not allowed
	1	1	¾
Horizontal exit	2	1½	Windows Not allowed
Exit Access Corridors	1	1	¾
Exit Passageways	2	1½	½
Smoke barrier	1	½	¾
Smoke partition	½	½	½

Table 1.10a: Fire Rating of Corridors and Internal Walls based on Occupancies

	Educational	Day-Care	Health Care	Residential	Board and care	Mercantile	Business
Fire resistance rating of fully Sprinklered Building							
Corridor	-	1 hour	-	1 hour	1 hour	-	-
Internal wall	-	1 hour	-	1 hour	1 hour	1 hour	-
Fire resistance rating of Non-Sprinklered Building							
Corridor	1 hour	2 hour	1 hour	1 hour	2 hour	1 hour	1 hour
Internal wall	1 hour	1 hour	1 hour	1 hour	1 hour	1 hour	1 hour

Note:

1. Smoke Separation shall be provided where no fire resistance rating is required.
2. For Door and window ratings refer to **Table 1.10**.
3. For Separation between different Occupancies refer to **Table 1.1**.



20.5. Fire Door Closers.

20.5.1. Fire doors used to protect the means of egress shall be self-closing or automatic-closing.

20.6. Fire Door Assemblies and Fire Window Assemblies.

20.6.1. Fire protection ratings for Fire Doors and windows shall be in accordance with NFPA 252 or NFPA 257, Standard on Fire Test for Window and Glass Block Assemblies.

20.6.2. All fire door assemblies and fire window assemblies shall bear an approved label from international and local approved test laboratories.

20.7. Fire Door Assemblies.

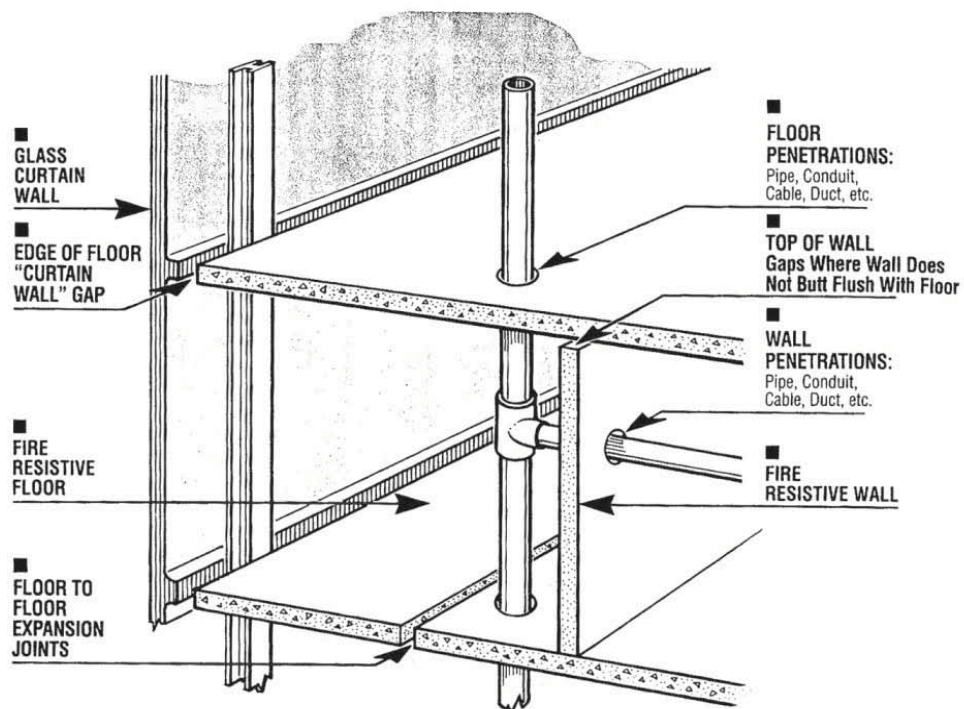
20.7.1. Opening protection in fire walls and fire barrier walls shall have a fire protection rating in accordance with [Table 1.10](#).

20.7.2. Fire door assemblies and fire window assemblies shall be installed in accordance with NFPA 80.



21. Fire Stopping

- 21.1.** The provision of this section shall specify the requirements for the Classification, Design, Installation, Inspection, Maintenance and Management of Firestop Systems to achieve required Fire-resistance-rated Construction and Compartmentalization.
- 21.2.** Firestop systems shall consist of a material, or combination of materials installed to retain the integrity of fire resistance rated construction by maintaining an effective barrier against the spread of flame, smoke and/or hot gases through penetrations, fire resistive joints, and perimeter openings in accordance with the requirements of the UAE Fire Code and other applicable International codes & standards referenced in this document.
- 21.3.** Firestop systems shall be used in locations including, but not limited to, the following:



- 21.3.1.** Penetrations through fire resistance rated floor and roof assemblies including both empty openings and openings containing penetrants.
- 21.3.2.** Penetrations through fire resistance rated wall assemblies including both empty openings and openings containing penetrants.



21.3.3. Membrane penetrations in fire resistance rated wall assemblies where items penetrate one side of the barrier.

21.3.4. Joints between fire resistance rated assemblies.

21.3.5. Perimeter gaps between rated floors/roofs and an exterior wall assembly.

21.4. Definitions

21.4.1. Firestopping

It is a general term for a passive fire protection system of various materials and components that are used to seal openings and joints in fire resistive wall and/or floor assemblies.

21.4.2. Firestop System

The use of a specific firestop material or combination of materials around a specific penetrant(s) or into a specific joint in conjunction with a specific wall and/or floor construction type.

21.4.3. Barrier

Any bearing or non-bearing wall or floor that has an hourly fire and smoke rating.

21.4.4. Through-penetration

The term is used to denote an opening in a fire rated wall or floor through which passes a mechanical, electrical, piping, structural, communication or other device.

21.4.5. Membrane-penetration

Any penetration in a fire-rated wall that breaches only one side of the barrier.

21.4.6. Fire Resistive Joint

Any gap, joint, or opening, whether static or dynamic, between two fire-rated barriers including where the top of a wall meets a floor; wall edge to wall edge configurations; floor edge to floor edge configurations; floor edge to wall configurations.

21.4.7. Perimeter Barrier

Any gap, joint, or opening, whether static or dynamic, between a fire-rated floor assembly and a non-rated exterior wall assembly.



21.4.8. Dynamic Joint

The linear opening or gap between adjacent fire resistant structures designed to allow independent movement of a building. A joint is designed into structures to accommodate movement in any plane caused by thermal, wind, seismic or other loading forces.

21.4.9. Static Joint

The linear opening or gap between adjacent fire resistant structures designed to not accommodate movement of a building.

21.4.10. 'F' Rating

The time, stated in hours, that a firestop system will prevent the passage of flame through an opening and not permit the projection of a water stream through a fire rated assembly, as determined by ASTM E-814, UL 1479, UL 2079 or other standards.

21.4.11. 'T' Rating

The period of time (in hours or 15 minute increments) a firestop system has been shown capable of keeping the unexposed surface of the firestop system and/or any penetrating items from exceeding a 3250 F (1630 C) temperature rise. This T rating also includes passage of F rating requirements for the same time period as determined by ASTM E 814, UL 1479 or other test standards (Please refer to [section 40](#) for acceptable alternative Test Standards).

21.4.12. 'L' Rating

The amount of air leakage through the fire rated assembly, determined by applying specified air pressure (0.30" water column) across the surface of the test assembly. The rating is expressed in cubic feet per minute (CFM) leakage per square foot of opening, as detailed in UL 1479 and UL 2079. An L rating is a measure of the ability of a fire-resistive assembly to prevent air passage through firestops, joint seals and other resistance rated assemblies. L ratings are obtained at ambient and/or elevated (400 OF / 205 OC) temperatures.

21.4.13. Tested and Listed System

Refers to materials, devices or assemblies that have been tested by an accredited testing laboratory after which the test results are published by an accredited quality assurance agency and the materials, devices or assemblies bear a Listing Label. Listed designs shall be provided for every firestop system.

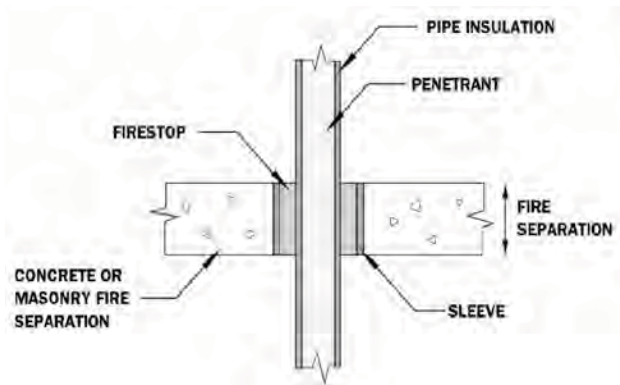


21.4.14. Engineering Judgment

An evaluation of a field condition which does not conform to an existing tested and listed firestop system.

21.5. Classification of Firestop systems**21.5.1. Through penetration firestop system**

- 21.5.1.1.** This category addresses openings in fire rated assemblies where penetrants are passing through a fire-rated construction and where the integrity of the wall and/or floor needs to be maintained.



- 21.5.1.2.** The penetrants include, but are not limited to, mechanical, electrical, piping, structural and communication devices.

Through Penetration Firestop System Ratings shall be established in accordance with ASTM E 814 or UL 1479 as the test method (Please refer to [section 40](#) for acceptable alternative Test Standards).

- 21.5.1.3.** The firestop system refers to all the necessary components in the approved firestop design, which can include but is not limited to the penetrant size, annular space, sealant depth, and other parameters in the listing.
- 21.5.1.4.** The rating of the firestop system shall be equivalent to the rating of the barrier in which the firestopping is installed.

21.5.2. Membrane-penetration

- 21.5.2.1.** This category addresses openings in fire rated assemblies where only one side of the fire rated barrier is penetrated and where the integrity of the wall or floor needs to be maintained. This would include items such as, but not be limited to, electrical outlet boxes and other electrical devices.

Membrane Firestop System Ratings shall be established in accordance with ASTM E119 as the test method (Please refer to [section 40](#) for acceptable alternative Test Standards).

- 21.5.2.2.** Membrane penetrations shall be permitted to be installed on both sides of the wall (or floor). If more than one (1) membrane penetration is installed in



the test assembly, the vertical and/or horizontal distance separating them shall be the minimum separating distance shown in any resulting listing.

21.5.3. Fire resistive joint systems

- 21.5.3.1.** This category addresses any gap, joint, or opening (whether static or dynamic) between two fire-rated barriers including where the top of a wall meets a floor; wall edge to wall edge configurations; floor edge to floor edge configurations; floor edge to wall configurations.

Fire Resistive Joint System Ratings shall be established in accordance with ASTM E 1966 or UL 2079 as the test method (Please refer to [section 40](#) for acceptable alternative Test Standards).

21.5.3.2.

- 21.5.3.3.** The system refers to all the necessary components in the approved firestop design, which can include but is not limited to the joint width, sealant or backing material depth, and other parameters in the listing.

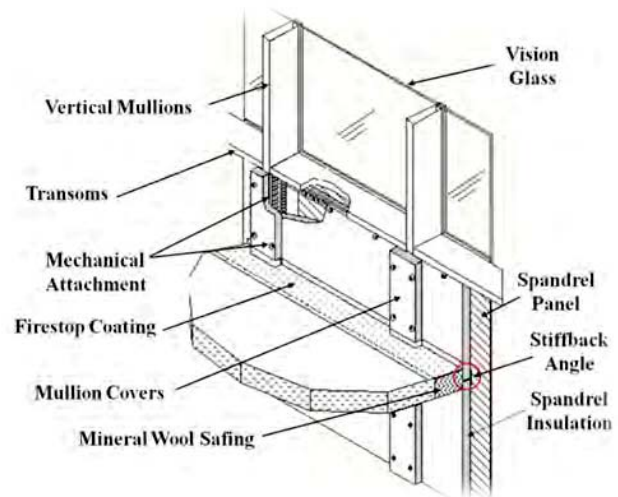
- 21.5.3.4.** The rating of the firestop system shall be equivalent to the rating of the two assemblies in which the firestopping is installed.

21.5.4. Perimeter fire barriers / External Curtainwall system

- 21.5.4.1.** This category addresses any gap, joint, or opening, whether static or dynamic, between a fire-rated floor assembly and a non-rated exterior wall assembly.

- 21.5.4.2.** Exterior curtain walls and perimeter joints shall be intended to restrict the interior vertical passage of flame and hot gases from one floor to another at the location where the floor intersects the inside of an exterior curtain wall assembly.

- 21.5.4.3.** A single or combination of materials used to create a firestop assembly at the perimeter gap between a fire resistance rated floor assembly and a non-resistance rated wall assembly, capable of preventing the spread of heat, fire, gases, smoke or other defined hazards through the opening in the wall and floor assembly.



Perimeter Fire Barrier System Ratings shall be established in accordance with ASTM E 2307 as the test method (Please refer to [section 40](#) for acceptable alternative Test Standards).

- 21.5.4.4.** The system refers to all the necessary components in the approved firestop design, which can include but is not limited to the gap size, sealant or backing material depth, and other parameters in the listing.
- 21.5.4.5.** The rating of the firestop system shall be equivalent to the rating of the floor in which the firestopping is installed.

21.6. Design & Selection of Firestop systems

21.6.1. Products

- 21.6.1.1.** All the products, as part of the system, shall bear design listing and approval label to conform to the construction type, penetrant type, annular space, joint gap and fire rating requirements of each separate assembly.
- 21.6.1.2.** Accessories – Fill material components for each firestop system shall be specified by the firestop product manufacturer as part of their design listed system. Accessories include, but are not limited to;
 - i. Permanent forming/damming/backing materials i.e. Mineral-wool Insulation, Foams, Sealants, Fire-rated Boards, PU Backer Rods etc.
 - ii. Temporary forming materials
 - iii. Substrate primers
 - iv. Steel sleeves
- 21.6.1.3.** Components of each firestop system shall be designed, tested, listed and approved according to referenced standards UL, BS, EN etc.

21.6.2. Submittal

- 21.6.2.1.** Product manufacturer/supplier shall provide a formal submittal to firestop installer that will consist of;
 - i. Product Data – Manufacturer's Specifications, Technical Data and Material Safety Data Sheet for each material including the composition and limitations, if any.
 - ii. Design Listings – System design listing, including illustrations, from an accredited testing laboratory as per referenced standards that is applicable to each firestop configuration.
 - iii. Engineering Judgment (EJ) – Where there is no specific tested and listed firestop system available for a particular configuration, the manufacturer will provide a site specific EJ. The EJ shall follow IFC Guidelines.
 - iv. Method Statement clearly defining the manufacturer's installation instructions.



21.6.3. Quality assurance

- 21.6.3.1.** Single Source Limitations: Firestop systems, for each kind of classified assembly, shall be obtained from a single manufacturer, where possible.
- 21.6.3.2.** Materials from different firestop manufacturers shall not be installed in the same firestop system or opening.
- 21.6.3.3.** Firestopping systems shall be flexible to allow movement as required by the firestop assembly and construction conditions (where applicable. Please refer to .sections 21.4.8 and 21.4.9).
- 21.6.3.4.** Firestopping materials shall not crack or pull back from contact surfaces such that a void is created.
- 21.6.3.5.** Firestopping materials shall be moisture resistant, and may not dissolve in water after curing.

21.7. Delivery, storage, and handling

- 21.7.1.** Firestop products shall be delivered to project site in original, unopened containers or packages with intact and legible manufacturer's labels identifying product name, product manufacturer, manufacturing and expiry dates, lot number, design listing and classification marking.
- 21.7.2.** Products shall be stored and handled as per manufacturer's instructions to prevent deterioration or damage due to moisture, temperature changes, contaminants, or other causes.
- 21.7.3.** All firestop materials shall be installed prior to expiration of shelf life.

21.8. Examination & preparation

- 21.8.1.** General conditions of substrates, opening configurations, penetrating items, joint gaps, and other conditions affecting performance shall be thoroughly examined.
- 21.8.2.** Installation shall commence only after unsatisfactory conditions have been corrected.
- 21.8.3.** The installer shall verify that all pipes, conduits, cables, and/or other items which penetrate fire-rated construction have been permanently installed before starting firestop installation.
- 21.8.4.** Surface Cleaning: Installer shall clean out openings before installing firestop systems to comply with written recommendations of firestopping manufacturer.



21.9. Project conditions (environmental limitations)

- 21.9.1.** Firestop shall be installed when ambient or substrate temperatures are within limits as per manufacturer's written instructions.
- 21.9.2.** Do not install firestopping when substrates are uncured, wet due to rain, frost, condensation, or other causes.
- 21.9.3.** Installer shall ensure that firestop materials are installed so as not to contaminate adjacent surfaces.
- 21.9.4.** Ventilation shall be as per the manufacturer's Material Safety Data Sheet.

21.10. Installation**21.10.1. Installer qualification**

- 21.10.1.1.** An acceptable installer is certified. To be certified, the installer shall be licensed by Civil Defence and qualified by the fire stopping manufacturer as having been provided the necessary training to install manufacturer's products as per specified requirements.

21.10.2. Installation – 'Through penetration firestop systems'

- 21.10.2.1.** Installation of through penetration firestop systems shall be performed by an installer qualified under "Installer Qualification".
- 21.10.2.2.** Installer shall provide and install through penetration firestop systems that have been tested as per ASTM E 814, UL 1479 or other test standards (Please refer to section 40 for acceptable alternative Test Standards). in a configuration that is representative of field conditions.
- 21.10.2.3.** Installer shall strictly follow design listed system including illustrations therein and manufacturer's installation instruction.
- 21.10.2.4.** 'F' Rating of the system shall be established in accordance with ASTM E 814, UL 1479 or other test standards (please refer to section 40 for alternative Test Standards).but not less than the fire resistance rating of the barrier being penetrated.
- 21.10.2.5.** 'T' Rating of the system shall be determined as per ASTM E 814, UL 1479, or other test standards (please refer to section 40 for alternative Test Standards). where required by the Building and Fire Codes.
- 21.10.2.6.** For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
- 21.10.2.7.** For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.



21.10.3. Installation – ‘Fire resistive joint systems’

- 21.10.3.1.** Installation of firestopping for fire resistive joints shall be performed by an installer qualified under "Installer Qualification".
- 21.10.3.2.** Installer shall provide and install fire resistive joint systems that have been tested as per ASTM E 1966, UL 2079 or other test standards (Please refer to [section 40](#) for acceptable alternative Test Standards). to achieve required fire ratings, but not less than the fire resistance rating of the construction in which the joint occurs.
- 21.10.3.3.** Installer shall strictly follow design listed system including illustrations therein and manufacturer’s installation instruction.
- 21.10.3.4.** Firestopping assemblies shall be capable of withstanding anticipated movements for the installed field conditions as determined by and ASTM E 1399 or other test standards (Please refer to [section 40](#) for acceptable alternative Test Standards).
- 21.10.3.5.** For firestopping assemblies exposed to view, traffic, moisture, and physical damage, installer shall provide firestop systems that do not deteriorate after curing under these conditions both during and after construction.
- 21.10.3.6.** For floor penetrations exposed to possible loading and traffic, installer shall provide firestop systems capable of supporting floor loads involved either by installing floor plates or by other means.

21.10.4. Installation – ‘Curtainwall / Perimeter fire barrier systems’

- 21.10.4.1.** Installation of perimeter barrier firestop systems shall be performed by an installer qualified under "Installer Qualification".

Installer shall provide and install perimeter fire barrier systems that have been tested as per ASTM E 2307 or other test standards (Please refer to [section 40](#) for acceptable alternative Test Standards). to achieve required fire ratings.
- 21.10.4.2.** Installer shall strictly follow design listed system including illustrations therein and manufacturer’s installation instruction.
- 21.10.4.3.** Perimeter fire barrier system accessories i.e. metal framing, curtain wall insulation, mechanical attachments, safing materials, and firestop materials shall be installed as applicable within the design listed system.

21.11. Coordination

- 21.11.1.** Coordinate construction of openings, joints and penetrating items with all trades and sub-trades to ensure that firestopping assemblies are installed according to specified requirements.



- 21.11.2. Schedule firestopping after installation of penetrants but prior to concealing the openings and joints.
- 21.11.3. Do not conceal firestopping installations until the owner's inspection agency or Authorities Having Jurisdiction have inspected each installation.

21.12. Identification

- 21.12.1. Identify installed firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:
 - i. The words "**Warning – Through-Penetration Firestop System--Do Not Disturb. Notify Building Management of Any Damage.**"
 - ii. Firestop product name with System listing number.
 - iii. Name and address of Manufacturer, Installer and Inspection Agency.
 - iv. Installation date.
- 21.12.2. Labels and markings may be omitted if they would be visible in a finished area with the written authorization of the Authority Having Jurisdiction.

21.13. Inspection

21.13.1. Through penetration firestop systems

Inspection of through penetration firestop systems through fire rated floor and wall assemblies shall be in accordance with ASTM E 2174, *Standard Practice for On-Site Inspection of Installed Fire Stops*.

21.13.2. Fire resistive joint systems and Curtainwall/ Perimeter fire barriers

Inspection of fire resistive joints and perimeter barriers shall be in accordance with ASTM E 2393, *Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers*.

21.14. Field Quality Control

- 21.14.1. Inspection of completed installations of firestop systems shall take place in successive stages as installation of firestop systems proceeds.
- 21.14.2. The Contractor shall cooperate fully and, when requested, permit samples of materials to be taken from original packaging as the materials are applied to building surfaces.



- 21.14.3.** Do not proceed with installation of firestop systems for the next area until inspecting agency determines completed work shows compliance with requirements.
- 21.14.4.** The independent inspection agency shall inspect firestop systems, conduct material evaluation and application tests and prepare inspection reports.
- 21.14.5.** Inspection agency shall state in each report whether inspected firestop systems comply with or deviate from requirements.
- 21.14.6.** Proceed with enclosing firestop systems with other construction only after inspection reports are issued and firestop systems comply with requirements.

21.15. Maintenance & Management

- 21.15.1.** Provide final protection and maintain conditions during and after installation that ensure firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated firestop systems immediately and install new materials to produce firestop systems complying with specified requirements.
- 21.15.2.** The required fire-resistance rating of installed firestop systems shall be visually inspected by the owner or owner's inspection agency annually. Damaged, altered or breached firestop systems shall be properly repaired, restored or replaced to comply with applicable codes as per the guidelines of Civil Defense.
- 21.15.3.** Any new openings made therein for passage of through penetrants shall be protected with approved firestop system to comply with applicable codes as per the guidelines of Civil Defense.

22. Ducts and Air-Transfer Openings

22.1. Fire Damper Requirements

- 22.1.1.** Fire dampers shall be installed to protect ducts and air-transfer openings that penetrate fire barriers and fire walls.
- 22.1.2.** Fire dampers shall be designed and tested in accordance with the requirements of UL 555 or EN 1366-2, Standard for Fire Dampers, and shall have the minimum fire protection rating specified in **Table 1.11** for the rating of the assembly penetrated.

22.1.3. Table 1.11: Fire Damper Rating

FIRE RESISTANCE RATING OF ASSEMBLY	MINIMUM FIRE DAMPER RATING
3 hour or greater fire resistance rated assemblies	3
Less than 3 hours fire resistance rated assemblies	1½
Ceiling of floor-ceiling or roof-ceiling assemblies	Same rating as of assemblies



22.1.4. Fire dampers shall be required in the following locations:

- i. Ducts and air-transfer openings penetrating walls or partitions having a fire resistance rating of 2 or more hours.
- ii. Ducts and air-transfer openings penetrating shaft walls having a fire resistance rating of 1 or more hours.
- iii. Ducts and air-transfer openings penetrating floors that are required to have protected openings where the duct is not protected by a shaft enclosure.
- iv. Air-transfer openings that occur in walls or partitions that are required to have a fire-resistive rating of 30 minutes or more.

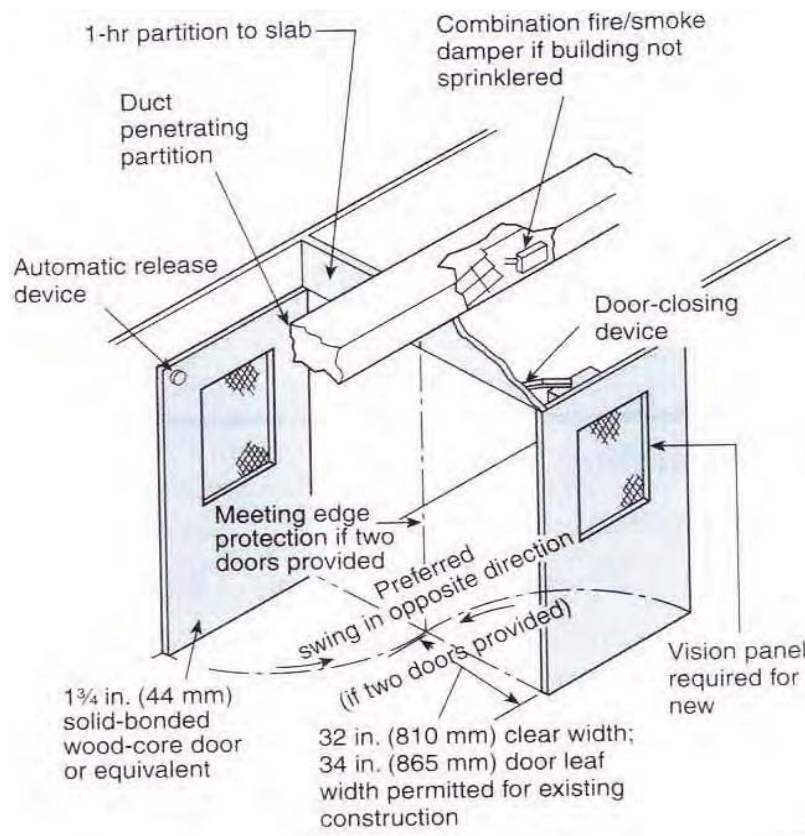


Figure 1.12: Example of Smoke and Fire Damper application

22.1.5. Fire dampers shall not be required in the following locations:

- i. In floors that do not require protected floor openings

- ii. In a duct system serving only one floor and used only for exhaust of air to the outside and not penetrating a wall or partition having a required fire resistance rating of 2 hours or more or passing entirely through the system and contained within its own dedicated shaft. See [Figure 1.13](#).
- iii. Where branch ducts connect to enclosed exhaust risers in which the airflow is upward, and steel sub ducts at least 560 mm in length are carried up inside the riser at each inlet.
- iv. In fire pump room.
- v. In standby generator room.

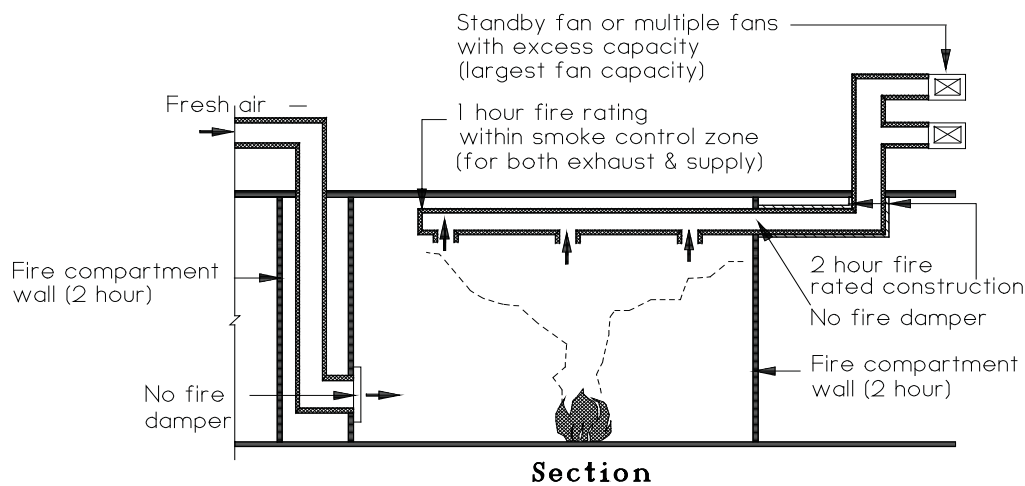


Figure 1.13: Penetrations of ventilation ducts for exhaust and supply air

22.2. Installation

- 22.2.1.** Air-conditioning, heating, and ventilating ductwork and related equipment, including fire dampers, smoke dampers, combination fire and smoke dampers, and ceiling radiation dampers, shall be installed in accordance with NFPA 90A or NFPA 90B, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

22.3. Access and Identification

- 22.3.1.** Fire and smoke dampers shall be provided with an approved means of access, as follows:



- i. The means of access shall be large enough to allow inspection and maintenance of the damper and its operating parts.
- ii. The access shall not affect the integrity of fire resistance-rated assemblies.
- iii. The access openings shall not reduce the fire resistance rating of the assembly.
- iv. Access points shall be permanently identified.
- v. Access doors in ducts shall be identified with a label having letters not less than 13 mm in height.
- vi. The label shall read as follows in:
 - a. FIRE/SMOKE DAMPER
 - b. SMOKE DAMPER
 - c. FIRE DAMPER
- vii. Access doors in ducts shall be tight-fitting and suitable for the required duct construction.

22.4. Fire Damper Actuation Device.

- 22.4.1.** The operating temperature of the heat-actuating device shall be approximately 27.8°C above the normal temperature within the duct system, but not less than 71°C; or it shall be not more than 141°C where located in a required smoke control system; or, where a combination fire and smoke damper is installed, it shall not exceed 177°C where located in a smoke control system.

23. Smoke Barriers

- 23.1.** Smoke barriers required by this Code shall be continuous from an outside wall to an outside wall, from a floor to a floor, or from a smoke barrier to a smoke barrier, or a combination thereof.
- 23.2.** Smoke barriers required by this Code shall be continuous through all concealed spaces, such as those found above a ceiling, including interstitial spaces.
- 23.3.** A smoke barrier required for an occupied space below an interstitial space shall not be required to extend through the interstitial space, provided that the construction assembly forming the bottom of the interstitial space provides resistance to the passage of smoke equal to that provided by the smoke barrier.
- 23.4.** Where a smoke barrier is penetrated by a duct or air-transfer opening, a smoke damper designed and tested in accordance with the requirements of UL 555S or EN 1366-10 shall be installed.
- 23.5.** Where a smoke barrier is also constructed as a fire barrier, a combination fire/smoke damper designed and tested in accordance with the requirements of UL 555 and UL 555S or EIS Fire Dampers as per EN 1366-2 shall be installed.



24. Smoke barrier Penetrations

- 24.1.** Penetrations for cables, cable trays, conduits, pipes, tubes, vents, wires, and similar items to accommodate electrical, mechanical, plumbing, and communications systems that pass through a wall, floor, or floor-ceiling assembly constructed as a smoke barrier, or through the ceiling membrane of a roof-ceiling of a smoke barrier, shall be protected by a listed system or a material capable of restricting the transfer of smoke.
- 24.2.** Where a smoke barrier is also constructed as a fire barrier, the penetrations shall be protected to limit the spread of fire for a time period equal to the fire resistance rating of the assembly, to restrict the transfer of smoke.
- 24.3.** Where sprinklers penetrate a single membrane of a fire resistance-rated assembly in buildings equipped throughout with an approved automatic fire sprinkler system, non-combustible escutcheon plates shall be permitted, provided that the space around each sprinkler penetration does not exceed $\frac{1}{2}$ in. (13 mm), measured between the edge of the membrane and the sprinkler.
- 24.4.** Where the penetration item uses a sleeve to penetrate the smoke barrier, the sleeve shall be securely set in the smoke barrier, and the space between the item and the sleeve shall be filled with a listed system or a material capable of restricting the transfer of smoke.
- 24.5.** Where designs take transmission of vibrations into consideration, any vibration isolation shall meet one of the following conditions:
 - i. It shall be made on either side of the fire barrier.
 - ii. It shall be designed for the specific purpose.

See **Figure 1.12**, **1.14** and **Figure 1.15** for penetration through fire and smoke barrier.

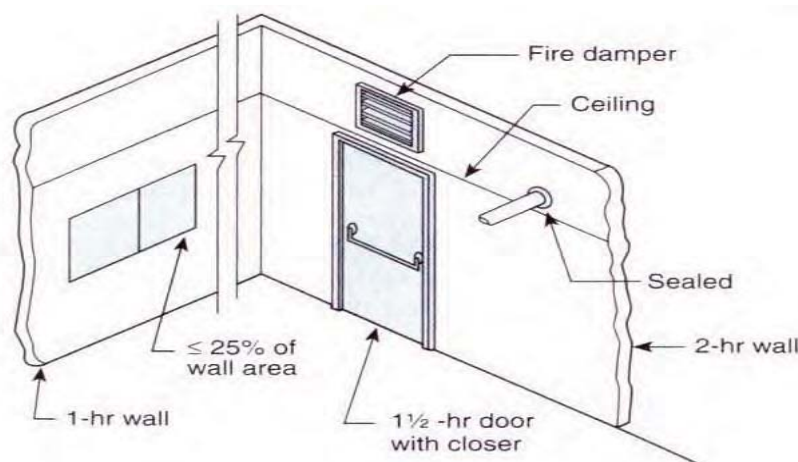


Figure 1.14: Penetration through fire barrier



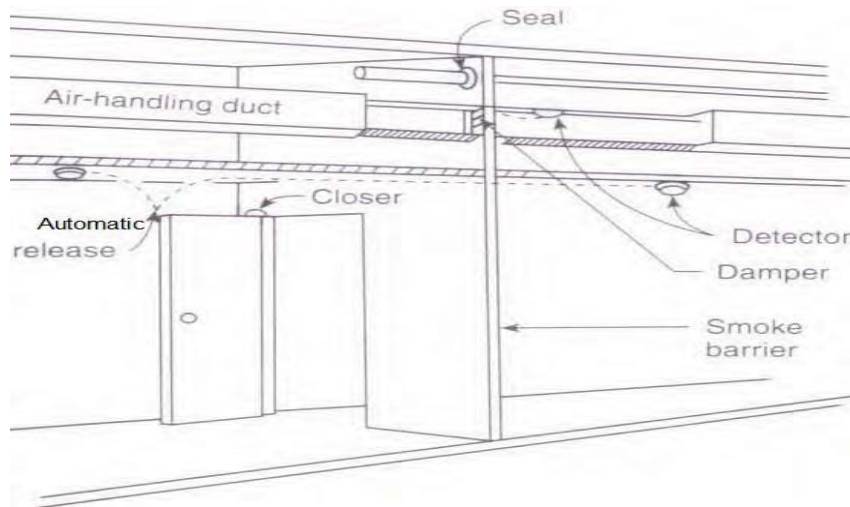


Figure 1.15: Penetration through smoke barrier

25. Smoke Damper Exceptions

25.1. Smoke dampers shall not be required in the following:

- i. Where ducts or air-transfer openings are part of an engineered smoke control system and the smoke damper will interfere with the operation of a smoke control system.
- ii. Where the air in ducts continues to move and the air-handling system installed is arranged to prevent recirculation of exhaust or return air under fire emergency conditions.
- iii. Where the air inlet or outlet openings in ducts are limited to a single smoke compartment
- iv. Where ducts penetrate floors that serve as smoke barriers

25.1.2. Smoke Damper Ratings.

- i. Smoke damper leakage ratings shall be not less than Class II as per UL 555S or $200 \text{ m}^3/(\text{h} \cdot \text{m}^2)$ as per EN 1366-10.
- ii. Elevated temperature ratings shall be not less than 250°F (140°C).

25.2. Smoke Detectors

Required smoke dampers in ducts penetrating smoke barriers shall close upon detection of smoke by means of approved smoke detectors, unless ducts penetrate smoke barriers above the smoke barrier doors and the door release detector actuates the damper.



- 25.3.** Required smoke dampers in air-transfer openings shall close upon detection of smoke by means of approved smoke detectors.

26. Vertical Openings

- 26.1.** Openings through floors shall be enclosed with fire barrier walls, shall be continuous from floor to floor or floor to roof, and shall be protected as appropriate for the fire resistance rating of the barrier.
- 26.2.** Shafts shall be permitted to terminate in a room or space having a use related to the purpose of the shaft, provided that the room or space is separated from the remainder of the building by construction having a fire resistance rating and opening protection.
- 26.3.** Shafts that do not extend to the bottom or top of the building or structure shall be permitted to be protected by approved fire dampers installed in accordance with their listing at the lowest or highest floor level, as applicable, within the shaft enclosure.
- 26.4.** The fire resistance rating for the enclosure of floor openings shall be not less than as follows:
- Enclosures connecting four stories or more shall be 2-hour fire barriers.
 - Enclosures connecting three stories or less shall be 1-hour fire barriers, but not less than the required fire resistance rating of the floor penetrated, and shall not be required to exceed 2 hours.
 - Enclosures for exits and Exit Passageways serving 4 floors and above shall be 2 hours fire rated and 1 hour fire rated for below 4 floors. See [Figure 1.16](#) for illustrations.

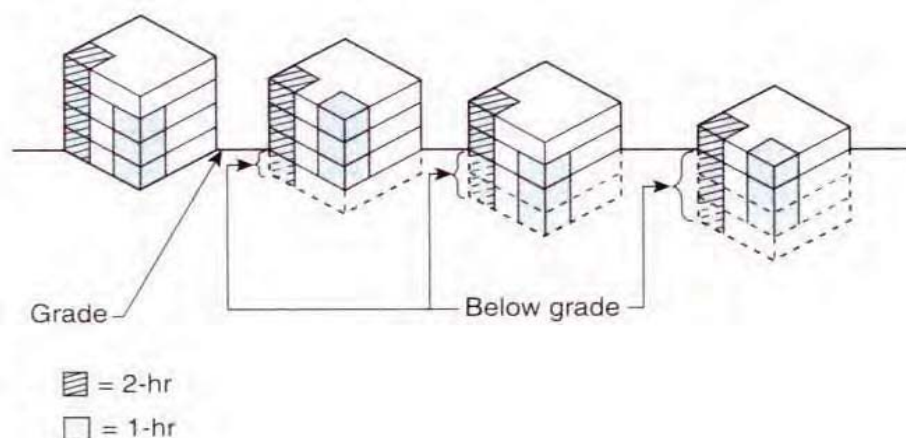
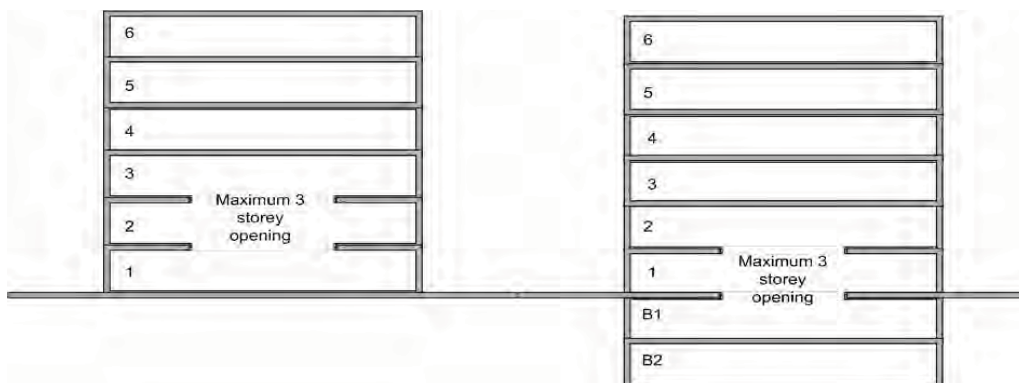


Figure 1.16: Fire rating for vertical opening enclosures



27. Communicating Space

- 27.1.** Unenclosed floor openings forming a communicating space between floor levels shall be permitted, provided that the following conditions are met:
- The communicating space does not connect more than three contiguous stories.
 - The lowest or next to lowest story within the communicating space is a street floor.
 - The entire floor area of the communicating space is open and unobstructed, such that a fire in any part of the space will be readily obvious to the occupants of the space prior to the time it becomes an occupant hazard.
- 27.2.** The communicating space is separated from the remainder of the building by fire barriers with not less than a 1-hour fire resistance rating, unless one of the following is met:
- In buildings protected throughout by an approved automatic sprinkler system and a smoke barrier.
 - Shall not apply to fully sprinklered residential housing units of detention and correctional occupancies.
- 27.3.** The communicating space has ordinary hazard contents protected throughout by an approved automatic sprinkler system or has only low hazard contents.
- 27.4.** Egress capacity is sufficient to provide for all the occupants of all levels within the communicating space to simultaneously egress the communicating space by considering it as single floor area in determining the required egress capacity.
- 27.5.** Each occupant within the communicating space has access to not less than one exit without having to traverse another story within the communicating space.
- 27.6.** Each occupant not in the communicating space has access to not less than one exit without having to enter the communicating space. See [Figure 1.17](#) for illustrations.



Elevation



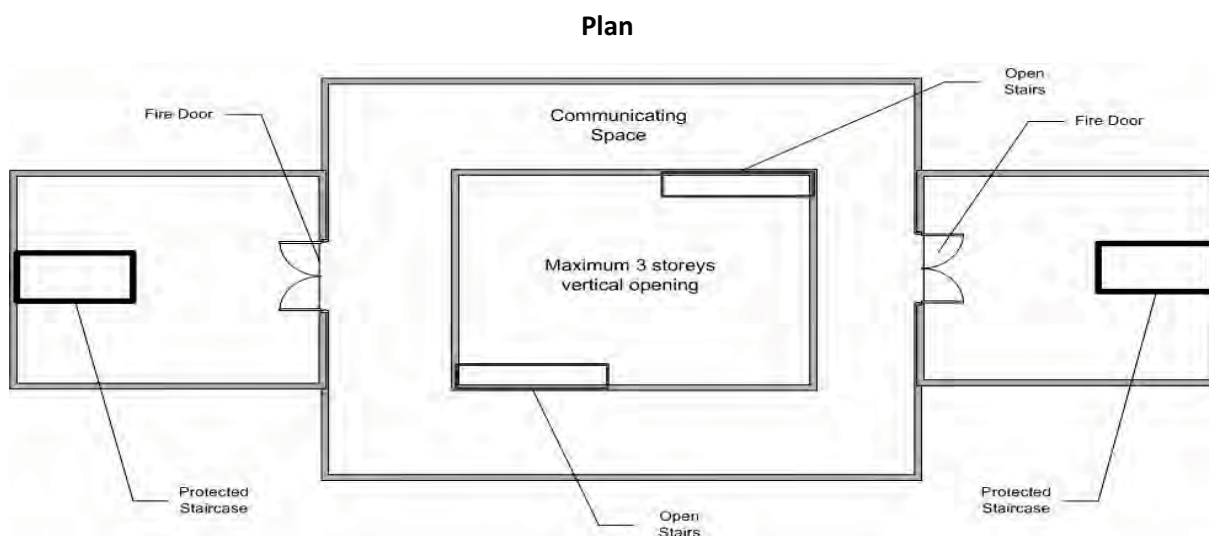


Figure 1.17: Example of Communicating Space

28. Atrium

28.1. An atrium shall be permitted, provided that the following conditions are met:

28.2. The atrium is separated from the adjacent spaces by fire barriers with not less than a 1-hour fire resistance rating with opening protection for corridor walls, unless one of the following criteria is met:

28.2.1. Any number of levels of the building shall be permitted to open directly to the atrium without enclosure based on the results of the engineering analysis.

28.2.2. Glass walls and inoperable windows shall be permitted in lieu of the fire barriers where all of the following criteria are met:

- i. Automatic sprinklers (window type sprinklers for maintaining fire rating only) shall be spaced along both sides of the glass wall and the inoperable window at intervals not to exceed 1830 mm.
- ii. The automatic sprinklers shall be located at a distance from the glass not to exceed 305 mm and shall be arranged so that the entire surface of the glass is wet upon operation of the sprinklers.
- iii. The glass shall be tempered, wired, or laminated glass held in place by a gasket system that allows the glass framing system to deflect without breaking (loading) the glass before the sprinklers operate.
- iv. The automatic sprinklers shall not be required on the atrium side of the glass wall and the inoperable windows where there is no



walkway or other floor area on the atrium side above the main floor level.

- v. Doors in glass walls shall be glass or other material that restricts the passage of smoke.
- vi. Doors shall be self-closing or automatic-closing upon detection of smoke.

28.3. Access to exits is permitted to be within the atrium and exit discharge is also permitted to be in the atrium if following conditions are met:

- i. The occupancy within the space meets the specifications for classification as low or ordinary hazard contents.
- ii. The entire building is protected throughout by an approved, supervised automatic sprinkler system.

28.4. An engineering analysis should be performed which demonstrates that the building is designed to keep the smoke layer interface above the highest unprotected opening to adjoining spaces, 1830 mm above the highest floor level of exit access open to the atrium for a period equal to $1\frac{1}{2}$ times the calculated egress time or 20 minutes, whichever is greater.

28.5. An engineered smoke control system is installed to also be independently activated by each of the following:

28.5.1. Upon actuation of the required automatic sprinkler system within the atrium or areas open to the atrium.

28.5.2. Manual controls that are readily accessible to the fire department.

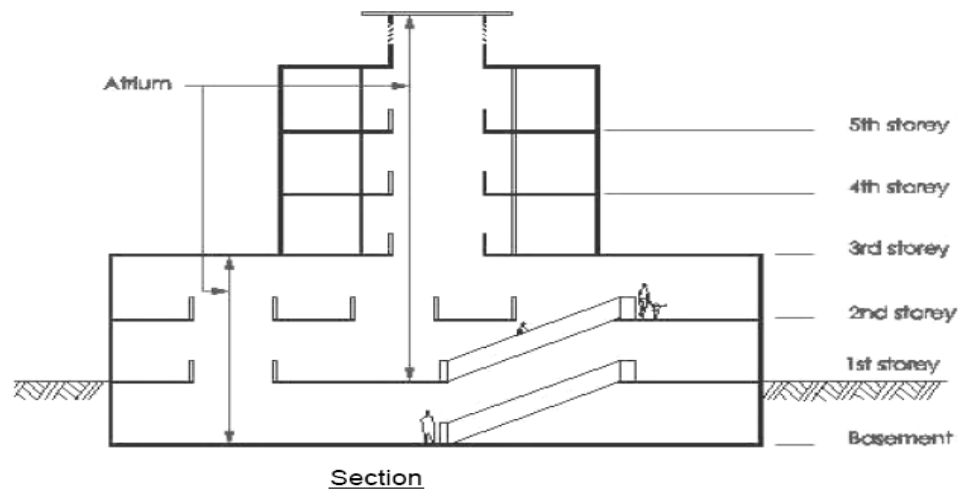


Figure 1.18: Example of Atrium



29. Convenience Openings

- 29.1.** A vertical opening serving as other than an exit enclosure, connecting only two adjacent stories, and piercing only one floor shall be permitted to be open to one of the two stories.
- 29.2.** Where permitted, unenclosed vertical openings not concealed within the building construction shall be permitted as follows:
- Such openings shall connect not more than two adjacent stories (one floor pierced only).
 - Such openings shall be separated from unprotected vertical openings serving other floors by a fire and smoke barriers.
 - Such openings shall be separated from corridors.
 - Such openings shall not serve as a required means of egress.

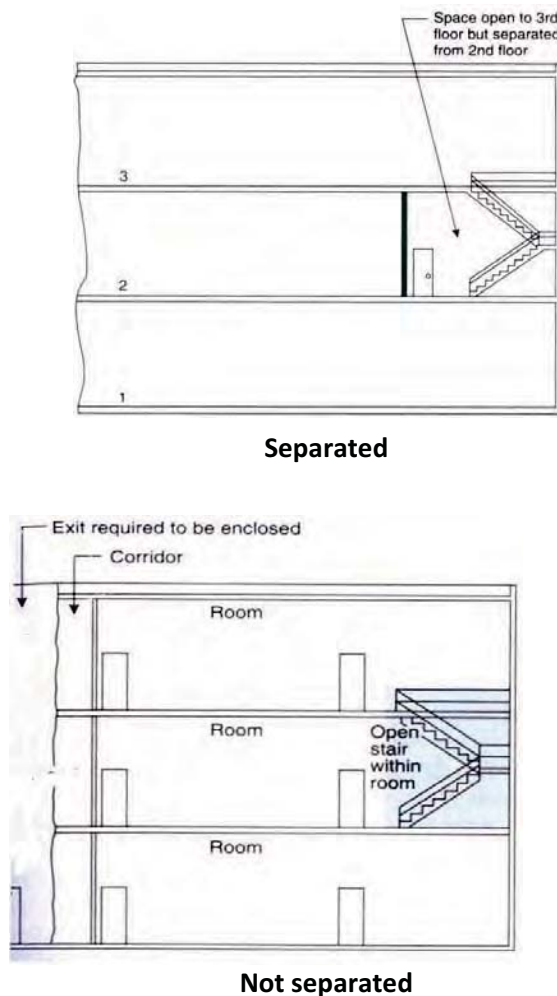
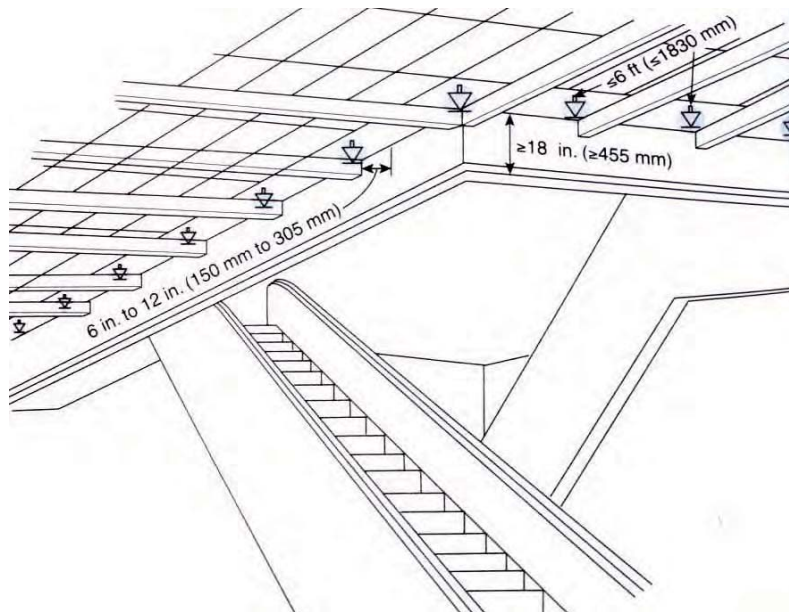


Figure 1.19: Example of Convenience Opening

30. Service Openings

- 30.1.** Service openings for conveyors, where required to be open on more than one story at the same time for purposes of operation, shall be provided with closing devices.
- 30.2.** Moving walks not constituting an exit, and escalators, shall have their floor openings enclosed or protected as required for other vertical openings
- 30.3.** In buildings protected throughout by an approved automatic sprinkler system, escalators or moving walk openings shall be permitted to be protected in accordance with the sprinkler-draft curtain method.



Sprinkler and draft curtain used in escalator opening

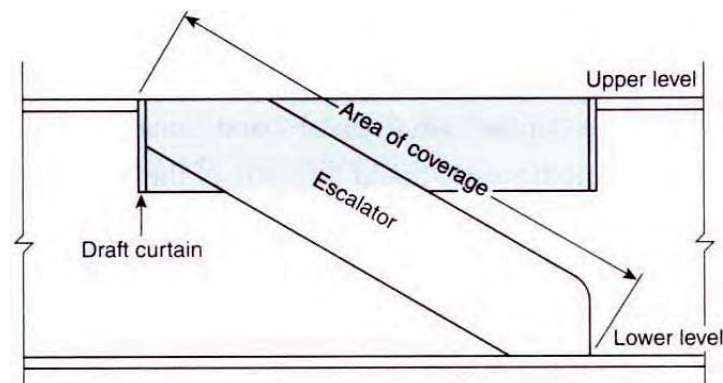


Figure 1.20: Example of Sprinkler-Draft Curtain used in service opening.

30.4. In buildings protected throughout by an approved automatic sprinkler system, escalators or moving walk openings shall be permitted to be protected by rolling steel shutters appropriate for the fire resistance rating of the vertical opening protected, and the following criteria shall be met:

30.4.1. The shutters shall close automatically and independently of each other upon smoke detection and sprinkler operation.

30.4.2. There shall be a manual means of operating and testing the operation of the shutter.

30.4.3. The shutters shall be operated not less than once a week to ensure that they remain in proper operating condition.

30.4.4. The shutters shall operate at a speed not to exceed 30 ft/min (0.15 m/s) and shall be equipped with a sensitive leading edge.

30.4.5. The leading edge shall arrest the progress of a moving shutter and cause it to retract a distance of approximately 6 in. (150 mm) upon the application of a force not exceeding 20 lbf (90 N) applied to the surface of the leading edge.

30.4.6. The shutter, following the retraction, shall continue to close.

30.4.7. The operating mechanism for the rolling shutter shall be provided with standby power.

31. Elevator Hoist way

31.1. The number of elevator cars permitted in a hoist way shall be as follows:

31.1.1. Where four or more cars serve the entire same portion of a building, the elevators shall be located in at least 2 separate hoist ways.

31.1.2. Not more than 4 elevators cars shall be located in one single hoist way enclosure.

31.1.3. Hoist way enclosure shall be at least 1 hour fire rated unless not required such as in atriums, communicating space, convenience openings or hoist way facing external facade.

32. Mezzanine

32.1. A mezzanine shall not be included as a story for the purpose of determining the allowable number of stories in a building.



32.2. Area Limitations.

32.2.1. The aggregate area of mezzanines within a room, other than those located in special-purpose industrial occupancies, shall not exceed one-third the open area of the room in which the mezzanines are located. See **Figure 1.21** for illustration.

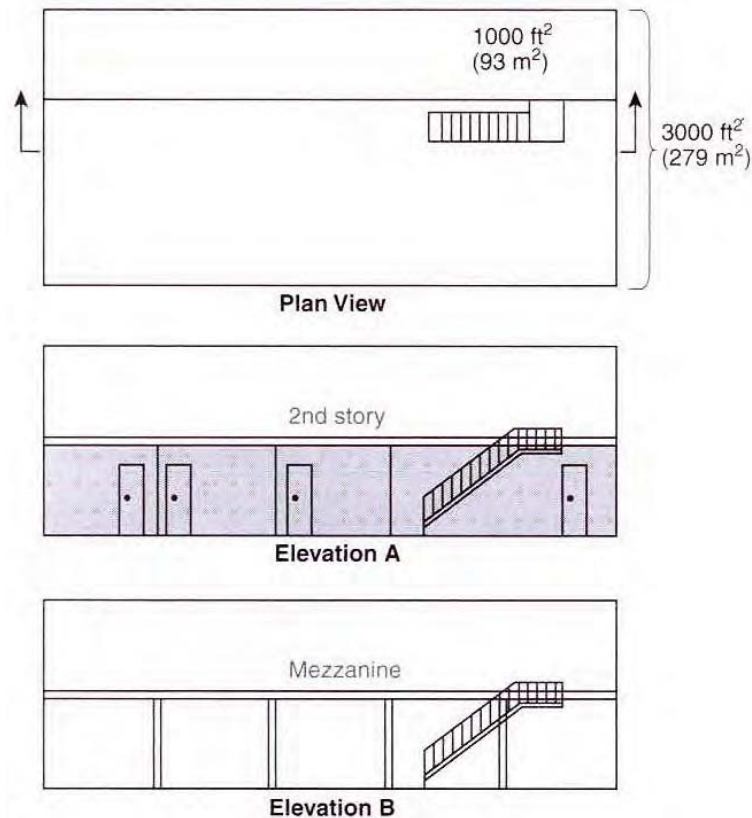


Figure 1.21: Area limitation for mezzanine

32.2.2. Enclosed space shall not be included in a determination of the size of the room in which the mezzanine is located.

32.2.3. There shall be no limit on the number of mezzanines in a room.

32.2.4. For purposes of determining the allowable mezzanine area, the area of the mezzanines shall not be included in the area of the room.

32.3. Openness

32.3.1. All portions of a mezzanine, other than walls not more than 1065 mm high, columns, and posts, shall be open to an unobstructed exit from the room in which the



mezzanine is located, unless the occupant load of the aggregate area of the enclosed space does not exceed 10.

- 32.3.2.** A mezzanine having two or more means of egress shall not be required to open into the room in which it is located if not less than one of the means of egress provides direct access from the enclosed area to an exit at the mezzanine level. See [Figure 1.22](#) and [1.23](#) for illustrations.

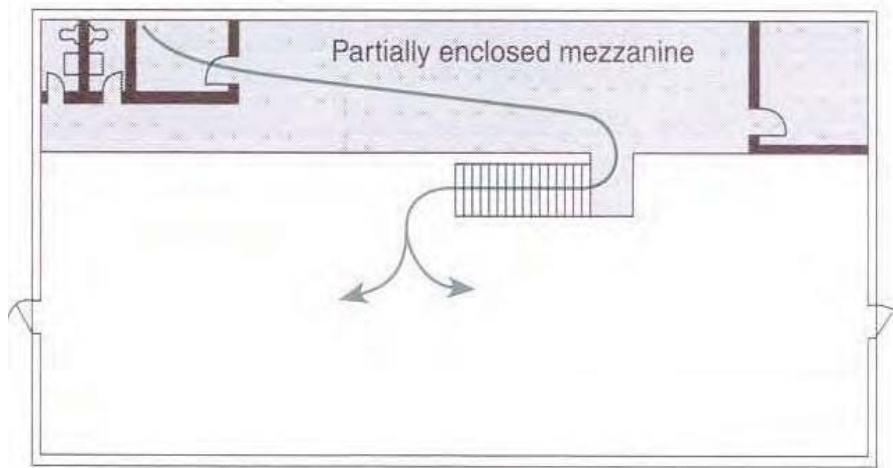


Figure 1.22: Partially enclosed mezzanine

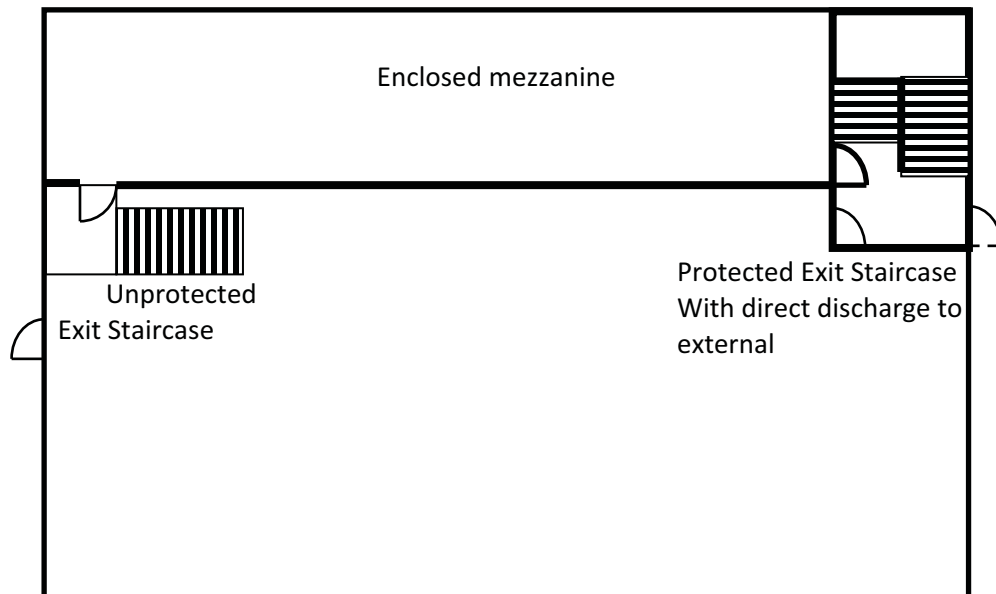


Figure 1.23: Fully Enclosed Mezzanine



33. Concealed Spaces

33.1. Draft Stops

33.1.1. Any concealed combustible space in which building materials having a flame spread index greater than Class A are exposed shall be draft stopped as follows:

- i. Every unoccupied attic space shall be subdivided by draft stops into areas not to exceed 280 m².
- ii. Any concealed space between the ceiling and the floor or roof above shall be draft stopped for the full depth of the space along the line of support for the floor or roof structural members and, if necessary, at other locations to form areas not to exceed 93 m² for any space between the ceiling and floor and 280 m² for any space between the ceiling and roof.

33.1.2. The above requirements shall not apply if either of the following conditions is met:

- i. The requirements shall not apply where the concealed space is protected throughout by an automatic sprinkler system.
- ii. The requirements shall not apply to concealed spaces serving as plenums.
- iii. Draft stopping materials shall be not less than 13 mm gypsum board or other approved materials adequately supported. The integrity of all draft stops shall be maintained.

33.2. Combustibles in Concealed Spaces

33.2.1. Combustible materials shall not be permitted within the concealed spaces of buildings classified as Type I or Type II construction and within walls required to be constructed of noncombustible or limited-combustible materials.

34. Interior Wall and Ceiling Finish Requirements

34.1. Materials applied, in total thickness of less than in. (0.90 mm), directly to the surface of walls and ceilings shall not be considered interior finish and shall be exempt from tests simulating actual installation if they meet the requirements of Class A interior wall or ceiling finish when tested accordingly.

34.2. Fixed or movable walls and partitions, paneling, and wall pads and crash pads, applied structurally or for decoration, acoustical correction, surface insulation, or other



purposes, shall be considered interior finish and shall not be considered decorations or furnishings.

34.3. Use of Interior Finishes.

Table 1.12: Interior Finish Classification Limitations

OCCUPANCY	EXITS	EXIT ACCESS CORRIDORS	OTHER SPACES
Assembly > 300 Occupant Load	A 1 or 2	A or B 1 or 2	A or B
Assembly ≤ 300 Occupant Load	A 1 or 2	A or B 1 or 2	A, B or C
Educational	A 1 or 2	A or B 1 or 2	A or B; C for low partitions
Day Care Centers	A 1 or 2	A 1 or 2	A or B
Day Care Homes	A or B 1 or 2	A or B	A, B or C
Health Care	A 1 or 2	A (B, on lower portion of corridor) 1 or 2	A (B, in small individual rooms)
Detention and Correctional	A or B 1 or 2	A or B 1 or 2	A, B or C
One-and-Two Family Dwelling, Lodging and Rooming House	A, B or C	A, B or C	A, B or C
Hotels and Dormitories	A 1 or 2	A or B 1 or 2	A, B or C
Apartment Buildings	A 1 or 2	A or B 1 or 2	A, B or C
Residential Board and Care	A 1 or 2	A 1 or 2	A or B
Mercantile	A or B 1 or 2	A or B	A or B
Business and Ambulatory Health Care	A or B 1 or 2	A or B	A, B or C
Industrial	A or B 1 or 2	A, B or C 1 or 2	A, B or C
Storage	A or B 1 or 2	A, B or C	A, B or C



35. Interior Wall or Ceiling Finish Testing and Classification

35.1. Interior wall or ceiling finish that is required elsewhere in this Code to be Class A, Class B, or Class C shall be classified based on test results from NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials, or ASTM E 84, Standard Test Method of Surface Burning Characteristics of Building Materials.

35.2. Fire-retardant coatings shall not be used to obtain compliance with the interior finish requirements of this Code.

35.3. Class A Interior Wall and Ceiling Finish

35.3.1. Class A interior wall and ceiling finishes shall be those finishes with a flame spread of 0–25 and smoke development of 0–450 and shall include any material classified at 25 or less on the flame spread test scale and 450 or less on the smoke test scale. Any element thereof, when so tested, shall not continue to propagate fire.

35.4. Class B Interior Wall and Ceiling Finish

35.4.1. Class B interior wall and ceiling finishes shall be those finishes with a flame spread of 26–75 and smoke development of 0–450 and shall include any material classified at more than 25 but not more than 75 on the flame spread test scale and 450 or less on the smoke test scale.

35.5. Class C Interior Wall and Ceiling Finish

35.5.1. Class C interior wall and ceiling finishes shall be those finishes with a flame spread of 76–200 and smoke development of 0–450 and shall include any material classified at more than 75 but not more than 200 on the flame spread test scale and 450 or less on the smoke test scale.

35.6. Interior wall and ceiling finish tested in accordance with NFPA 286, Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth, and meeting the conditions of clause 37.10, shall be permitted to be used where a Class A classification in accordance with NFPA 255 or ASTM E 84 is required.

35.7. Wherever the use of Class C interior wall and ceiling finish is required, Class A or Class B shall be permitted. Where Class B interior wall and ceiling finish is required, Class A shall be permitted.

35.8. Products tested in accordance with NFPA 265, Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile Coverings on Full Height Panels and Walls, shall comply with the criteria of clause 37.9. Products tested in accordance with NFPA 286 shall comply with the criteria of clause 37.10.



35.9. Products shall be tested using the method B test protocol of NFPA 265. The following conditions shall be met:

- i. Flame shall not spread to the ceiling during the 40 kW exposures.
- ii. During the 150 kW exposure, the following criteria shall be met:
 - a. Flame shall not spread to the outer extremities of the sample on the 2440 mm × 3660 mm wall.
 - b. Flashover shall not occur.

35.10. Products shall be tested using the test protocol of NFPA 286. The following conditions shall be met:

- i. Flame shall not spread to the ceiling during the 40 kW exposures.
- ii. During the 160 kW exposure, the following criteria shall be met:
 - a. Flame shall not spread to the outer extremities of the sample on the 2440 mm × 3660 mm wall.
 - b. Flashover shall not occur.
 - c. The peak heat release rate throughout the test shall not exceed 800 kW.
 - d. For new installations, the total smoke released throughout the test shall not exceed 1000 m³).

36. Specific Materials

36.1. Textile Wall or Ceiling Materials

36.1.1. The use of textile materials on walls or ceilings shall comply with one of the following conditions:

- i. Textile materials having a Class A rating shall be permitted on the walls or ceilings of rooms or areas protected by an approved automatic sprinkler system.
- ii. Textile materials having a Class A rating shall be permitted on partitions that do not exceed three-quarters of the floor-to-ceiling height or do not exceed 2440 mm in height, whichever is less.



- iii. Textile materials having a Class A rating shall be permitted to extend not more than 1220 mm above the finished floor on ceiling-height walls and ceiling-height partitions.
- iv. Textile materials shall be permitted on walls and partitions where tested in accordance with NFPA 265.

36.2. Expanded Vinyl Wall or Ceiling Coverings

36.2.1. The use of expanded vinyl wall or ceiling coverings shall comply with one of the following conditions:

- i. Materials having a Class A rating shall be permitted on the walls or ceilings of rooms or areas protected by an approved automatic sprinkler system.
- ii. Materials having a Class A rating shall be permitted on partitions that do not exceed three-quarters of the floor-to-ceiling height or do not exceed 8 ft (2440 mm) in height, whichever is less.
- iii. Materials having a Class A rating shall be permitted to extend up to 1220 mm above the finished floor on ceiling-height walls and ceiling-height partitions.
- iv. Materials shall be permitted on walls and partitions where tested in accordance with NFPA 265.
- v. Materials shall be permitted on walls, partitions, and ceilings where tested in accordance with NFPA 286.

36.3. Cellular or Foamed Plastic

36.3.1. Cellular or foamed plastic materials shall not be used as interior wall and ceiling finish, unless specifically permitted by:

- i. Cellular or foamed plastic material meeting the definition of foamed plastic insulation subjected to large-scale fire tests that substantiate the combustibility characteristics of the material for the use intended under actual fire conditions. The tests shall be performed on a finished foamed plastic assembly related to the actual end-use configuration, including any cover or facing, and at the maximum thickness intended for use.
- ii. Cellular or foamed plastic shall be permitted for trim not in excess of 10 percent of the wall or ceiling area, provided that it is not less than



20 lb/ft³ (320 kg/m³) in density, is limited to ½ in. (13 mm) in thickness and 4 in. (100 mm) in width, and complies with the requirements for Class A or Class B interior wall and ceiling finish; however, the smoke rating shall not be limited.

36.4. Light-Transmitting Plastics

36.4.1. Light-transmitting plastics used as interior wall and ceiling finish shall be permitted based on large-scale fire tests that substantiate the combustibility characteristics of the plastics for the use intended under actual fire conditions. The tests shall be performed on a light-transmitting plastic assembly related to the actual end-use configuration and on the maximum thickness intended for use.

36.5. Metal Ceiling and Wall Panels

36.5.1. Listed, factory-finished Class A metal ceiling and wall panels shall be permitted to be finished with one additional application of paint. These painted panels shall be permitted for use in areas where Class A interior finishes are required. The total paint thickness shall not exceed in. (0.90 mm).

36.6. Trim and Incidental Finish

36.6.1. Interior wall and ceiling trim and incidental finish, not in excess of 10 percent of the aggregate wall and ceiling areas of any room or space shall be permitted to be Class C materials in occupancies where interior wall and ceiling finish of Class A or Class B is required.

36.6.2. Wall Base. Interior floor trim material used at the junction of the wall and the floor to provide a functional or decorative border, and not exceeding 150 mm in height, shall meet the interior wall finish requirements for its location or the requirements for Class II interior floor finish. If a Class I floor finish is required, the interior floor trim shall be Class I.

36.7. Bulletin Boards and Posters

36.7.1. Bulletin boards and posters attached directly to the wall shall not exceed 20 percent of the aggregate wall area to which they are applied.

37. Interior Floor Finish Testing and Classification

37.1. Carpet and carpet-like interior floor finishes shall comply with ASTM D 2859, Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials.

37.2. Floor coverings, other than carpet, that are judged to represent an unusual hazard shall have a minimum critical radiant flux of 0.1 W/cm².



- 37.3.** Interior floor finishes shall be classified in accordance with 10.6.4 based on test results from NFPA 253, Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source, or ASTM E 648, Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source.

37.4. Class I Interior Floor Finish

- 37.4.1.** Class I interior floor finish shall have a critical radiant flux of not less than 0.45 W/cm².

37.5. Class II Interior Floor Finish.

- 37.5.1.** Class II interior floor finish shall have a critical radiant flux of not less than 0.22 W/cm², but less than 0.45 W/cm²,

- 37.5.2.** Wherever the use of Class II interior floor finish is required, Class I interior floor finish shall be permitted.

38. Interior Finish in relation to Automatic Sprinklers

- 38.1.** Where an approved automatic sprinkler system is provided, Class C interior wall and ceiling finish materials shall be permitted in any location where Class B is required, and Class B interior wall and ceiling finish materials shall be permitted in any location where Class A is required.

- 38.2.** Where an approved automatic sprinkler system is provided throughout the fire compartment or smoke compartment containing the interior floor finish, Class II interior floor finish shall be permitted in any location where Class I interior floor finish is required, and where Class II is required, no critical radiant flux rating shall be required.

39. Material Approval

- 39.1.** All the Materials, Systems, Assemblies, equipment, Products and Accessories, referred to in this chapter with respect to Life Safety, Fire Safety and Emergency Services shall be Listed, Approved and Registered by the Civil Defence Material Approval Department.
- 39.2.** The above requirement applies to all the products with or without international listing, registration or approval.

40. Further References

- 40.1.** The following International Codes and Standards were referred, studied and consulted for this chapter. Further details where applicable can be referred to in these Codes and



Standards. Also see **XV. ACKNOWLEDGEMENT OF INTERNATIONAL CODES AND STANDARDS.**

- NFPA 101: Life Safety Code
- NFPA 5000: Building Construction and Building Code
- NFPA 70: National Electric Code
- IBC: International Building Codes

- Test Requirements: ASTM E-814-02, "Standard Method of Fire Tests of Through Penetration Fire Stops"

- Underwriters Laboratories (UL) of Northbrook, IL runs ASTM E-814 under their designation of UL 1479 and publishes the results in their "FIRE RESISTANCE DIRECTORY" that is updated annually.
 - i. UL Fire Resistance Directory:
 - a. Fire stop Devices (XHJI)
 - b. Fire Resistance Ratings (BXUV)
 - c. Through-Penetration Fire stop Systems (XHEZ)
 - d. Fill, Voids, or Cavity Material (XHHW)
 - e. Forming Materials (XHKU)
 - f. Joint Systems (XHBN)
 - g. Perimeter Fire Containment Systems (XHDG)
 - h. Fire Resistance Ratings (BXRH)
 - ii. Alternate "Omega Point Laboratories Directory" (updated annually).

- Test Requirements: UL 2079, "Tests for Fire Resistance of Building Joint Systems" (July 1998.)

- D. ANSI/ASTM E2307, "Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus."

- Test Requirements: ASTM E 1966-01, "Standard test method for Fire Resistive Joint Systems"

- Inspection Requirements: ASTM E 2174 – 01, "Standard Practice for On-site Inspection of Installed Fire Stops."

- International Fire stop Council Guidelines for Evaluating Fire stop Systems Engineering Judgments

- ASTM E-84-01, Standard Test Method for Surface Burning Characteristics of Building Materials.

- All major building codes which are applicable: ICBO, SBCCI, BOCA, and IBC.



- Where the BS standards to be used for the specifications of the project use the following BS standards:
 - i. BS 476, “Fire Tests on Building Materials”
 - ii. BS 6401, Method of measurement, in the agency, of the specific optical density of smoke generated by materials”.
 - iii. BS6399: Loading for buildings
 - iv. Part 1: 1996: Code of practice for dead and imposed loads
 - v. Part 3: 1988: Code of practice for Imposed roof loads
 - vi. Durability Criteria: DafStb guidelines for the protection and repair of concrete building components, Part 4, Section 2.4.5.6, with subsequent fire testing to ensure long term functionality.
- ANSI/UL 2079, “Tests for Fire Resistance of Building Joint Systems”
- International Fire stop Council Recommended (IFC) Guidelines for Evaluating Fire stop Systems Engineering Judgments

A. American Society For Testing and Materials (ASTM):

1. ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials
2. ASTM E 119: Methods of Fire Tests of Building Construction and Materials.
3. ASTM E 176: Terminology of Fire Standards
4. ASTM E 814: Test Method for Fire Tests of Through-Penetration Firestops
5. ASTM E 1966: Test Method for Resistance of Building Joint Systems
6. ASTM E 1399: Test Method for Cyclic Movement and Measuring Minimum and Maximum Joint Width
7. ASTM E 2307: Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-Story Test Apparatus
8. ASTM E 2174: Standard Practice for On-Site Inspection of Installed Fire Stops
9. ASTM E 2393: Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers

B. UNDERWRITERS LABORATORIES (UL):

1. UL 263: Fire Tests of Building Construction and Materials
2. UL 723: Test for Surface Burning Characteristics of Building Materials
3. UL 1479: Fire Tests of Through-Penetration Fire Stops
4. UL 2079: Tests for Fire Resistance of Building Joint Systems



C. EUROPEAN STANDARDS (EN)

1. EN 1363-1: Fire Resistance Tests – General Requirements
2. EN 1363-2: Fire Resistance Tests – Alternative and Additional Procedures
3. EN 1364-3: Fire resistance tests for non-loadbearing elements. Curtain walling. Full configuration (complete assembly)
4. EN 1364-4: Fire resistance tests for non-loadbearing elements. Curtain walling. Part configuration.
5. EN 1366-3: Fire Resistance Tests for Service Installations – Penetration Seals
6. EN 1366-4: Fire Resistance Tests for Service Installations – Linear Joint & Gap Seals.
7. EN 1366-2: Fire resistance tests for service installations - Part 2: Fire dampers
8. EN 1366-10: Fire Resistance tests for service installations – Part 10: Smoke control dampers
9. EN 12101-4: Smoke and heat control systems - Part 4: Installed SHEV systems for smoke and heat ventilation
10. EN 12101-8: Smoke and Heat control systems- Part 8: Smoke control dampers
11. EN 15650: Ventilation for buildings – Fire dampers
12. EN 13501-3: Fire classification of construction products and building elements – Part
13. 3: Classification using data from fire resistance tests on products and elements used in building service installations: fire resisting ducts and fire dampers
14. EN 13501-4: Fire classification of construction products and buildings elements –
15. Part 4: Classification using data from fire resistance tests on components of smoke control systems.

D. INTERNATIONAL CODE FAMILY

1. IBC 2009: International Building Code
2. IFC 2009: International Fire Code

E. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

1. NFPA 1: Fire Code
2. NFPA 3: Standard for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems
3. NFPA 80: Standard for Fire Doors and Other Opening Protectives
4. NFPA 101: Life Safety Code
5. NFPA 5000: Building Construction and Safety Code

F. INTERNATIONAL FIRE COUNCIL (IFC)

1. IFC Guidelines for evaluating Firestop Systems Engineering Judgments (EJ's)



CHAPTER 2

FIRE SERVICE OPERATIONAL REQUIREMENTS

1. Definitions

1.1. Breeching inlet

A connection through which the Civil Defence fire department can pump supplemental water into the sprinkler system, standpipe, or other system, furnishing water for fire extinguishment to supplement existing water supplies.

1.2. Fire Service access level

Level where Civil Defence Fire Appliances (Fire Truck/Engine) are deployed and where fire fighters have direct access into the building.

1.3. Fire Access Roadway

The road to the building or structure to allow access for Civil Defence fire-fighting and rescue apparatus.

1.4. Fire Accessway

The path adjacent to the building or structure to allow operational setup for Civil Defence fire-fighting and rescue apparatus such as Aerial Appliances.

1.5. Landing Valve

A 65 mm diameter threaded water outlet normally located inside the staircase landing (See section 15.6 for details on approved locations) for trained or Civil Defence fire fighters to use during fire.

1.6. Hose Reel or Hose Rack

A 25 mm or 40 mm diameter threaded water outlet with a connected hose for trained occupants or Civil Defence fire fighters to use during fire.

1.7. Standpipe

The vertical portion of the system piping that delivers the water supply for hose connections (and sprinklers on combined systems), vertically from floor to floor. The term standpipe can also refer to the horizontal portion of the system piping that delivers the water supply for two or more hose connections (and sprinklers on combined systems) on a single level.



2. General

- 2.1. Civil Defence Fire-fighters need to be able to reach a fire quickly, with their equipment, if they are to successfully deal with a fire. This is even more important in a high rise building where the fire could be at a height of many meters from fire service access level.
- 2.2. Physical safety and lives, both those of the fire-fighters and those of the occupants of the building, and the preservation of the building and its contents, can be jeopardized by delays in reaching the area of the fire.
- 2.3. Rescue by the fire service can provide an additional factor of safety, but this is not generally taken into account in any calculation of probable risk to the building or occupants for the design of a building. Fire-fighting access should be aimed at assisting the Civil Defence service in protecting life, protecting fire-fighters, reducing building losses, salvaging property and goods and minimizing environmental damage.

3. Access Level

- 3.1. Fire Service access level can be at ground level, podium level or at parking lot level, where these are not below ground.
- 3.2. At fire service access level, Civil Defence vehicles shall be able to approach and park to within 15 m and within sight of a suitable entrance which gives access to the Interior of the Building, a Firefighting Lift and associated staircases.

4. Access to Buildings with Standpipes or Risers

- 4.1. Buildings fitted with standpipes and automatic sprinkler system shall have accessways for pumping appliances within 18 m of the breaching inlet. The breaching inlets shall be visible from the accessways. See [Figure 2.1](#) for illustration.
- 4.2. Breaching inlets should be visible from fire engine access road to avoid delay in locating them upon arrival of the fire crew. For better control and limit to only one hose length being used, the breaching inlets shall not be sited more than 18m away from the fire engine access road.

5. Public Fire Hydrants (By UAE Municipality)

- 5.1 Consideration should be given to establish Public Fire Hydrant System as part of UAE infrastructure. UAE Municipality should stress on provision of Public Fire Hydrant System at all upcoming developments and following basic guidelines shall be applicable for such installations.



5.2 Spacing between public hydrants along public roads shall be as follows:

- i. Residential and Commercial Occupancies shall be 120 m
- ii. Light Hazard Storage Occupancies shall be 100 m
- iii. Ordinary Hazard Storage Occupancies shall be 100 m
- iv. High Hazard Storage Occupancies shall be 60 m
- v. Light Hazard Industrial Occupancies shall be 100 m
- vi. Ordinary Hazard Industrial Occupancies shall be 100 m
- vii. High Hazard Industrial Occupancies shall be 60 m

5.3 Minimum flowrate for any public fire hydrant shall be 500 Gallons per Minute (1900 LPM) (250 GPM/outlet, 950 LPM/outlet).

5.4 Two numbers of public fire hydrants shall be considered for hydraulic demand calculation, thus reaching the total flow requirement to 1000 Gallons per Minute (3800 LPM).

5.5 Minimum Pressure required at most remote hydrant shall be 6.9 bars.

6. Private Fire Hydrant

6.1 Private Fire Hydrant Systems are the Hydrant network System provided on private property specifically to protect the buildings and structures within that particular property.

6.2 Where private Fire Hydrant network is required by the Civil Defence, the Fire Hydrant network system shall be 'dedicated'. Combined networks with irrigation, processes or domestic use are not allowed.

6.3 Fire hydrants shall be located at not less than 6 m and not more than 30 m from the building to be protected.

6.4 Every part of a fire engine access road and/or an accessway in a private property shall be within an unobstructed distance of

- i. 30 m for high hazard occupancies
- ii. 50 m for light and ordinary storage occupancies
- iii. 50 m for light and ordinary industrial occupancies
- iv. 60 m for residential and commercial occupancies

6.5 Where a Public Hydrant conforming to distance requirements of [section 6.4](#) is not available, Private hydrant(s) shall be provided in accordance with section 6. See [Figure 2.4](#) and [Figure 2.5](#) for illustrations.



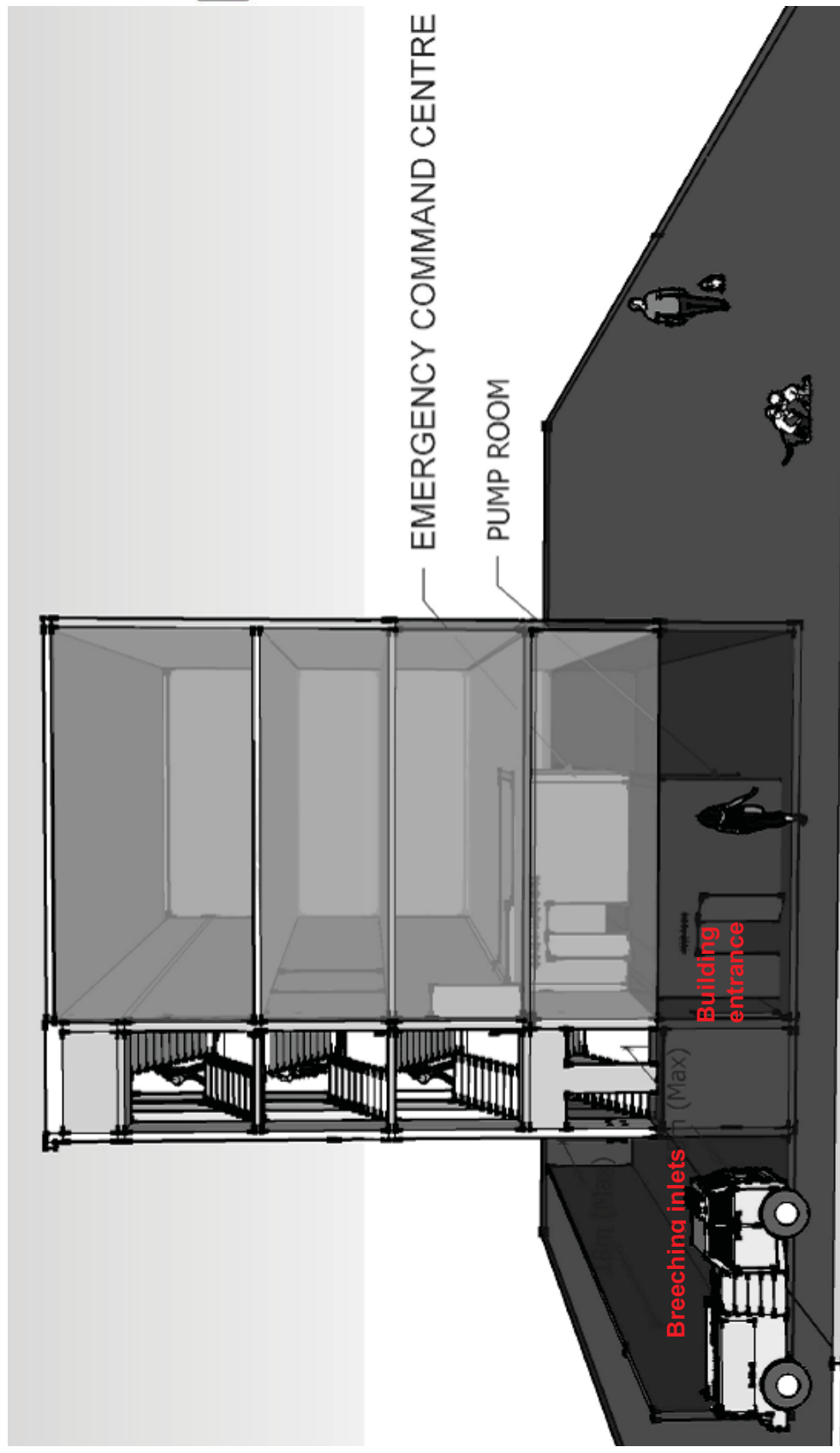
6.6 Spacing between Private Hydrants along Fire Engine access way and access road

- i. Residential and Commercial Occupancies shall be 120 m
- ii. Light Hazard Storage Occupancies shall be 100 m
- iii. Ordinary Hazard Storage Occupancies shall be 100 m
- iv. Light Hazard Industrial Occupancies shall be 100 m
- v. Ordinary Hazard Industrial Occupancies shall be 100 m
- vi. High Hazard Occupancies shall be 60 m

6.7 Minimum flowrate for each Private fire hydrant shall be 500 Gallons per Minute (1900 LPM) (250 GPM/outlet, (950 LPM/outlet).**6.8** Two number of Private fire hydrant shall be considered for hydraulic demand calculations which is, a total flow requirement of 1000GPM (3800 LPM).**6.9** Minimum Pressure required for Private fire hydrant is 6.9 bars.**6.10** Private Fire Hydrant Water supply for fire fighting shall be for 2 hours.**6.11 Fire Pump for Hydrants**

- i. Hydraulic calculation shall be provided to size up the fire pump required for the fire hydrant network. Separate pumps may be required to address pressure fluctuation within the hydrant network.
- ii. Each fire pump flowrate shall be a minimum of 1000 GPM (3800 LPM) for hydrant demand at minimum pump pressure of 10.3 bar.





Page | 110

7. Pipe for hydrant water supply.

- 7.1** Piping and Fittings Material for Hydrant water supply shall be approved by Civil Defence and shall conform to manufacturing standards as per [Table 2.1](#) and [Table 2.2](#)
- 7.2** Hydrants shall be of approved type and have not less than a 6-in. (152-mm) diameter connection with the mains. See [Figure 2.2](#) for Pit for Gate Valve, Check Valve, and Fire Department Connection.

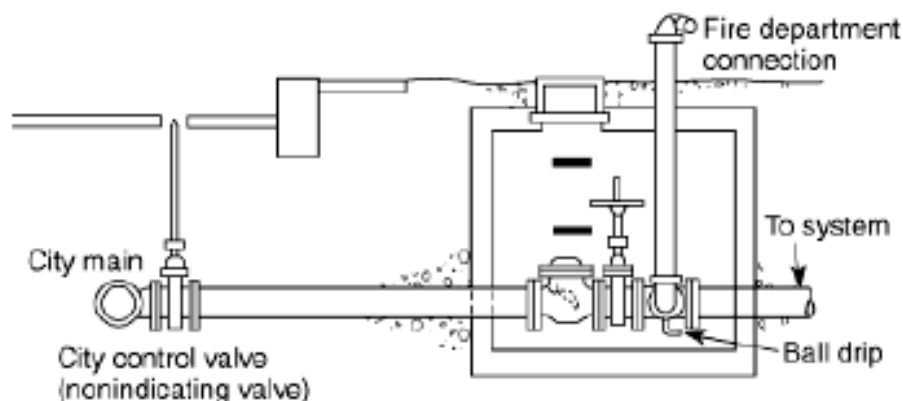


Figure 2.2: Typical Pit for Gate Valve, Check Valve, and Fire Department Connection.

7.3 Location and Signage for fire department connections (Breeching Inlets)

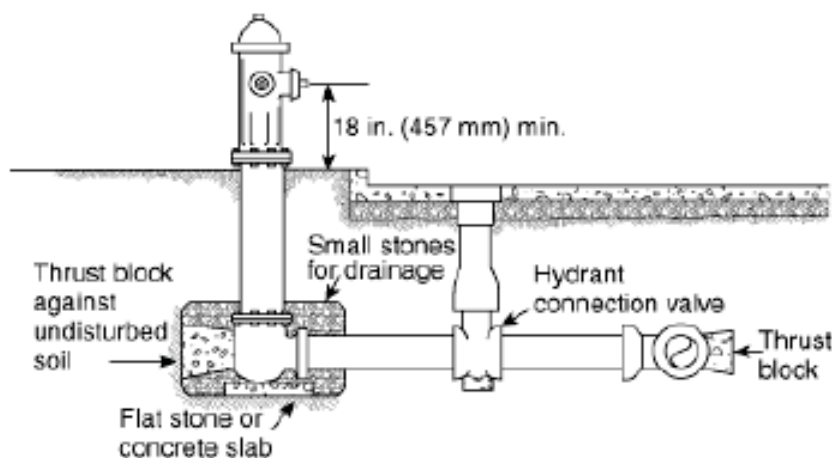
- 7.3.1** Fire department connections shall be located on the street side of the buildings.
- 7.3.2** Fire department connections shall be located and arranged so that hose lines can be readily and conveniently attached to the inlets without interference from any nearby objects, including buildings, fences, posts, or other fire department connections.
- 7.3.3** Each fire department connection to sprinkler systems shall be designated by a sign as follows:
- The sign shall have raised or engraved letters at least 25.4 mm in height on a plate or fitting.
 - The sign shall indicate the service for which the connection is intended and shall read, for example, as follows:

WATER TANK / SPRINKLER / STANDPIPE

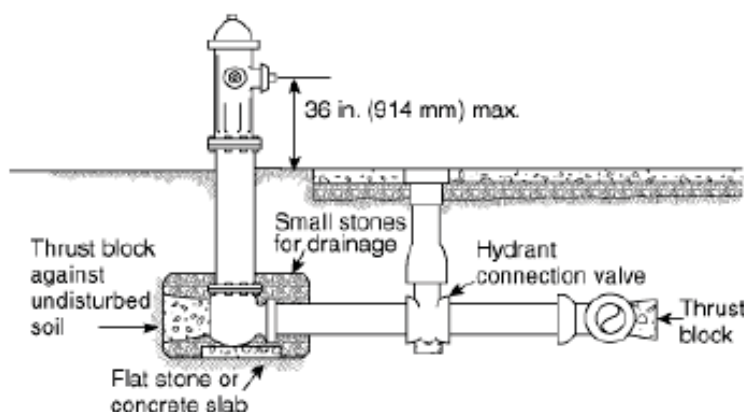
- 7.3.4** A sign at inlets shall indicate the pressure required to deliver the greatest system demand. A valve shall be installed in the hydrant connection. Independent gate valves on 2½-in. (65-mm) outlets shall be permitted.



- 7.4** Hydrants shall be set on flat stones or concrete slabs and shall be provided with small stones (or the equivalent), placed about the drain to ensure drainage.
- 7.5** The center of a hose outlet shall be not less than 457 mm and not more than 914mm above final grade. See **Figure 2.3** for illustrations.



Minimum height of outlet (457mm)



Maximum height of outlet (914mm)

Figure 2.3: Minimum and maximum outlet height for hydrant

- 7.6** Hydrants shall be protected with barricades if subject to mechanical damage.
- 7.7** The means of hydrant protection shall be arranged in a manner that does not interfere with the connection to, or operation of, hydrants.
- 7.8** The following shall not be installed in the service stub between a fire hydrant and private water supply piping:
- Check valves
 - Detector check valves
 - Backflow prevention valves



iv. Other similar appurtenances

- 7.9** Underground piping shall be listed for fire protection service or shall comply with the standards in [Table 2.1](#) and [2.2](#)

Table 2.1: Manufacturing Standards for Underground Pipe

MATERIALS AND DIMENSIONS	STANDARD
Ductile Iron	
Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water	AWWA C104
Polyethylene Encasement for Ductile Iron Pipe Systems	AWWA C105
Ductile Iron and Gray Iron Fittings, 3-in. Through 48-in., for Water and Other Liquids	AWWA C110
Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings	AWWA C111
Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges	AWWA C115
Thickness Design of Ductile Iron Pipe	AWWA C150
Ductile Iron Pipe, Centrifugally Cast for Water	AWWA C151
Standard for the Installation of Ductile Iron Water Mains and Their Appurtenances	AWWA C600
Steel	
Steel Water Pipe 6 in. and Larger	AWWA C200
Coal-Tar Protective Coatings and Linings for Steel Water Pipelines Enamel and Tape — Hot Applied	AWWA C203
Cement-Mortar Protective Lining and Coating for Steel Water Pipe 4 in. And Larger — Shop Applied	AWWA C205
Field Welding of Steel Water Pipe	AWWA C206
Steel Pipe Flanges for Waterworks Service — Sizes 4 in. Through 144 in.	AWWA C207
Dimensions for Fabricated Steel Water Pipe Fittings	AWWA C208
A Guide for Steel Pipe Design and Installation	AWWA M11
Copper	
Specification for Seamless Copper Tube	ASTM B 75
Specification for Seamless Copper Water Tube	ASTM B 88
Requirements for Wrought Seamless Copper and Copper-Alloy Tube	ASTM B 251
Concrete	
Reinforced Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids	AWWA C300
Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids	AWWA C301
Reinforced Concrete Pressure Pipe, Non-Cylinder Type, for Water and Other Liquids	AWWA C302
Reinforced Concrete Pressure Pipe, Steel-Cylinder Type, Pretensioned, for Water and Other Liquids	AWWA C303
Standard for Asbestos-Cement Distribution Pipe, 4 in. Through 16 in., for Water and Other Liquids	AWWA C400
Standard Practice for the Selection of Asbestos-Cement Water Pipe	AWWA C401
Cement-Mortar Lining of Water Pipe Lines 4 in. and Larger — in Place	AWWA C602
Standard for the Installation of Asbestos-Cement Water Pipe	AWWA C603
Plastic	
Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. Through 12 in., for Water and Other Liquids	AWWA C900



8. Steel Pipe.

- 8.1** Steel piping shall not be used for general underground service unless specifically listed for such service.

9. Pipe Type and Class.

- 9.1** The type and class of pipe for a particular underground installation shall be determined through consideration of the following factors:

- i. Fire resistance of the pipe
- ii. Maximum system working pressure
- iii. Depth at which the pipe is to be installed
- iv. Soil conditions
- v. Corrosion
- vi. Susceptibility of pipe to other external loads, including earth loads, installation beneath buildings and traffic or vehicle loads

- 9.2** Pipe under driveways shall be buried at a minimum depth of 3 ft (0.9 m).

- 9.3** Pipe under railroad tracks shall be buried at a minimum depth of 4 ft (1.2 m)

- 9.4** The depth of cover shall be measured from the top of the pipe to finished grade and due consideration shall always be given to future or final grade and nature of soil.

10. Working Pressure.

- 10.1** Pipe and fittings shall be designed to withstand a system working pressure of not less than 150 psi (10.3 bar).

11. Master Streams.

- 11.1** Master streams shall be delivered by monitor nozzles, hydrant-mounted monitor nozzles and similar master stream equipment capable of delivering more than 250 gpm (950 L/min).



Table 2.2: Fittings Materials and Dimensions

MATERIALS AND DIMENSIONS	STANDARD
Cast Iron	
Cast Iron Threaded Fittings, Class 125 and 250	ASME B16.4
Cast Iron Pipe Flanges and Flanged Fittings	ASME B16.1
Malleable Iron	
Malleable Iron Threaded Fittings, Class 150 and 300	ASME B16.3
Steel	
Factory-Made Wrought Steel Buttweld Fittings	ASME B16.9
Buttwelding Ends for Pipe, Valves, Flanges, and Fittings	ASME B16.25
Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures	ASTM A 234
Steel Pipe Flanges and Flanged Fittings	ASME B16.5
Forged Steel Fittings, Socket Welded and Threaded	ASME B16.11
Copper	
Wrought Copper and Bronze Solder Joint Pressure Fittings	ASME B16.22
Cast Bronze Solder Joint Pressure Fittings	ASME B16.18

12. Protection Against Damage

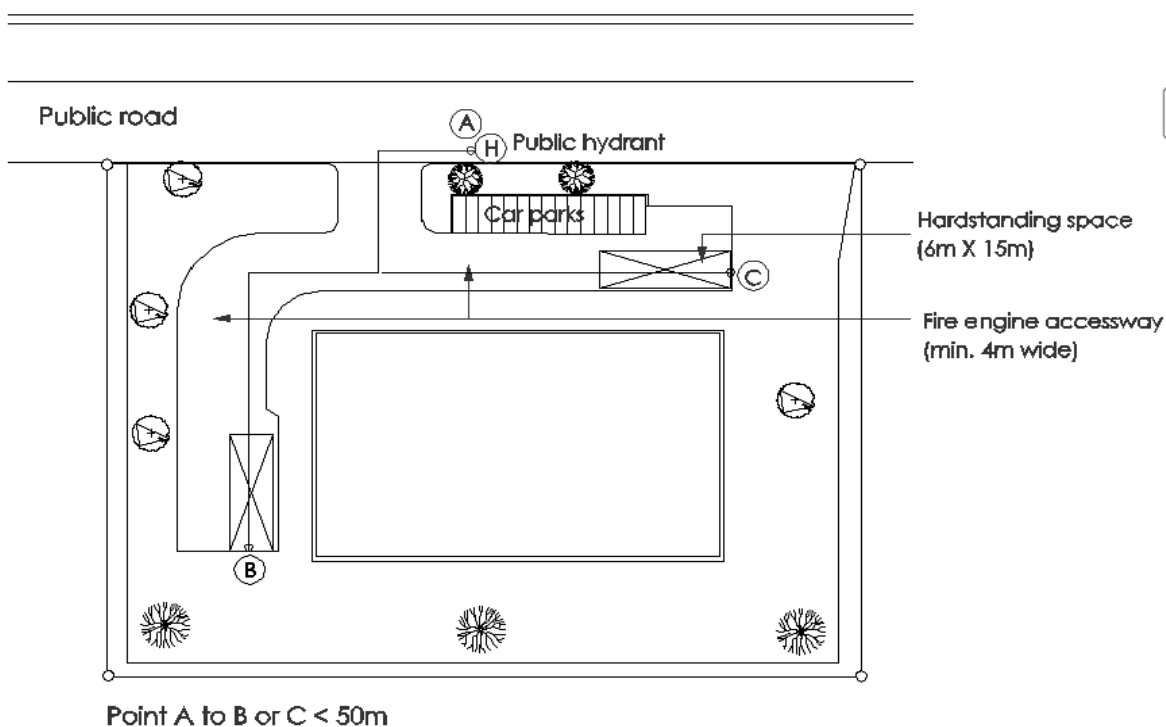
- 12.1** Pipes shall not be run under buildings.
- 12.2** Where pipes must be run under buildings, special precautions shall be taken, including the following:
- Arching the foundation walls over the pipe
 - Running pipe in covered trenches
 - Providing valves to isolate sections of pipe under buildings
- 12.3** Fire service mains shall be permitted to enter the building adjacent to the foundation.
- 12.4** Where adjacent structures or physical conditions make it impractical to locate risers immediately inside an exterior wall, such risers shall be permitted to be located as close as practical to exterior walls to minimize underground piping under the building.
- 12.5** Where a riser is located close to building foundations, underground fittings of proper design and type shall be used to avoid locating pipe joints in or under the foundations.
- 12.6** Mains shall be subjected to an evaluation of the following specific loading conditions and protected, if necessary:



- i. Mains running under railroads carrying heavy cargo
- ii. Mains running under large piles of heavy commodities
- iii. Mains located in areas that subject the mains to heavy shock and vibrations

12.7 Where it is necessary to join metal pipe with pipe of dissimilar metal, the joint shall be insulated against the passage of an electric current using an approved method.

12.8 In no case shall pipe be used for grounding of electrical services.



12.9 **Note:** The distance from A to B or C shall be 30m, 50m or 60m depending on the Hazard.

Figure 2.4: Distance from furthest point of private fire engine accessway to a public hydrant



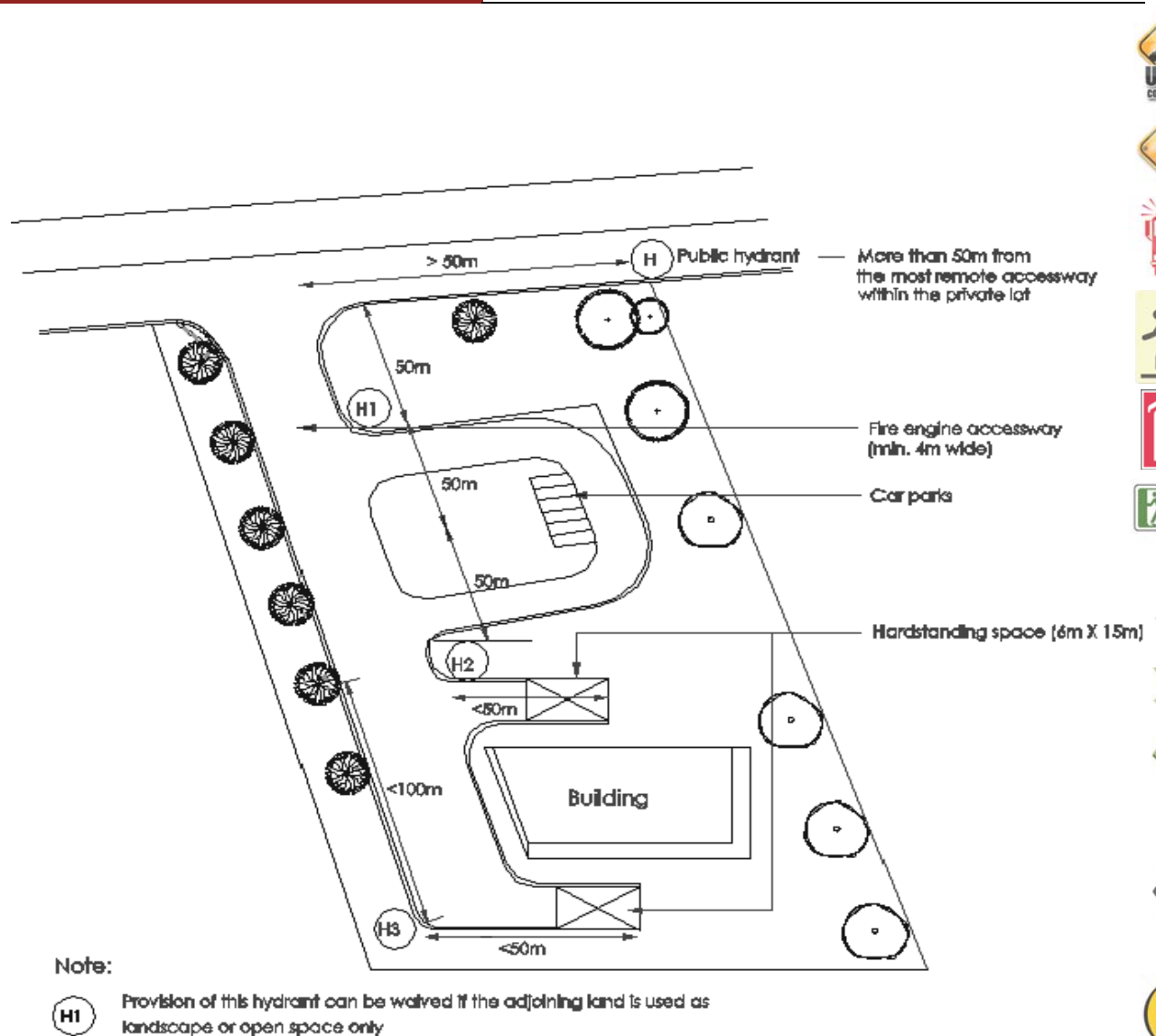


Figure 2.5: Spacing between private fire hydrants

12.10

Note: In situations where more than one private hydrants are required, the hydrants shall be located along the fire engine access road and/or an accessway such that every part of the access road and/or accessway is within an unobstructed distance of 30m, 50m or 60m from any hydrant depending on the type of hazard. Construction and installation of fire hydrants shall comply with the requirements stated in NFPA 24: Installation of Private Fire Service Mains and Their Appurtenances.



Table 2.3 : Civil Defence Vehicle Access specifications

CIVIL DEFENCE VEHICLE ACCESS SPECIFICATIONS	
Item	Requirements
Maximum Parking distance of Civil Defence Vehicle from building entrance	15 m.
Maximum Parking distance of Civil Defence Vehicle from Breeching inlet	18 m.
Maximum Road Grade of the Civil Defence Vehicle Access	10%

- 12.11** Where there is a building above a level or levels of open sided car park, fire service access level at car park level is acceptable provided there is a route available for fire-fighters to access the fire-fighters' lift at that level.
- 12.12** A suitable access pathway shall also be provided to enable fire-fighters to inspect all elevations of a building during or after a fire. A suitable pathway could be a paved or gravel path. Any such pathway should be a minimum of 1 m wide and Plants, Bushes, Walls or other features should not impede such pathway.
- 12.13** Where there is a building above an open sided car park, an access pathway through the car park at its lowest level would be acceptable.

13. Accessway for Fire Fighting Appliances

- 13.1** The accessway shall have a minimum width of 6 m throughout. Such accessway must be able to accommodate the entry and maneuvering of fire engine, extended ladders, pumping appliances, aerial appliances, turntable and / or hydraulic platforms.
- 13.2** For cluster housing developments (Cluster housing is landed housing with shared communal facilities) fire engine access road with a minimum 4 m width shall be provided for access by Fire appliance to within a travel distance of 60 m from every point on the projected plan area of any building in the housing developments. See [Figure 2.6](#) for illustrations.



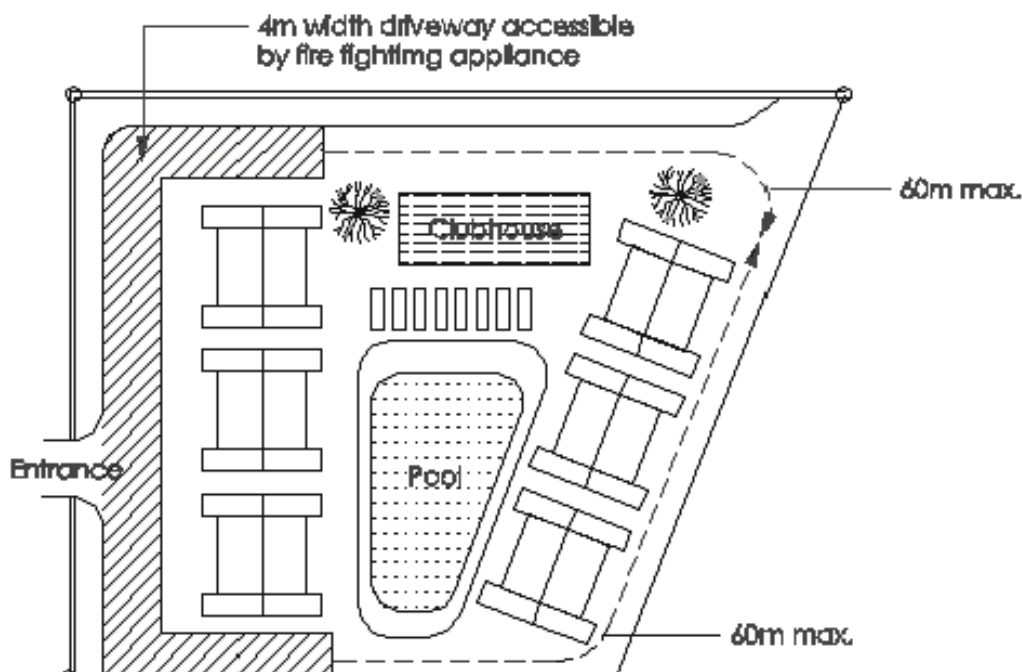
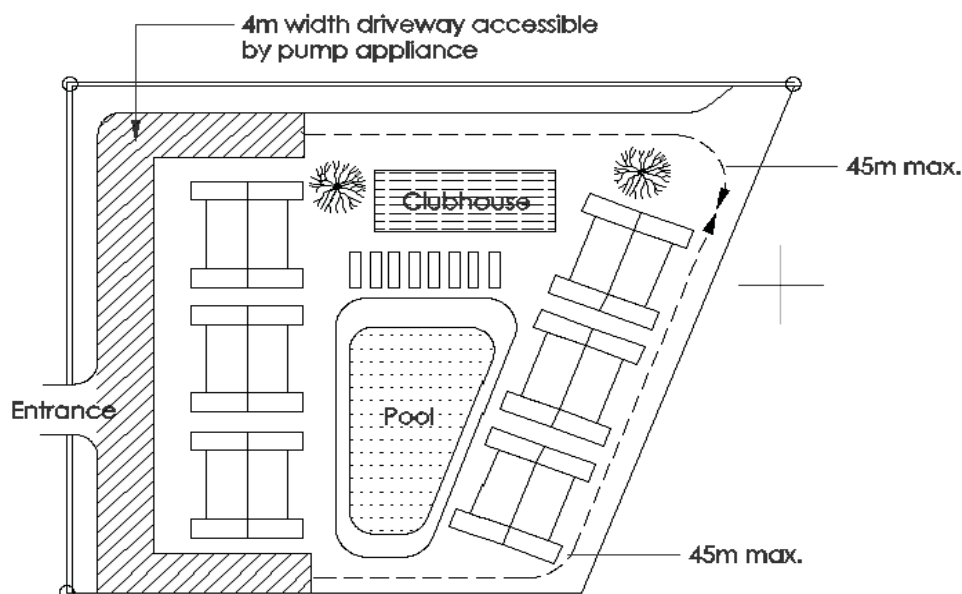


Figure 2.6: Distance from the edge of the fire engine access road to the most remote point in the compound for buildings not exceeding 60m.

- 13.3** For Lowrise residential occupancy (except for hotels, dormitories and lodging) buildings with habitable height of less than 15 m, no accessway will be required. However, fire engine access road having minimum 4 m width for access by Fire appliance shall be provided to within a travel distance of 60 m of every point on the projected plan area of the building.
- 13.4** The requirement for fire engine access road shall not apply to non-residential standalone buildings, such as clubhouse, carpark, etc. that are located within the housing development.
- 13.5** Breeching inlets shall be located on the external wall above ground level nearest to the vertical run of the standpipe.





Vehicle access to be within 45m from the projected plan area of the building

Figure 2.7: Distance from edge of fire engine access to the most remote point of compound of buildings not exceeding 45m

13.6 For Lowrise buildings under day-care, detention and correctional, educational, health care, business, mercantile and assembly occupancies not exceeding the habitable height of 15 m, accessway will not be required. However, provision of fire engine access road having minimum 4m width for Fire appliance will be required to within a travel distance of 45m of every point on the projected plan area of the building. See [Figure 2.7](#).

13.7 For Midrise and Highrise buildings under day-care, detention and correctional, educational, health care, business, mercantile and assembly occupancies exceeding the habitable height of 15 m, accessway shall be provided. Accessway shall be provided based on the gross floor area (including toilets, stores, circulation areas, etc.) of the largest floor in the building as shown in [Table 2.4](#).

Table 2.4: Extent of fire engine access for non-industrial and non-storage occupancies (without sprinklers)

Minimum	1/6 perimeter (min 15 m)
2000 meter sq. to 4000 meter sq.	1/4 perimeter
4000 meter sq. to 8000 meter sq.	1/2 perimeter
>8000 meter sq. to 16,000 meter sq.	3/4 perimeter
>16000 meter sq.	Whole perimeter



- 13.8** For buildings protected by an automatic sprinkler system, the floor area shall be doubled as shown in [Table 2.5](#).

Table 2.5: Extent of fire engine access for non-industrial and non-storage occupancies (with sprinklers)

Minimum	1/6 perimeter (min 15 m)
4000 meter sq. to 8000 meter sq.	1/4 perimeter
>8000 meter sq. to 16,000meter sq.	1/2 perimeter
>16,000meter sq. to 32,000meter sq.	3/4 perimeter
>32,000meter sq.	Whole perimeter

- 13.9** Accessway shall be provided to within 18 m of breaching inlet for all midrise and highrise buildings that exceed the habitable height of 15 m.

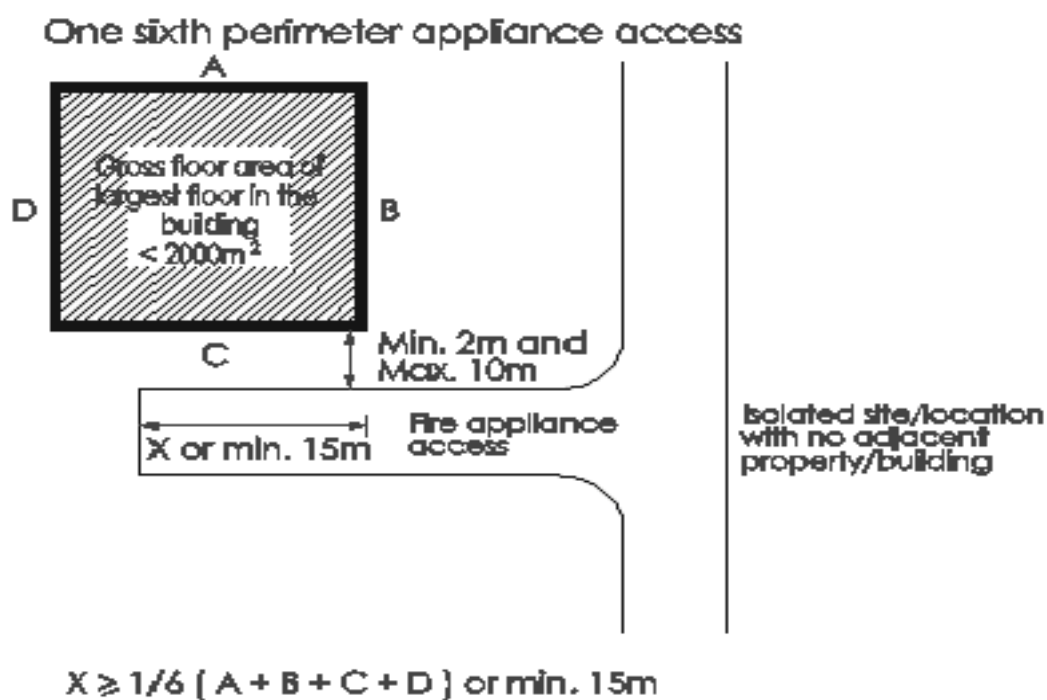


Figure 2.8: Minimum length of fire engine access



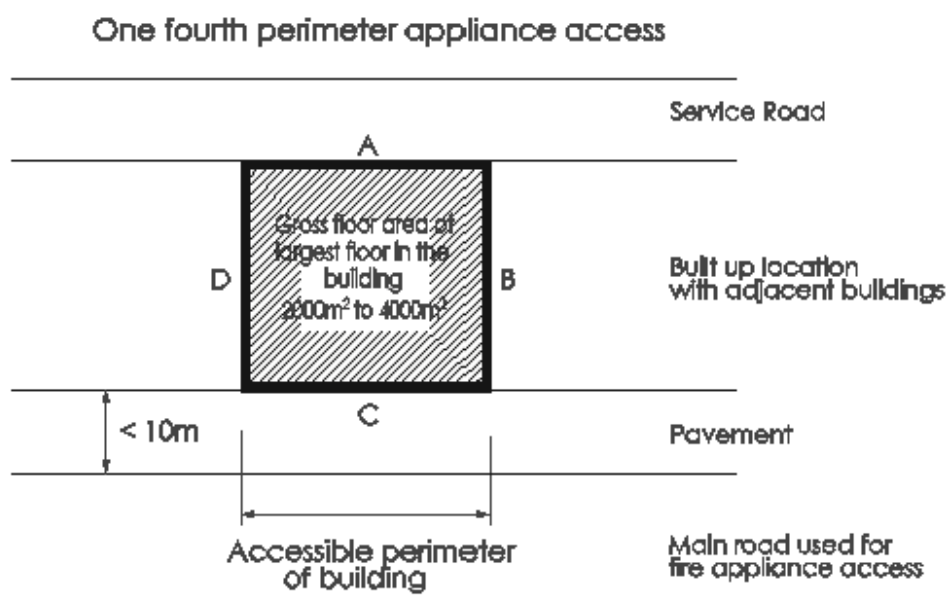


Figure 2.9: Quarter Perimeter Accessway

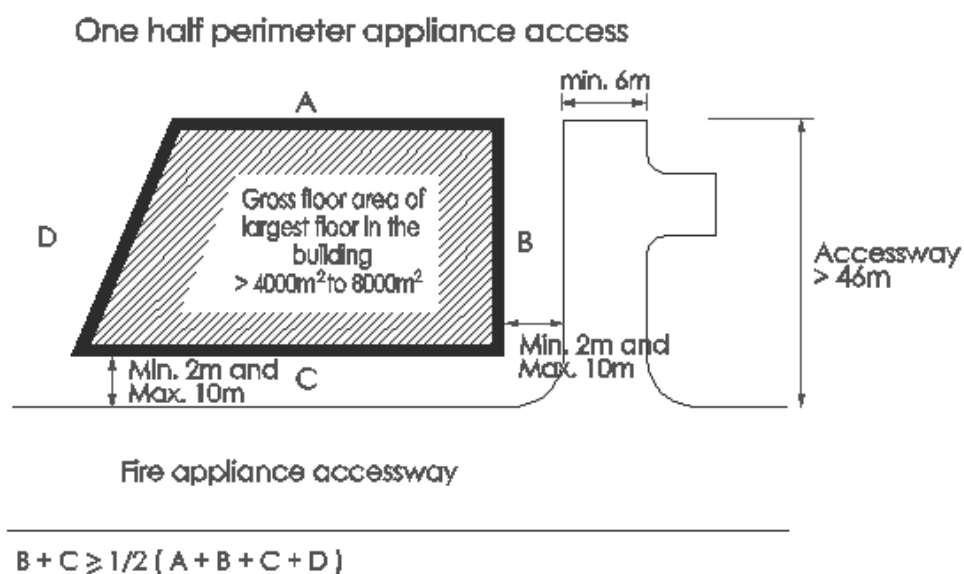


Figure 2.10: Half Perimeter Accessway



- 13.10** For buildings under all industrial and storage occupancies, accessway shall be provided for fire fighting appliances. The provision of accessway shall be calculated based on the following gross cubical extent of the building as shown in [Table 2.6](#).

Table 2.6: Extent of fire engine access for industrial and storage occupancies (without sprinklers)

Minimum Volume	1/6 perimeter (min 15m)
More than 28,400 meter cube	1/4 perimeter
More than 56,800 meter cube	1/2 perimeter
More than 85,200 meter cube	3/4 perimeter
More than 113,600 meter cube	Whole perimeter

- 13.11** For buildings protected by an automatic sprinkler system, the cubical extent of the building can be doubled as shown in [Table 2.7](#).

Table 2.7: Extent of fire engine access for industrial and storage occupancies (with sprinklers)

Minimum Volume	1/6 perimeter (min 15m)
More than 56,800 meter cube	1/4 perimeter
More than 113,600 meter cube	1/2 perimeter
More than 170,400 meter cube	3/4 perimeter
More than 227,200 meter cube	Whole perimeter

- 13.12** ***Note:** The fire loads in industrial premises are much higher and fires could be more complex in nature, scale and magnitude compared to commercial buildings. Larger compartment sizes are common in such buildings especially in process and storage areas. The high rack storage of materials creates a large volume of combustibles. It is important to note that for industrial buildings, the gross cubicle extent is used for the calculation of the extent of accessway required. For buildings protected by an automatic sprinkler system, the cubical extent of the buildings can be doubled.*

- 13.13** Accessway shall be positioned so that the nearer edge shall be not less than 2 m or more than 10 m from the centre position of the access opening, measured horizontally.
- 13.14** Accessway shall be laid on a level platform or if on an incline, the gradient shall not exceed 10%.
- 13.15** Dead-end accessway and fire engine access road shall not exceed 45 m in length or if exceeding 45 m, be provided with turning facilities as shown in [Figure 2.11](#).



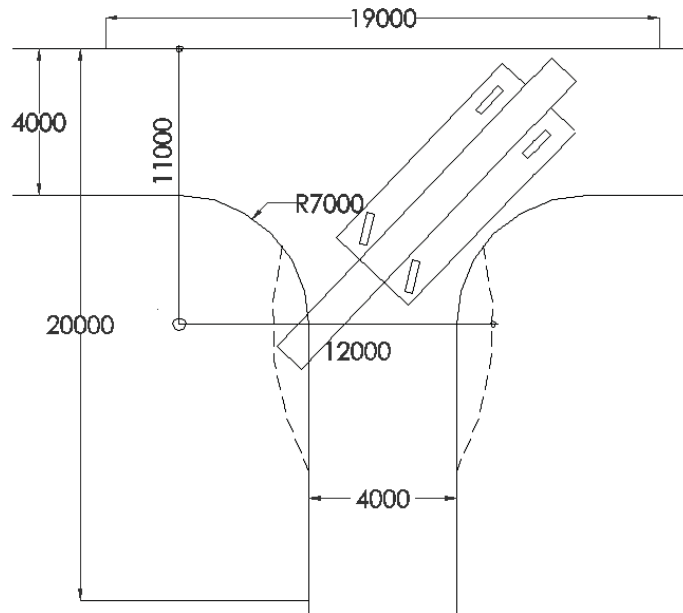


Figure 2.11: Turning Facility for Fire Engine

- 13.16** The outer radius for turning of accessway and fire engine access road shall comply with the requirements as shown in [Figure 2.12](#).

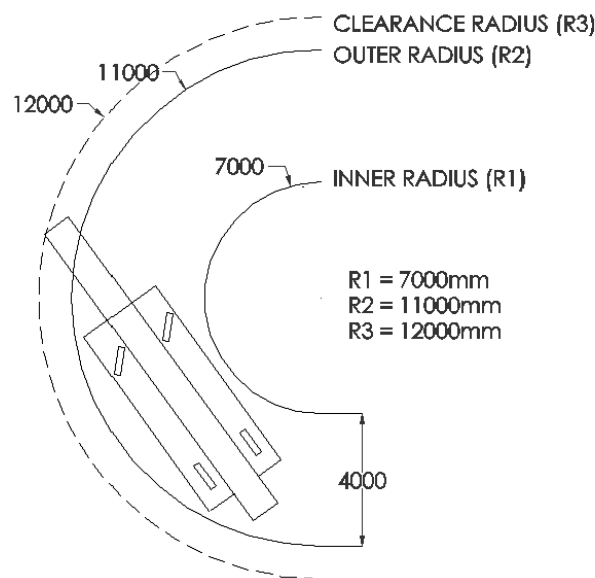


Figure 2.12: U- Turn Facility for Fire Engine

- 13.17** Overhead clearance of accessway and fire engine access road shall be at least 4.5 m for passage of fire fighting appliances. Overhead obstruction to accessway could be entrance gate, link or bridges connecting buildings. See [Figure 2.13](#).



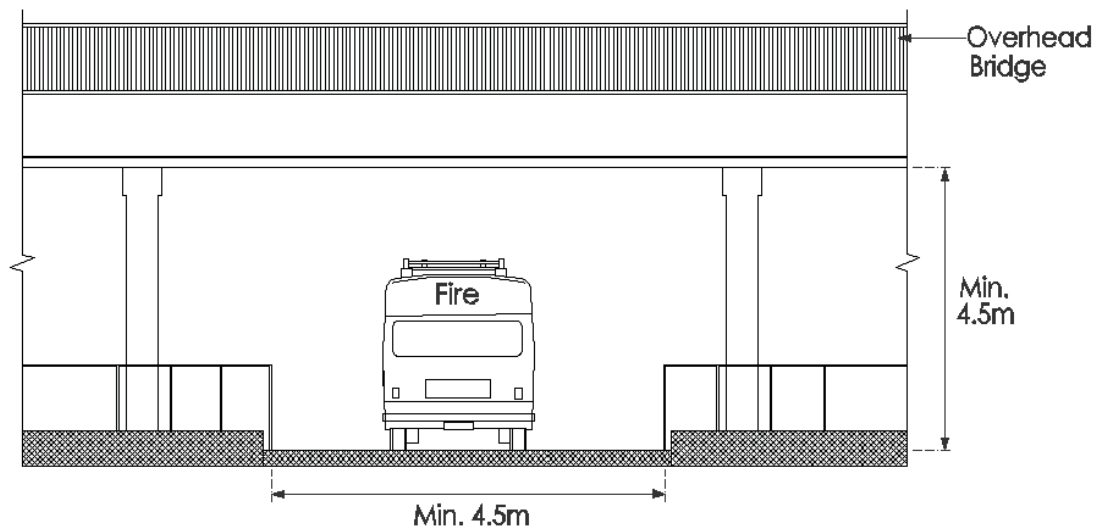


Figure 2.13: Overhead Clearance for Fire Engine Access road

- 13.18** Public roads can serve as Fire access provided the location of such public roads is in compliance with the fire engine access requirements.
- 13.19** Accessway and fire engine access road shall be kept clear of obstructions and other parts of the building, plants, trees or other fixtures shall not obstruct the path between the accessway and access openings. See [Figure 2.14](#).

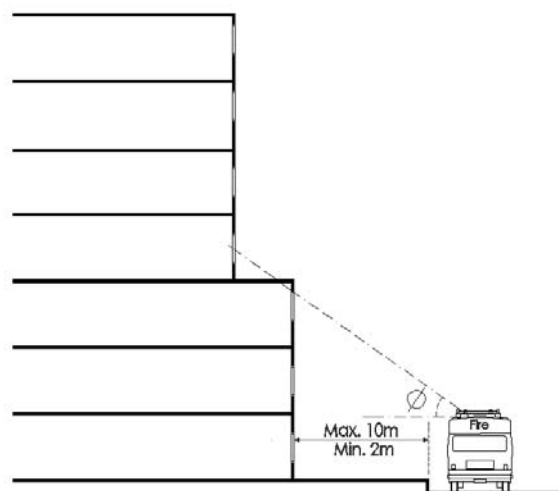


Figure 2.14: Aerial Appliances Clearance

- 13.20** **Note:** The podium edge is obstructing the reach of the boom of fire engine to 4th storey. Other obstructions could be roadside trees, entrance porch etc. To allow full extension of aerial ladders at a safe climbing or elevation angle θ of 60 to 80 degrees, sufficient space is needed to position the fire engine. Public road may be



used as hardstanding by fire engine, provided the edge of the public road to the facade of the building where access openings are located should not exceed 10m.

- 13.21** Tower block is relocated nearer to the edge of the podium base to avoid obstruction to the boom of fire engine. The fire engine shall be located at least 2m, but not more than 10m away from the external wall or façade (including any overhead obstruction) of the building. If the fire engine is located within 2m from the building, the aerial ladder when set-up would fall outside the safe working limit i.e. the inclination of the ladder would be too steep. If the fire engine is located more than 10m from the building, the effective reach of the aerial ladder would be reduced.

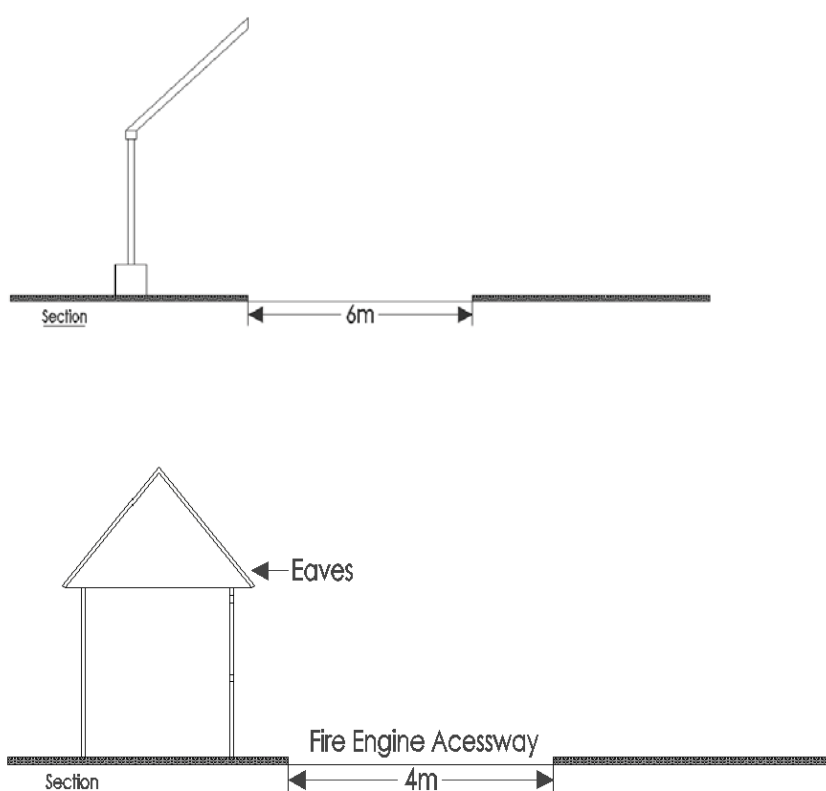


Figure 2.15: Barrier or Gantries

- 13.22** The security barrier, when lifted up, shall not obstruct the fire engine accessway. Eaves of the security post or guard house shall not project into the fire engine accessway.
- 13.23** All corners of accessway shall be marked. Marking of corners shall be in contrasting colour to the ground surfaces or finishes.



- 13.24** Accessway provided on turfed area must be marked with contrasting object (preferably reflective) that is visible at night. The markings are to be at an interval not more than 3 meters apart and shall be provided on both sides of the accessway.
- 13.25** Sign post displaying the wordings 'Fire Engine Access –Keep Clear' shall be provided at the entrance of the accessway. Size of wordings shall not be less than 50mm.

14. Fire Access Roadways

- 14.1** Civil Defence Fire department access roads shall consist of Roadways, Fire Lanes, Parking lot's lanes, or a combination thereof.

Table 2.8: Fire Access roadways and route specifications.

ACCESS ROADWAYS AND ROUTE SPECIFICATIONS.		
Item	For Standard Fire Appliances	For High Reach Fire Appliances
Minimum weight carrying capacity of all-weather driving surface to withstand Civil Defence Vehicle	41,000 Kg	81,000 Kg
Maximum Dead end	45 m	45 m
Minimum Unobstructed width	6 m	6 m
Minimum Unobstructed vertical clearance for any Grade	4.5 m	4.5m
Maximum Road Grade	10%	10%
Minimum width of road between Krebs	6 m	6m
Minimum width of Gateways	4 m	4m
Minimum turning circle (Roundabout) radius walls	16 m	16m

- 14.2** High Reach appliances are typically heavier than normal pumping appliances. However because the weight of high reach appliances is distributed over a number of axles, it is considered that their infrequent use of an access roadway designed to 41,000 kg should not cause damage. It is therefore reasonable to design the Roadbase to 41,000 kg, although any bridges forming part of the access route should be designed to the full 81000 kg capacity.
- 14.3** However, the Fire appliance weights mentioned should be checked with Civil Defence to account for any changes to vehicles or the introduction of new vehicles.

15. Fire Fighter Access within the building

15.1 Fire Lift

- 15.1.1** In any building which is classified as highrise or Highdepth building having more than 2 level of basement, there shall be provided at least one fire lift, which shall be contained within a separate protected shaft or a common



protected shaft containing other lifts subject to such other lifts being served at each storey by a fire fighting lobby.

- 15.1.2** Minimum dimension of a Firelift shall be of 1950mm either in length of breadth.
- 15.1.3** A fire lift shall have access to every habitable floor above or below the designated floor and shall be adjacent and accessible to an exit staircase and be approached by a fire fighting lobby at each storey.
- 15.1.4** Fire lift shall be provided with an operational feature that would enable firemen to cancel first or earlier call which had been inadvertently made to the fire lift during an emergency.
- 15.1.5** This operational feature could be built into the lift control system or alternatively a separate by-pass switch could be provided. If the operational feature is built into the lift control, it is not mandatory to provide a separate by-pass switch.
- 15.1.6** A lift mainly intended for the transport of goods shall not be designated as a fire lift.
- 15.1.7** The power supply to the lift shall be connected to a sub-main circuit exclusive to the lift and independent of any other main or sub-main circuit. The power cables serving the lift installation shall be routed through an area of negligible fire risk.

15.2 Homing of lifts

- 15.2.1** In a fire emergency when any one of the fire detection devices or fire alarm systems is activated, all the passenger lifts shall be brought to the ground floor or egress level with the lift landing doors remaining opened.
- 15.2.2** In the event of power failure or power interruption in the building, the supply to the lifts shall be automatically switched over to the emergency power supply from the generating plant and all lifts shall be brought to the ground floor with the lift landing doors remaining open. Normal operation of the lift shall be automatically reset on the return of normal power supply.
- 15.2.3** All passenger lifts, including hydraulic lifts, can be provided with Automatic Rescue Device (ARD). The ARD shall permit the lifts to move and park at the nearest lift landing floor with the lift/landing doors in the opened position in the event of power failure. Homing any of the lifts to a basement storey is not permitted.

15.3 Alternative Homing Floor

- 15.3.1** Where the lifts open directly into an occupancy area in a designated floor, for example, a shopping floor or an office floor, an alternative designated floor shall also be identified. The lifts shall be brought to the alternative floor



in the event that there is a fire in the designated floor, in close vicinity of the lift landing door. The activation of any detector or sprinkler head covering the lift landing space at the designated floor would cause the lift to be re-directed to home to the alternative floor.

15.3.2 The alternative floor shall have minimum fire hazard and pre-selected for the homing of passenger lifts, and where people can escape to safety in an exit staircase or other exit from the lift landing door.

15.3.3 Lift hoistways shall be vented in accordance with NFPA and ASME requirements

15.3.4 Emergency power supply for lighting, ventilation and alarm systems shall be provided for all passenger lifts.

15.3.5 In any building which is classified as highrise, the emergency power supply shall be so sized and arranged such that:

- i. At least one lift (other than the fire lift) with access to every storey, or
- ii. One lift from each vertical zone if the lifts are arranged to serve different zones in the building, shall remain operative in the event of power failure or fire.

15.3.6 A manual overriding switch with the same function as the FIRE SWITCH shall be provided for each of the above designated lift(s). The fire switch shall be located in a designated location such as the emergency command centre.

15.4 Fire Fighting Stairs

15.4.1 Fire-fighting stairs should be a minimum of 1200 mm wide.

15.5 Fire Fighting Lobby

15.5.1 Before a fire can be fought by fire-fighters, a space should be dedicated where they can gather their equipment such as lengths of hose, branches, door opening tools etc., before advancing to fight the fire.

15.5.2 The fire fighting lobby shall have a clear floor area of not less than 5 m². The clear floor area should not exceed 20 m² for spaces serving up to four lifts or 5 m² per lift for spaces serving more than four lifts.

15.5.3 All principal dimensions shall be not less than 1.5 m and should not exceed 8 m in spaces serving up to four lifts or 2 m per lift in spaces serving more than four lifts.

15.5.4 The fire fighting lobby shall be free of combustible materials and ignition sources.



15.6 Location of Landing valves

15.6.1 Landing valves shall be located in accordance to the following preference:

- i. In fire Fighting lobby (if provided), for the first landing valve.
- ii. In Fire fighting or exit staircase, for the first landing valve.
- iii. In smoke free enclosure or external corridor.
- iv. In the common corridor or area within a protected shaft.

15.6.2 Every part of the floor area shall be within 30 m coverage of a landing valve.

15.7 Emergency Command Centre

15.7.1 An Emergency Command Centre shall be provided in any building which is 'Highrise' with 23 m or more in height with the exception of One-and-Two-Family Dwelling and such Emergency Command Center shall have the following:

- i. Fire lift
- ii. Emergency voice communication system
- iii. Engineered smoke control system.

15.7.2 An Emergency Command Centre shall be of adequate size to house all the terminals and supervisory/control equipment, etc of the building's fire protection/detection systems and a free working space of at least 8.9 m² with no dimension lesser than 2440 mm.

15.7.3 An Emergency Command Centre shall be located adjacent to the fire lift lobby at the designated storey of the building (i.e. the lobby of the building on the first storey or immediately adjacent thereto)

15.7.4 Air conditioning or Mechanical ventilation where required for the Emergency Command Centre shall be provided with secondary power supply and shall have ductworks independent of any other ductwork serving other parts of the building.

15.7.5 Two way emergency communication system shall be provided between an Emergency Command Centre and the following area:

- i. Every fire fighting lobby, including ground floor
- ii. All fire fighting related mechanical equipment rooms inclusive of sprinkler pump room, wet rising main pump room, hose reel pump room, switch rooms and generator rooms
- iii. All rooms housing smoke control equipment
- iv. All lift machine rooms



- v. Fire lift
- vi. Fire fighting staircase
- vii. Each area of refuge
- viii. Air-handling control rooms.

15.7.6

These following devices shall be provided in the Emergency Command Centre

- i. Building plan indicating typical floor plans and detail location of building exit staircases, means of egress, exit routes, protected corridors and exit access, fire protection system, fire compartments, fire fighting equipment and fire department access.
- ii. Emergency Voice /Alarm communication system unit.
- iii. Fire Detection and alarm system unit.
- iv. Annunciator visually indicating the location of elevator and their operation.
- v. Status indicator and control of air handling system.
- vi. Controls for unlocking electromagnetic or access control stairways doors.
- vii. Sprinkler valve and waterflow detector display panels.
- viii. Emergency and standby power status indicators.
- ix. Fire Pump status indicators.
- x. Generator supervision devices and manual start and transfer features.
- xi. Public address system.
- xii. Controls for smoke management systems including jet fans.

16. Material Approval

- 16.1.** All the Materials, Systems, Assemblies, equipment, Products and Accessories, referred to in this chapter with respect to Life Safety, Fire Safety and Emergency Services shall be Listed, Approved and Registered by the Civil Defence Material Approval Department.
- 16.2.** The above requirement applies to all the products with or without international listing, registration or approval.



17. Further References

17.1. The following International Codes and Standards were referred, studied and consulted for this chapter. Further details where applicable can be referred to in these Codes and Standards. Also see **XV. ACKNOWLEDGEMENT OF INTERNATIONAL CODES AND STANDARDS.**

- NFPA 1: Uniform Fire Code
- NFPA 14: Standard for the installation of Standpipe and Hose Systems
- NFPA 24: Standard for the Installation of Private Fire Service Mains and Their Appurtenances
- NFPA 22: Standard for Water Tanks for Private Fire Protection
- NFPA 20: Standard for the Installation of Stationary Pumps for Fire Protection



CHAPTER 3

MEANS OF EGRESS

1. Definition

1.1 Means of Egress

A continuous and unobstructed way of travel from any point in a building or structure to a public way consisting of three separate and distinct parts: The exit access, the exit and the exit discharge.

2. General

2.1 The provisions of this section of the Code express the way of determining the design, construction, protection, location and arrangement of exit facilities to provide safe means of egress for occupants from all occupancies hereafter erected, altered or changed in occupancy. Means of Egress consists of vertical and horizontal travel which can be intervening room spaces, doorways, hallways, corridors, passageways, balconies, ramps, stairs, elevators, enclosures, lobbies, horizontal exits, courts and yards.

2.2 Such means of egress is categorized into distinct following sections.

- i. The Exit Access
- ii. The Exit
- iii. The Exit Discharge

3. The Exit Access

3.1 The Exit Access is that part of the means of egress which leads to an exit. In other words all spaces occupied and traversed to reach an exit is considered as the Exit Access such as doors, intervening room spaces, hallways, corridors, passageways, elevators, balconies, lobbies and ramps. Stairs can be used within any category, as an exit access, as the exit and as the exit discharge depending upon the location of stair in the building.

3.2 Doors

3.2.1 Every door and door assembly shall be designed and constructed so that the way of egress travel is obvious and direct. Other features such as décor and windows that, because of their physical appearance or design or the materials used in their construction have the potential to be mistaken for doors shall be made inaccessible to the occupants by barriers or railings. Doors can be of several types. This section covers Standard doors, Revolving doors, Powered doors, Access controlled doors, Sliding doors and Rolling shutters.



3.3 Measurement of Door width

3.3.1 For purposes of calculating egress capacity, the width of doors shall be measured as follows:

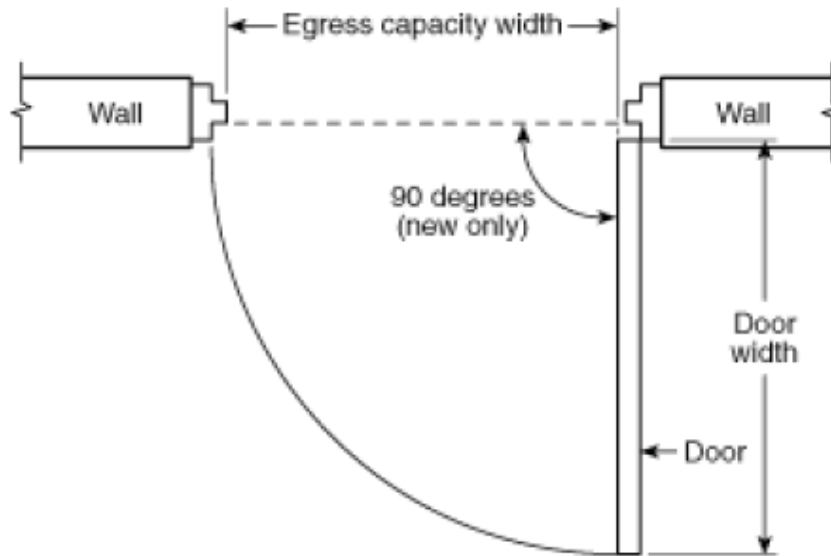


Figure 3.1: Door width — egress capacity

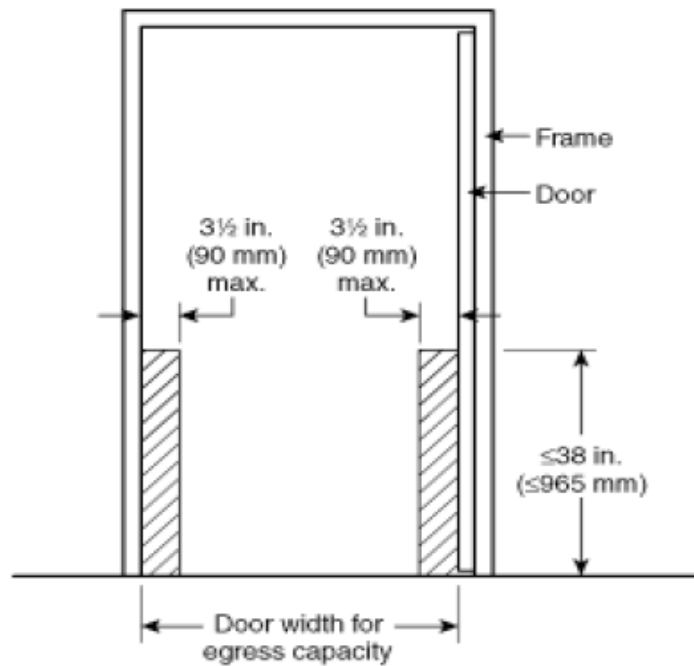


Figure 3.2: Door width — egress capacity with permitted obstructions



3.3.2 For new swinging doors, only the width of the doorway when the door is open 90 degrees shall be included.

3.3.3 For all doors, projections not more than 90 mm at each side of the doorway at a height of not more than 965 mm shall not be considered a reduction in egress capacity width.

3.3.4 For swinging doors, egress capacity width shall be measured between the face of the door and the stop.

3.4 Measurement of Clear width

3.4.1 Clear width shall be measured at the narrowest point in the door opening.

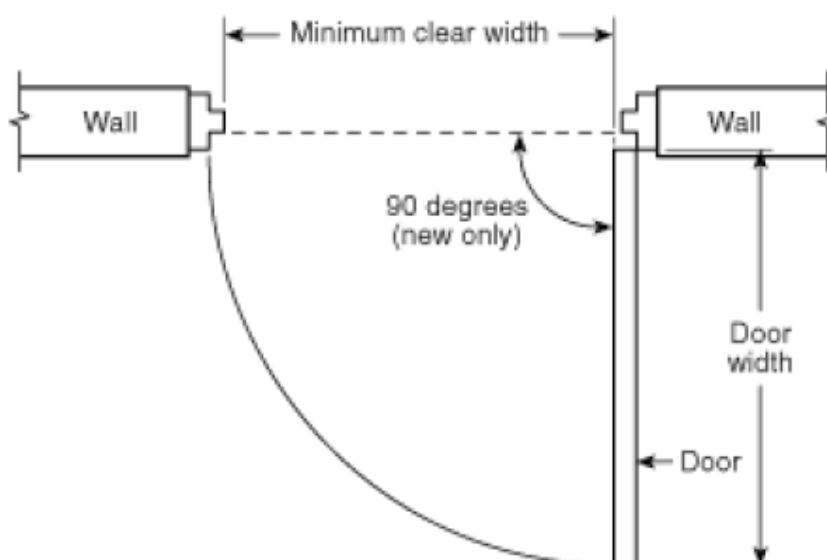


Figure 3.3: Minimum clear width (between face of door and stop)

3.4.2 For swinging doors, projections of not more than 100 mm into the doorway width on the hinge side shall not be considered reductions in width, provided that such projections are for purposes of accommodating panic hardware or fire exit hardware and are located not less than 865 mm above the floor. Projections exceeding 2030 mm above the floor shall not be considered reductions in width.



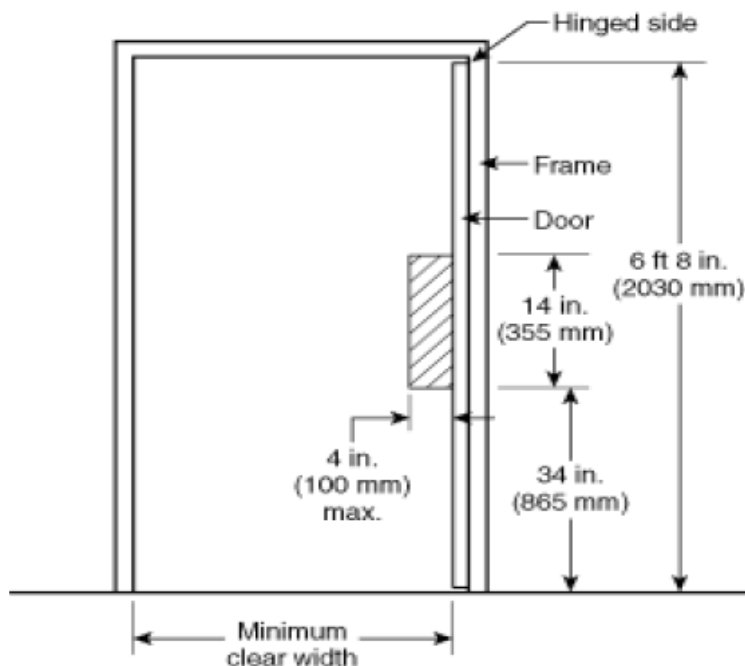


Figure 3.4: Minimum clear width with permitted obstructions

3.5 Minimum Door Width

3.5.1 Door openings in means of egress shall be not less than 915 mm in clear width. Where a pair of doors is provided, not less than one of the doors shall provide not less than 810 (915)-mm clear width opening.

3.5.2 No door into a means of egress, when fully opened, shall project more than 180mm into the required width of an aisle, corridor, passageway, or landing.

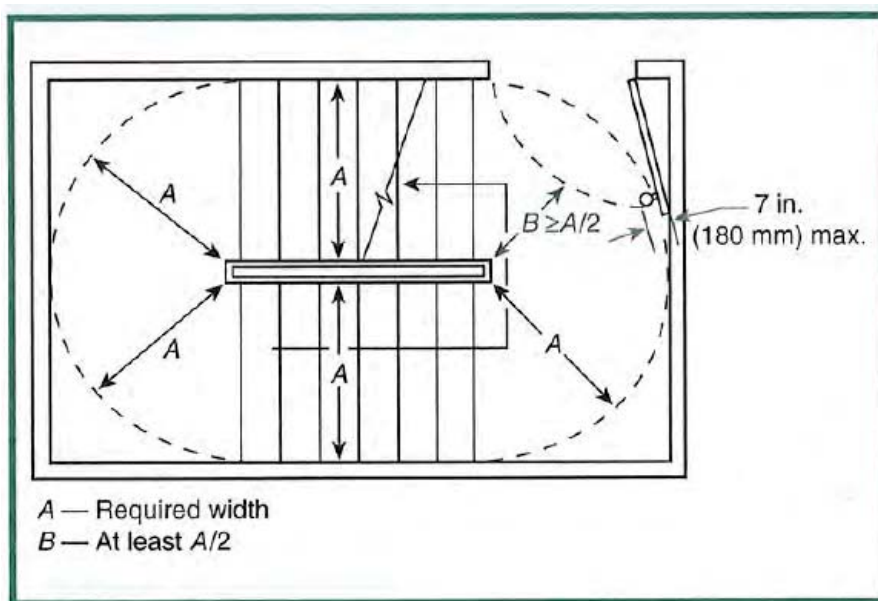


Figure 3.5: Minimum required width



3.6 Floor Level at Door

- 3.6.1** The elevation of the floor surfaces on both sides of a door shall not vary by more than 13 mm.
- 3.6.2** The elevation of the floor surfaces shall be maintained on both sides of the doorway for a distance not less than the width of the widest leaf.
- 3.6.3** Thresholds at doorways shall not exceed 13 mm in height.
- 3.6.4** Raised thresholds and floor level changes in excess of 6.3 mm at doorways shall be beveled with a slope not steeper than 1 in 2.

3.7 Swing and Force

- 3.7.1** Any door in a means of egress shall be of the side-hinged or pivoted-swinging type, and shall be installed to be capable of swinging from any position to the full required width of the opening in which it is installed.
- 3.7.2** Where doors are subject to two-way traffic, or where their opening can interfere with pedestrian traffic, an appropriately located vision panel can reduce the chance of accidents.
- 3.7.3** Doors required to be of the side-hinged or pivoted-swinging type shall swing in the direction of egress travel where serving a room or area with an occupant load of 50 or more.
- 3.7.4** A door shall swing in the direction of egress travel under either of the following conditions:
- Where the door is used in an exit enclosure
 - Where the door serves a high hazard contents area
- 3.7.5** During its swing, any door in a means of egress shall leave not less than one-half of the required width of an aisle, a corridor, a passageway, or a landing unobstructed and shall project not more than 180 mm into the required width of an aisle, a corridor, a passageway, or a landing, when fully open.
- 3.7.6** The forces required to fully open any door manually in a means of egress shall not exceed 67 N to release the latch, 133 N to set the door in motion, and 67 N to open the door to the minimum required width.

3.8 Locks, Latches and Alarm Devices

- 3.8.1** Doors shall be arranged to be opened readily from the egress side whenever the building is occupied.
- 3.8.2** Every door in a stair enclosure serving more than four stories shall meet one of the following:



- i. Re-entry from the stair enclosure to the interior of the building shall be provided.
- ii. An automatic release that is actuated with the initiation of the building fire alarm system shall be provided to unlock all stair enclosure doors to allow re-entry.

3.8.3 Re-entry provisions apply only to enclosed exit stairs and not to outside stairs.

3.8.4 There shall be not more than four stories intervening between stories where it is possible to leave the stair enclosure to access another exit. See **Figure 3.6**.

3.8.5 Re-entry shall be possible on the top story or next-to-top story served by the stair enclosure, and such story shall allow access to another exit.

3.8.6 Doors allowing re-entry shall be identified as such on the stair side of the door.

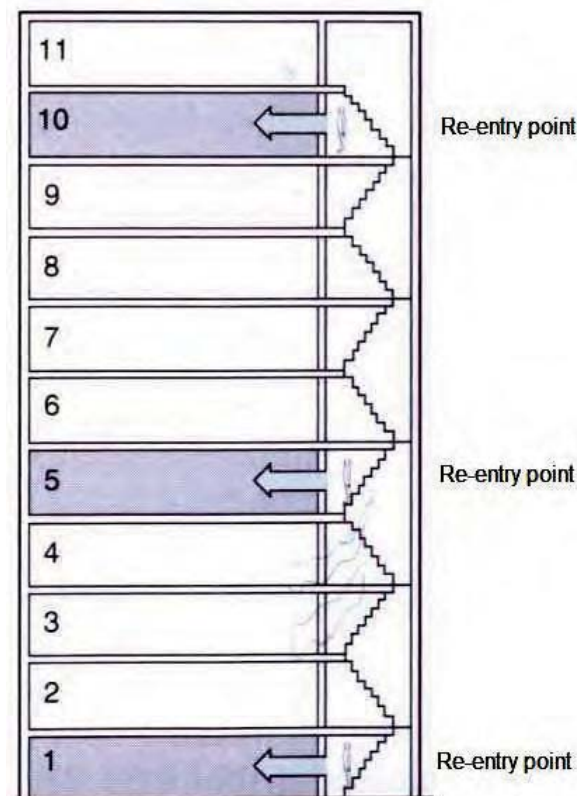


Figure 3.6: Re-entry floor

3.8.7 Doors not allowing re-entry shall be provided with a sign on the stair side indicating the location of the nearest door, in each direction of travel that allows re-entry or exit.

3.8.8 If a stair enclosure allows access to the roof of the building, the door to the roof either shall be kept locked or shall allow re-entry from the roof.



3.8.9 A latch or other fastening device on a door shall be provided with a releasing device that has an obvious method of operation and that is readily operated under all lighting conditions.

3.8.10 The releasing mechanism for any latch shall be located not less than 865 mm, and not more than 1220 mm, above the finished floor. The releasing mechanism shall open the door with not more than one releasing operation.

3.8.11 Where pairs of doors are required in a means of egress, each leaf of the pair shall be provided with a releasing device that does not depend on the release of one door before the other.

3.9 Access Controlled Doors

3.9.1 Doors in the means of egress shall be permitted to be equipped with an approved entrance and egress access control system, provided that all of the following criteria are met:

- i. A sensor shall be provided on the egress side, arranged to detect an occupant approaching doors that are arranged to unlock in the direction of egress upon detection of an approaching occupant or loss of power to the sensor.
- ii. Loss of power to the part of the access control system that locks the doors shall automatically unlock the doors in the direction of egress.
- iii. The doors shall be arranged to unlock in the direction of egress from a manual release device located 1015 mm to 1220 mm vertically above the floor and within 1525 mm of the secured doors.
- iv. The manual release device shall be readily accessible and clearly identified by a sign that reads as follows: PUSH TO EXIT.
- v. Activation of the building automatic sprinkler or fire detection system, if provided, shall automatically unlock the doors in the direction of egress, and the doors shall remain unlocked until the fire-protective signaling system has been manually reset.

3.10 Self-Closing Devices

3.10.1 A door normally required to be kept closed shall not be secured in the open position at any time and shall be self-closing or automatic-closing.

3.10.2 Doors shall be permitted to be automatic-closing, provided that the following criteria are met:

- i. Upon release of the hold-open mechanism, the door becomes self-closing.



- ii. The release device is designed so that the door instantly releases manually and, upon release, becomes self-closing.
- iii. The automatic releasing mechanism or medium is activated by the operation of approved smoke detectors.
- iv. Upon loss of power to the hold-open device, the hold-open mechanism is released and the door becomes self-closing.

3.11 Powered Doors

- 3.11.1** Where means of egress doors are operated by power upon the approach of a person or are provided with power-assisted manual operation, the design shall be such that, in the event of power failure, the doors open manually to allow egress travel or close when necessary to safeguard the means of egress.
- 3.11.2** The forces required to manually open the doors shall not exceed 133 N to set the door in motion, and 67 N to open the door to the minimum required width.
- 3.11.3** The door shall be designed and installed such that, when a force is applied to the door on the side from which egress is made, it shall be capable of swinging from any position to provide full use of the required width of the opening in which it is installed.
- 3.11.4** A readily visible, durable sign in letters not less than 25 mm high on a contrasting background that reads as follows in both English and Arabic, shall be located on the egress side of each door: IN EMERGENCY, PUSH TO OPEN.

3.12 Revolving Doors

- 3.12.1** Revolving doors shall not be permitted as a component in a means of egress.

3.13 Doors in Folding Partitions

- 3.13.1** Where permanently mounted folding or movable partitions divide a room into smaller spaces, a swinging door or open doorway shall be provided as an exit access from each such space.

3.14 Fire Rating Requirements for Doors

- 3.14.1** Fire rating of doors shall be as follows based on location and occupancies in the table below:



Table 3.1A: Fire Rating Requirements for Doors at various locations

OCCUPANCY	LOCATION	DOOR FIRE RATING	SMOKE PROOF	SELF CLOSING	LATCHES
All Occupancies	Exit Stairs	90 Minutes	Yes	Yes	Not Allowed
All Occupancies	Exit Discharge	90 Minutes	Yes	Yes	Not Allowed
All Occupancies	Exit Corridor	60 Minutes	Yes	No	Not Allowed
All Occupancies	Service Corridor	60 Minutes	No	No	Allowed
All Occupancies	Service Rooms	60 Minutes	No	No	Allowed
All Occupancies	Access Panel	60 Minutes	No	No	Allowed
All Occupancies	Elevator Lobby	60 Minutes	Yes	Yes	Not Allowed
All Occupancies	Horizontal Exits	90 Minutes	Yes	Yes	Not Allowed
Labour Accommodation	Room Door	30 Minutes	No	No	Allowed
Residential Flats	Main Flat Door	60 Minutes	No	No	Allowed
Hotels	Main Room Door	60 Minutes	No	No	Allowed
Office	Main Entrance	60 Minutes	Yes	Yes	Allowed

4. Exit Access Corridors

4.1 Exit Access Corridors, also termed as Exit enclosures shall provide access to exit without passing through any intervening rooms other than corridors, lobbies, and other spaces permitted to be open to the corridor. Exit access corridors shall also provide access to not less than two approved exits. Exit staircases can also be accessed by external exit passageway. See [Figure 3.7](#) for examples of external exit passageways.

4.2 Separation and protection of Exit Access Corridors

- 4.2.1** Corridors used as exit access and serving an area having an occupant load exceeding 30 people shall be separated from other parts of the building by smoke partitions. The separating construction shall meet the following requirements:
- The separation shall have not less than a 1-hour fire resistance rating.
 - Separation of 1 hour fire rating shall not be with light weight construction in Highrise, Midrise, Highdepth Underground buildings and buildings connecting four or more stories.
 - The separation required between the exit access corridor and the other parts of the building shall be constructed of an assembly of noncombustible material and shall be supported by construction having not less than a 1-hour fire resistance rating.



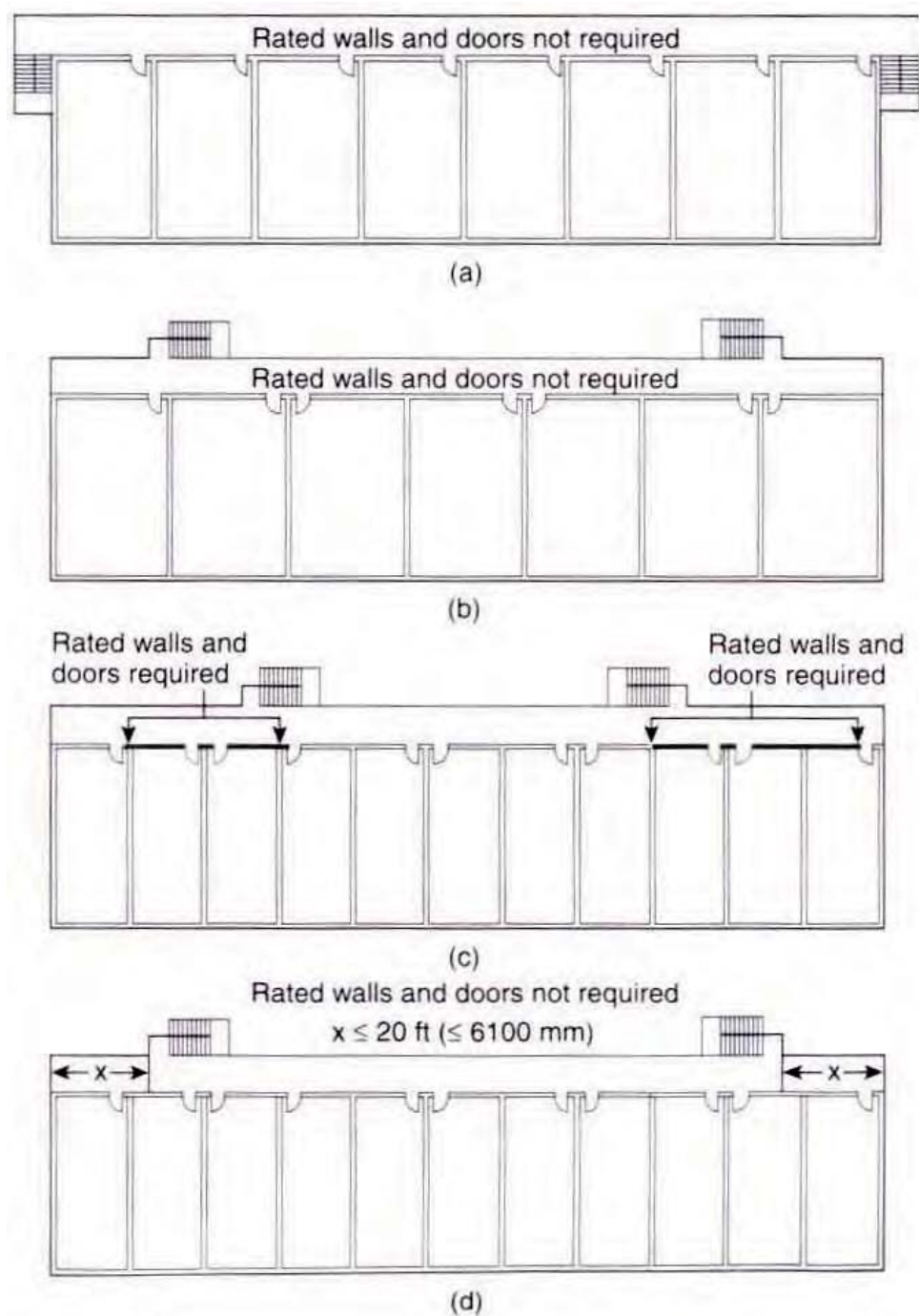


Figure 3.7: External Exit Passageways.

4.2.2 Also Refer to [Chapter 1. CONSTRUCTION AND COMPARTMENTALIZATION, Table 1.10a](#): Fire Rating of Corridors and Internal Walls based on **Occupancies and provision of sprinklers**.

4.2.3 Openings in the separation shall be protected by fire door assemblies equipped with door closers. See [3.14. Fire Rating Requirements for Doors](#).



- 4.2.4** Openings in exit enclosures shall be limited to doors from normally occupied spaces and corridors and doors for egress from the enclosure.
- 4.2.5** Means of egress from the level of exit discharge is permitted to pass through an exit stair enclosure or exit passageway serving other floors.
- 4.2.6** Vision panels in doors are permitted.
- 4.2.7** Penetrations into, and openings through, an exit enclosure assembly shall be limited to the following:
- Fire doors with self-closer.
 - Electrical conduits serving the stairway such as security systems, public address systems, and fire department emergency communications devices.
 - Required exit doors.
 - Ductwork and equipment necessary for independent stair pressurization.
 - Sprinkler piping.
 - Standpipes.
- 4.2.8** Penetrations for fire alarm circuits, where the circuits are installed in metal conduit and the penetrations are protected.
- 4.2.9** Penetrations or communicating openings shall be prohibited between adjacent exit enclosures
- 4.2.10** An exit enclosure shall provide a continuous protected path of travel to an exit discharge.
- 4.2.11** An exit enclosure shall not be used for any purpose that has the potential to interfere with its use as an exit. Occupancy is prohibited other than for egress, refuge, and access.

4.3 Ramps

- 4.3.1** Ramps are permitted as part of means of egress and are preferred over stairs under some circumstances, provided conformity to the following construction requirements are ensured and Civil Defence Authority approves.



Table 3.1: Ramps Specifications

RAMP SPECIFICATIONS	
ITEM	REQUIREMENTS
Minimum unobstructed width	1200 mm
Maximum projections at or below Handrail height on each side	114 mm
Maximum slope	1 in 12 (8.3%)
Maximum cross slope	1 in 48 (2%)
Maximum rise for a single Ramp run	760 mm
Maximum slope of landings	1 in 48 (2%)
Minimum width of landing in the direction of travel	1220mm

4.3.2 All ramps serving as required means of egress shall be of permanent fixed non-combustible construction.

4.3.3 The ramp floor and landings shall be solid and without perforations.

4.3.4 Ramps shall have landings located at the top, at the bottom, and at doors opening onto the ramp.

4.3.5 Every landing shall have a width not less than the width of the ramp.

4.3.6 Where the ramp is not part of an accessible route, the ramp landings shall not be required to exceed 1220 mm in the direction of travel, provided that the ramp has a straight run.

4.3.7 Any changes in travel direction shall be made only at landings.

4.3.8 Ramps and intermediate landings shall continue with no decrease in width along the direction of egress travel.

4.3.9 Enclosure and Protection of Ramps

4.3.9.1 Ramps in a required means of egress shall be enclosed or protected as a stair.

5. Exits

5.1 Exit is that part of the means of egress which is separated from all other spaces of a building by construction required providing a protected way of travel to the Exit Discharge. Exits include exterior doors, exit stairs, exit ramps and horizontal exits.

5.2 Exit Stairs

5.2.1 Stairs, whether interior or exterior to a building, serve multiple functions, allowing normal occupant movement among floors of building, providing



egress during emergencies and fires and facilitating rescue and fire control operations by Fire fighters.

Table 3.2: Exit Stair Specifications

EXIT STAIR SPECIFICATIONS	
Item	Requirements
Minimum unobstructed width for less than 2000 people	1200 mm *
Minimum unobstructed width for more than 2000 people	1420 mm *
Maximum riser height	180 mm
Minimum riser height	100 mm
Minimum tread depth	280 mm
Minimum headroom	2030 mm
Maximum height between landings	3660 mm
Maximum tread and landing slope	21 mm (1 in 48)

- * Note:**
- i. Also see [5.2.3.1](#) for Occupant Load consideration
 - ii. Also see [Section 11.8](#), [Table 3.6 A](#) & [3.6 B](#) for Occupant load factors, Discharge densities and minimum corridor widths.

5.2.2 Measurement of Headroom

5.2.2.1 Measurement of headroom clearance shall be in accordance with [Figure 3.8](#) and [Table 3.3](#) below.

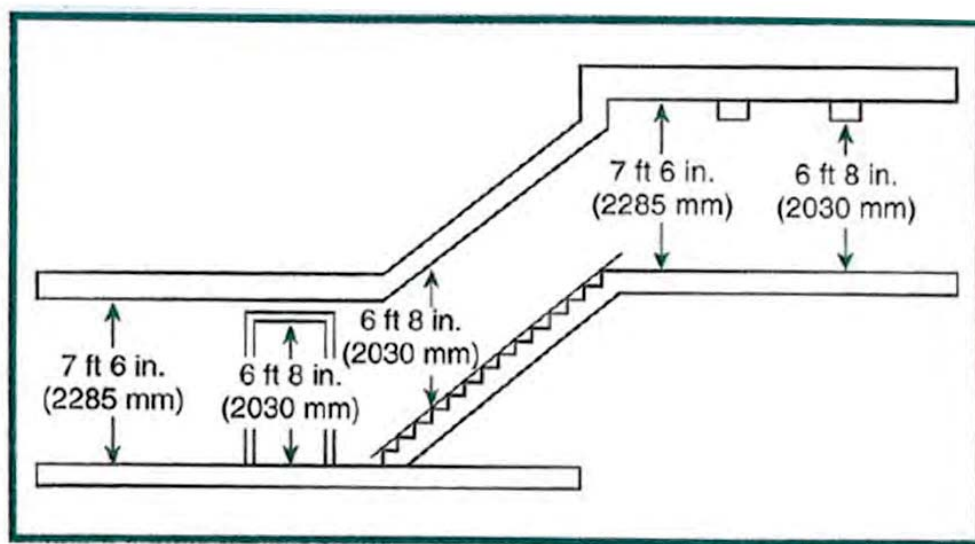


Figure 3.8: Headroom



Table 3.3: Headroom in Means of Egress

HEAD ROOM SPECIFICATIONS	
Items	Requirements
Minimum Headroom	2285 mm
Minimum Headroom with projections from ceiling	2030 mm
Minimum Headroom at Stairs	2030 mm
Maximum projections	6.3 mm
If change in elevation is between 6.3 mm – 13 mm	Shall be beveled 1 to 2
If change in elevation exceed 13 mm	Shall be achieved with a Ramp or a Stair

5.2.3 Minimum Stair Width measurement

- 5.2.3.1** The minimum width clear of all obstructions, except projections not more than 114 mm at or below handrail height on each side. The stair width requirement is based on accumulating the occupant load on each story the stair serves.
- 5.2.3.2** The total cumulative occupant load assigned to a particular stair shall be that stair's share of the total occupant load.
- 5.2.3.3** For downward egress travel, stair width shall be based on the total number of occupants from stories above the level where the width is measured.
- 5.2.3.4** For upward egress travel, stair width shall be based on the total number of occupants from stories below the level where the width is measured.

5.2.4 Landings

- 5.2.4.1** Stairs shall have landings at door openings.
- 5.2.4.2** Stairs and intermediate landings shall continue with no decrease in width along the direction of egress travel.
- 5.2.4.3** Every landing shall have a dimension, measured in the direction of travel, that is not less than the width of the stair.
- 5.2.4.4** Landings shall not be required to exceed 1220 mm in the direction of travel, provided that the stair has a straight run.

5.2.5 Tread and Landing Surfaces

- 5.2.5.1** Stair treads and landings shall be solid, without perforations.



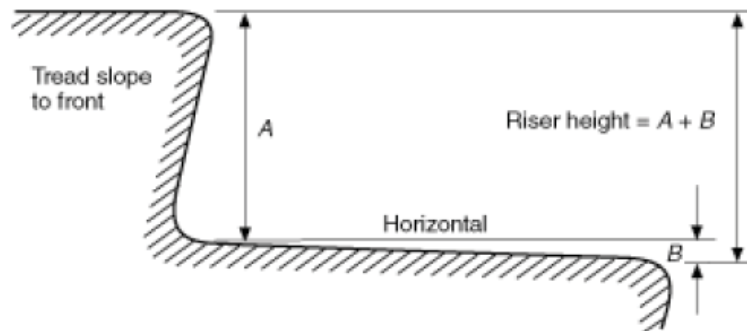


Figure 3.9: Riser measurement with tread slope to the front

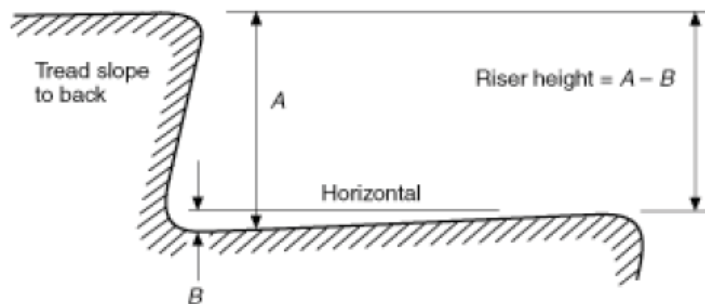


Figure 3.10: Riser measurement with tread slope to back

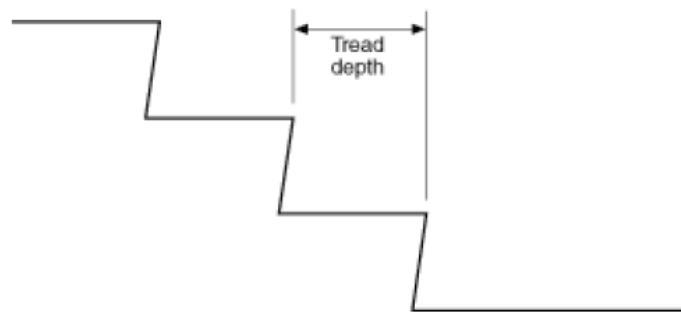


Figure 3.11: Tread depth

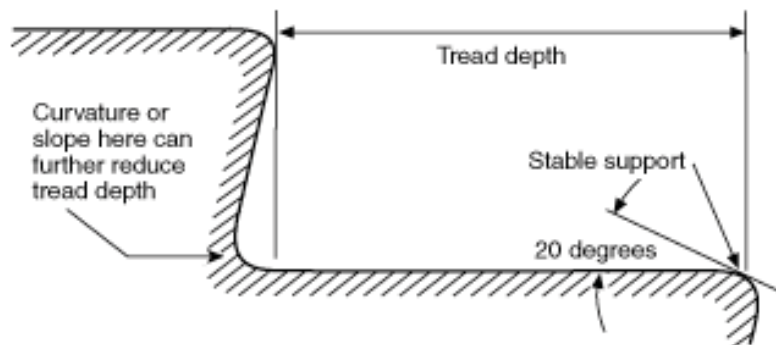


Figure 3.12: Tread measurement with stable support at leading edge



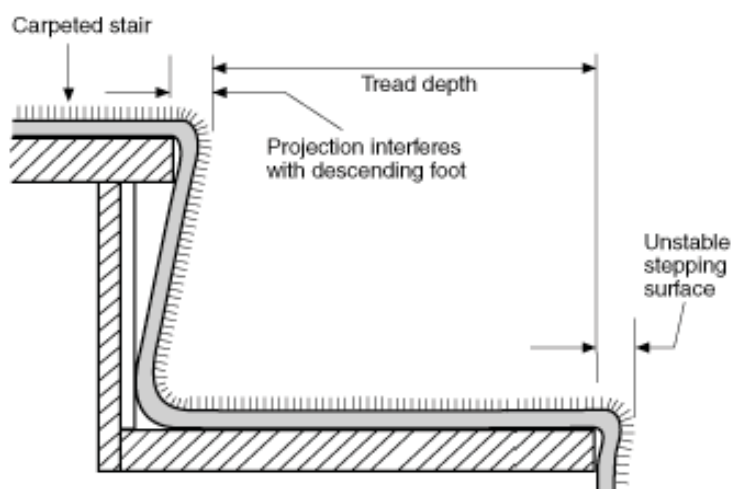


Figure 3.13: Tread measurement with an unstable stepping surface at leading edge

5.2.6 Separation and Protection of Inside Stairs

- 5.2.6.1** All inside stairs serving as an exit shall be enclosed and protected with the required fire rated construction.
- 5.2.6.2** Refer to **Chapter 1. CONSTRUCTION AND COMPARTMENTALIZATION, section 27: Vertical Openings for Fire Rating requirements of Exit Stairs and Exit Passageways.**
- 5.2.6.3** Exit stairs serving Highrise buildings, Midrise buildings, Highdepth Underground buildings and buildings connecting four or more stories shall be constructed of RCC (Reinforced Concrete) with a minimum of 2 hour fire rating.
- 5.2.6.4** Exit Stairs serving Lowrise buildings, Lowdepth Underground buildings and buildings connecting Three or less stories shall be protected with 2 hour fire rated construction.
- 5.2.6.5** Where nonrated walls or unprotected openings enclose the exterior of a stairway, and the walls or openings are exposed by other parts of the building at an angle of less than 180 degrees, the building enclosure walls within 3050 mm horizontally of the nonrated wall or unprotected opening shall be constructed as required for stairway enclosures, including opening protective's.



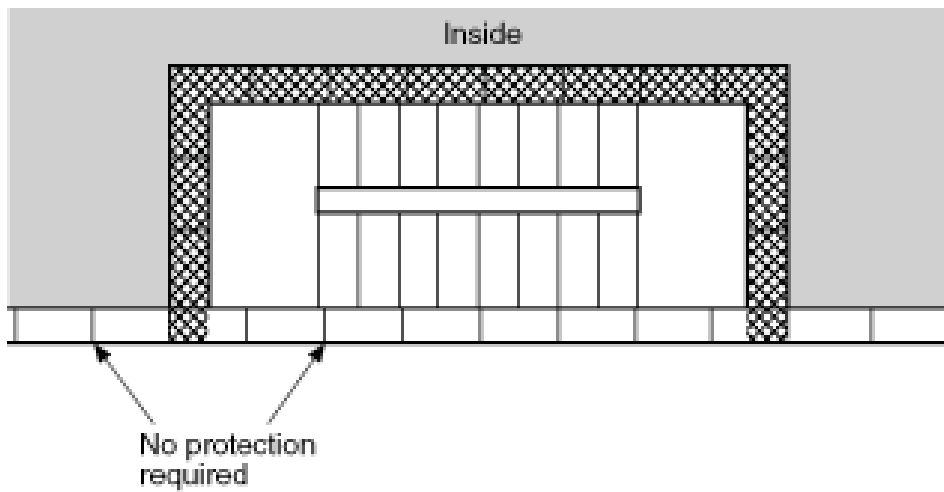


Figure 3.14: Stairway with nonrated exterior wall in same plane as the building exterior wall

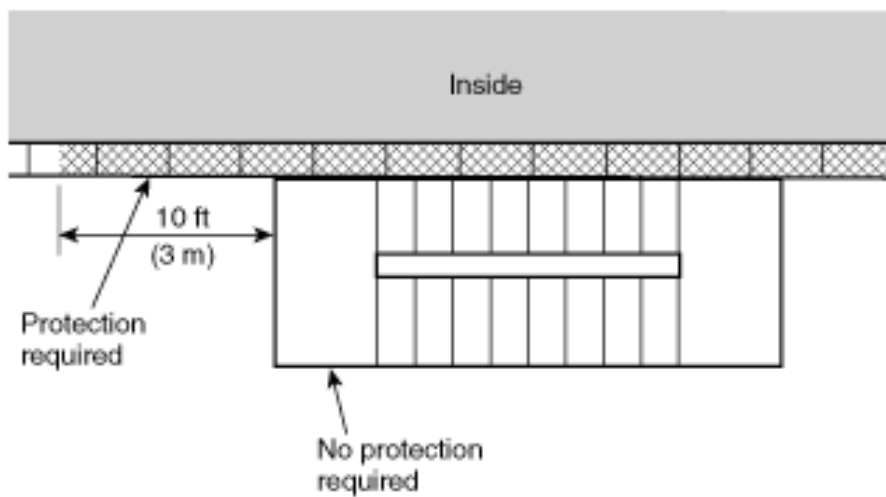


Figure 3.15: A stairway with an unprotected exterior perimeter protruding past the building exterior wall



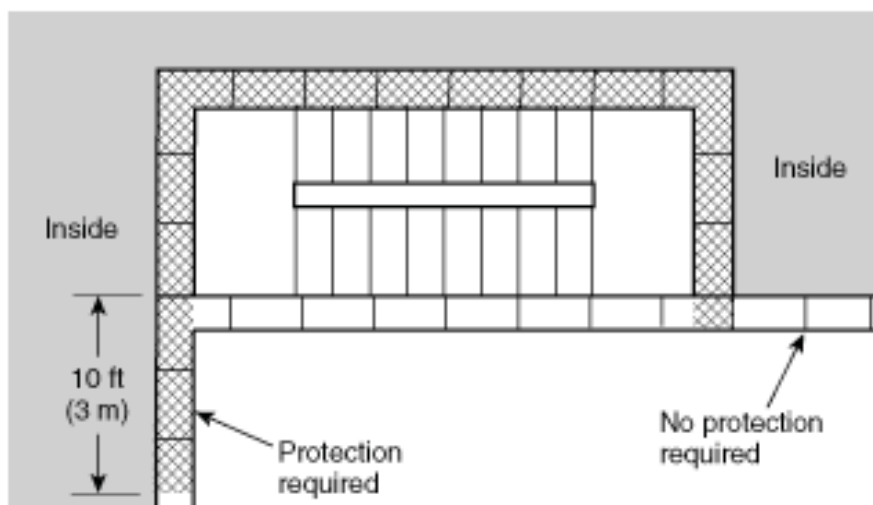


Figure 3.16: A stairway with nonrated exterior wall exposed by an adjacent exterior wall of a building

- 5.2.6.6** Fire rated construction shall extend vertically from the ground to a point 3050 mm above the topmost landing of the stairs or to the roofline, whichever is lower.
- 5.2.6.7** The fire resistance rating of the separation extending 3050 mm from the stairs shall be at least 1 hour fire rating.
- 5.2.6.8** Enclosed, usable spaces within exit enclosures shall be prohibited, including under stairs, unless the following criteria are met:
 - i. The space shall be separated from the stair enclosure by the same fire resistance as the exit enclosure
 - ii. Entrance to the enclosed, usable space shall not be from within the stair enclosure.

5.2.7 Separation and Protection of Outside Stairs

- 5.2.7.1** An open staircase used as a means of egress may link no more than Four floors.
- 5.2.7.2** Outside stairs shall be separated from the interior of the building by construction with the fire resistance rating required for enclosed stairs except as follows:
 - i. Outside stairs serving an exterior exit access balcony that has two remote outside stairways or ramps shall be permitted to be unprotected. See [Figure 3.17](#).



- ii. Outside stairs serving not in excess of two adjacent stories, including the story of exit discharge, shall be permitted to be unprotected where there is a remotely located second exit.

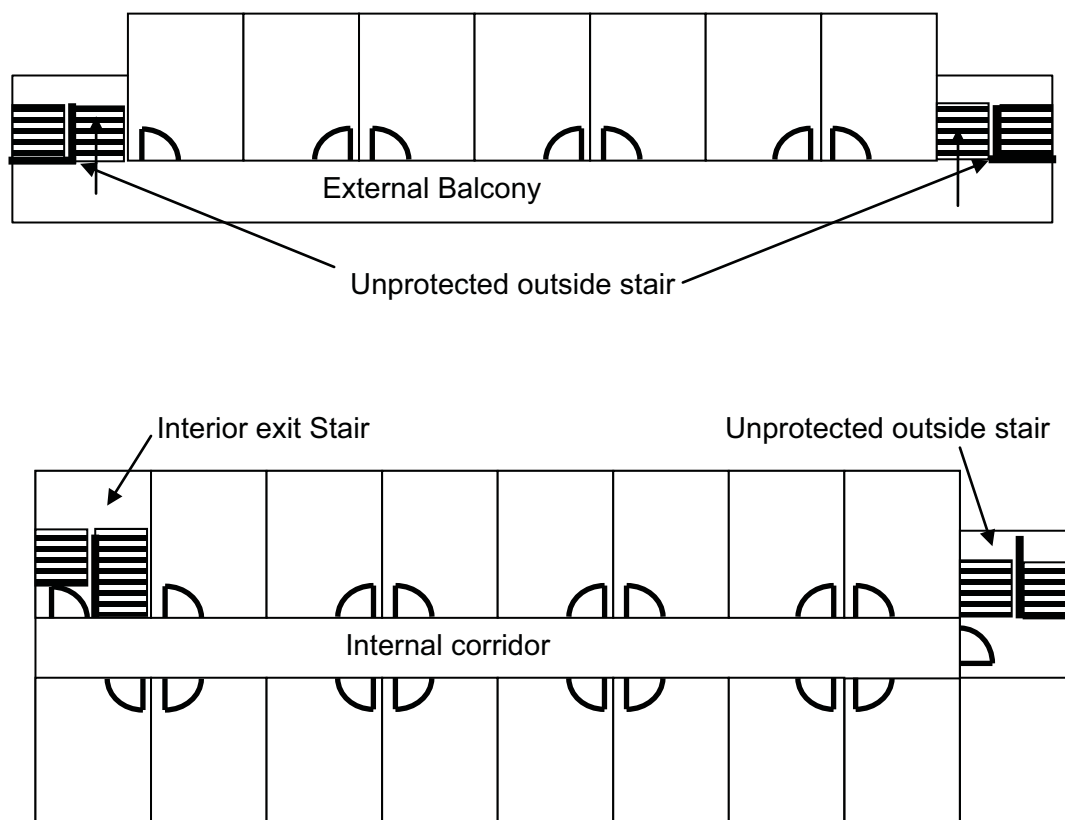


Figure 3.17: Exterior and Interior approach to exit staircase.

5.2.7.3 The fire resistance rating of a separation extending 3050 mm from the stairs shall be at least 1 hour fire rating. See [Figure 3.18](#) for illustrations. Wall construction shall extend as follows:

- i. Vertically from the ground to a point 3050 mm above the topmost landing of the stairs or to the roofline, whichever is lower
- ii. Horizontally for not less than 3050 mm



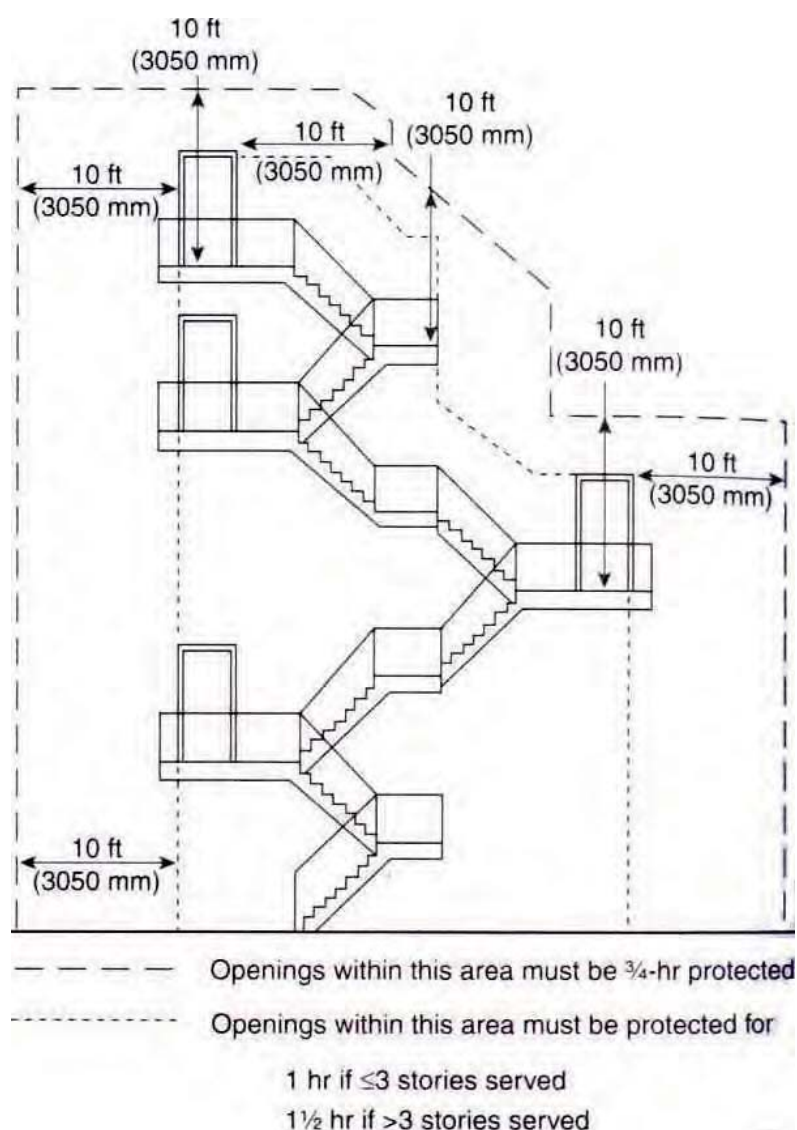


Figure 3.18 – Protection of Outside Staircase

5.2.7.4 Roof construction shall meet the following criteria:

- i. It shall provide protection beneath the stairs
- ii. It shall extend horizontally to each side of the stair for not less than 3050 mm.

5.2.8 Protection of Openings

- 5.2.8.1** All openings below an outside stair shall be protected with an assembly having not less than a 1 hour fire protection rating.
- 5.2.8.2** Openings to the side of an outside stair within 3m should also have a fire protection rating of 1 hour.

5.2.8.3 In the case of normally openable windows etc. these should be fixed shut at all times.

5.2.8.4 Outside stairs, shall be not less than 50 percent open on one side. Outside stairs shall be arranged to restrict the accumulation of smoke.

5.2.9 Special Provisions for Outside Stairs

5.2.9.1 Outside stairs shall be arranged to avoid any impediments to the use of the stairs by persons having a fear of high places. Outside stairs more than three stories in height, shall be provided with an opaque visual obstruction not less than 1220 mm in height.

5.2.10 Scissor or Interlocked Stairs

5.2.10.1 Interlocking or scissor stairs shall be considered only as single exit. See **Figure 3.19** and **3.20**.

5.2.10.2 Interlocking or scissor stairs shall be permitted provided that they meet the following criteria:

- i. They are enclosed in with the proper non-combustible type of construction with the required fire rating.
- ii. They are separated from each other by 2-hour fire resistance-rated noncombustible construction.
- iii. No protected or unprotected penetrations or communicating openings exist between the stair enclosures.

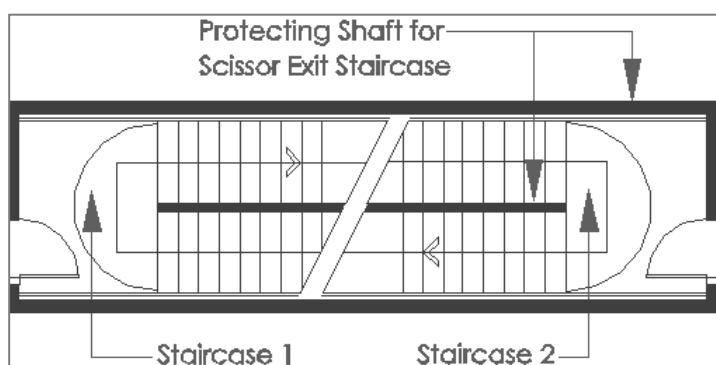


Figure 3.19 – Plan view of a typical Interlocking (scissors) staircase



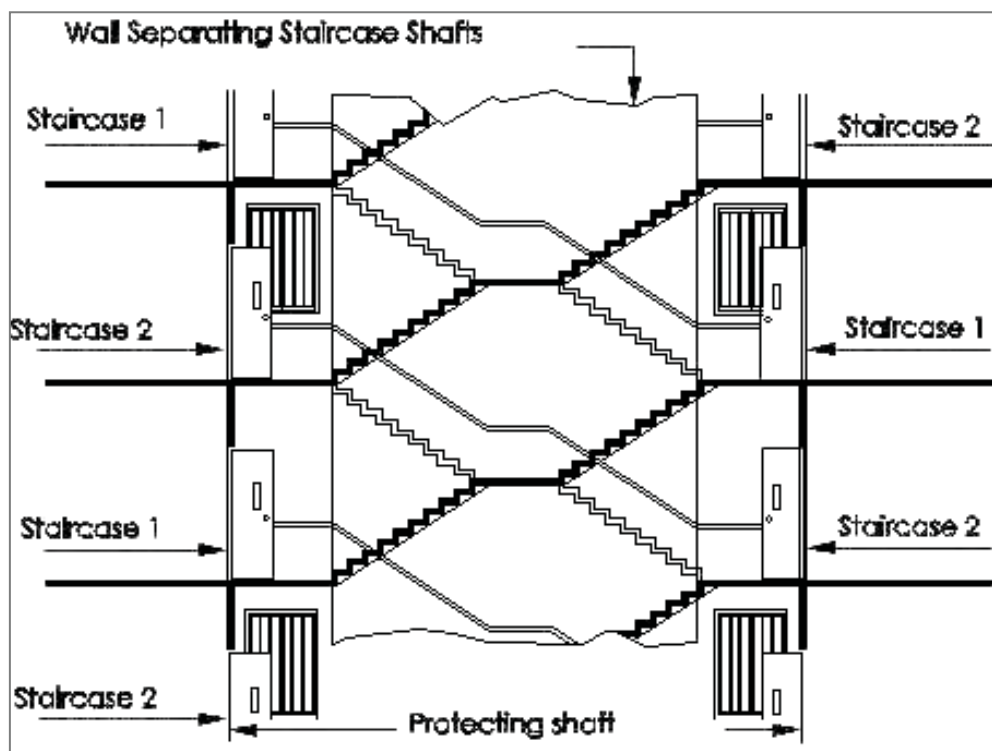


Figure 3.20 – Sectional view of a typical Interlocking (scissors) staircase

5.2.11 Spiral Stairs

5.2.11.1 Spiral Stairs is not allowed as a part of means of egress.

5.2.12 Fire Escape Ladders

5.2.12.1 Fire escape ladders shall be permitted in the means of egress only where providing one of the following:

- As secondary means of egress from boiler rooms or
- Similar spaces subject to occupancy not to exceed three persons who are all capable of using the ladder.
- Fire escape ladders shall comply with ANSI A14.3, Safety Requirements for Fixed Ladders.
- Ladders shall be installed with a pitch that exceeds 75 degrees.
- The lowest rung of any ladder shall not be more than 305 mm above the level of the surface beneath it.



5.2.13 Handrails

5.2.13.1 Stairs and ramps shall have handrails on both sides.

5.2.13.2 In addition to the handrails required at the sides of stairs exceeding 1905 mm in width, handrails shall be provided within 760 mm of all portions of the required egress width.

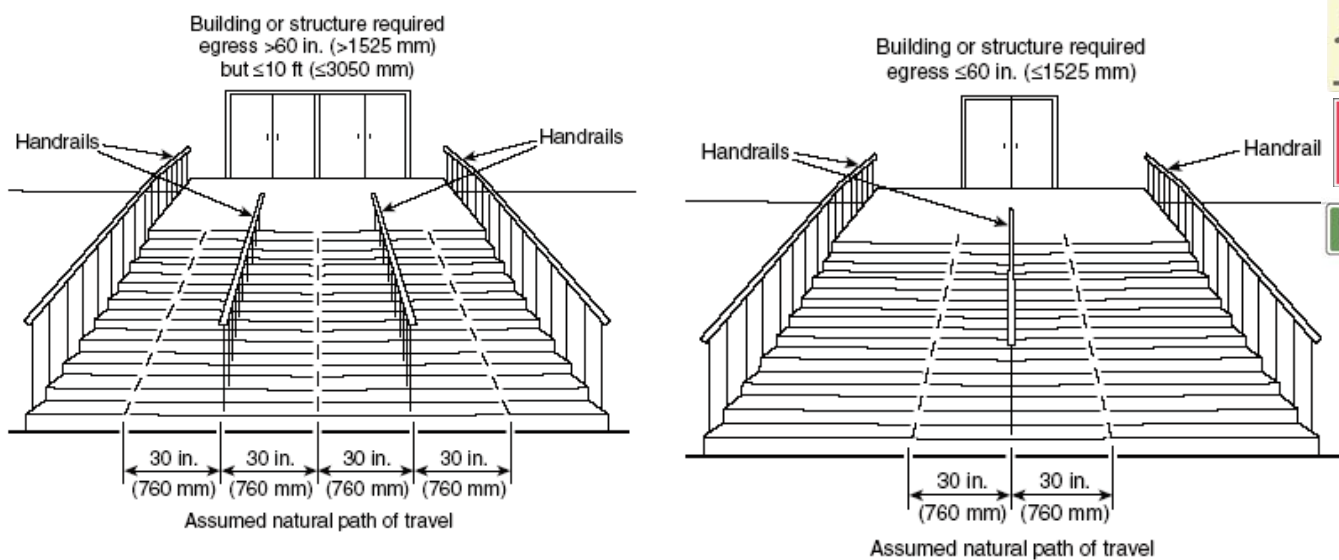


Figure 3.21- Handrails location

5.2.13.3 Required guards and handrails shall continue for the full length of each flight of stairs. At turns inside handrails shall be continuous between flights at landings.

5.2.14 Handrail Details

5.2.14.1 Handrails on stairs shall be not less than 865 mm, and not more than 965 mm, above the surface of the tread, measured vertically to the top of the rail from the leading edge of the tread.



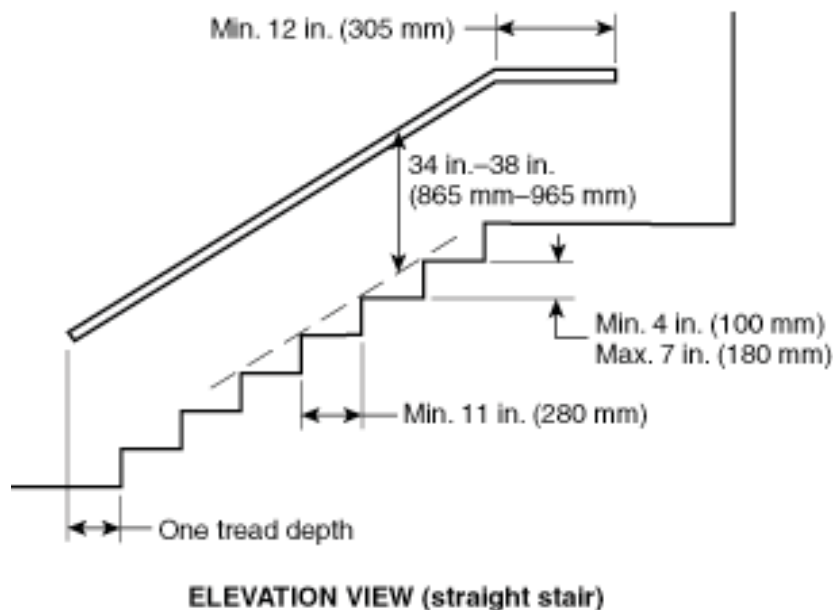


Figure 3.22- Handrail details

- 5.2.14.2** The height of required handrails that form part of a guard shall be permitted to exceed 965 mm, but shall not exceed 1065 mm, measured vertically to the top of the rail from the leading edge of the tread.
- 5.2.14.3** Additional handrails that are lower or higher than the main handrail shall be permitted.
- 5.2.14.4** Handrails shall be installed to provide a clearance of not less than 57 mm between the handrail and the wall to which it is fastened.
- 5.2.14.5** Circular cross section with an outside diameter of not less than 32 mm and not more than 51 mm.

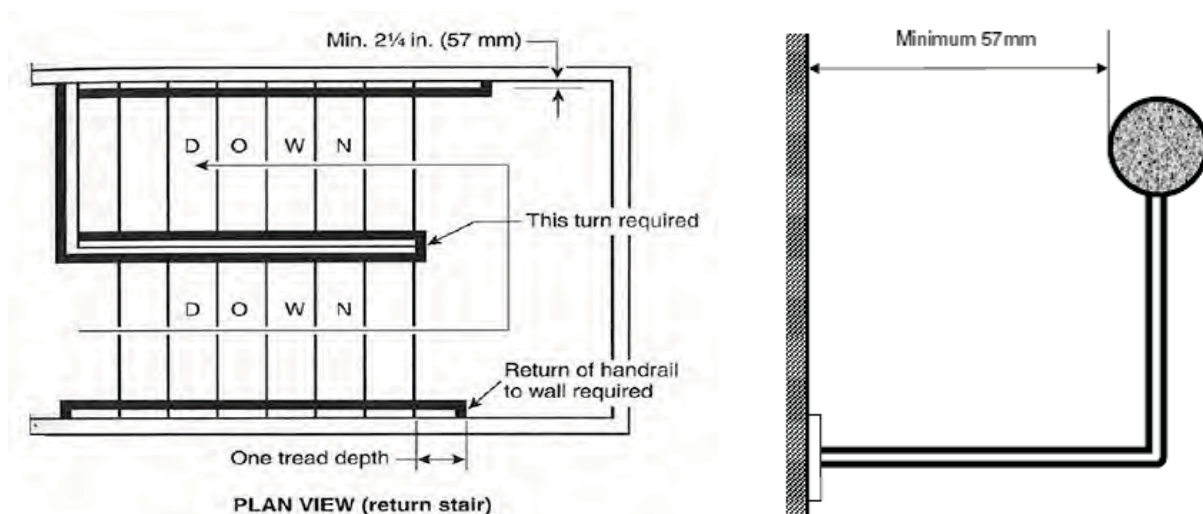


Figure 3.23- Handrail measurement



5.2.14.6 Handrails should be designed so they can be grasped firmly with a comfortable grip and so the hand can be slid along the rail without encountering obstructions. The profile of the rail should comfortably match the hand grips. Handrails shall be continuously graspable along their entire length.

5.2.15 Guards

5.2.15.1 Guards shall be provided at the open sides of means of egress that exceed 760 mm above the floor or grade below. Means of egress components that might require protection with guards include stairs, landings, balconies, corridors, passageways, floor or roof openings, ramps, aisles, porches, and mezzanines.

5.2.15.2 The height of guards required shall be measured vertically to the top of the guard from the surface adjacent there to and shall be not less than 1065 mm high.

5.2.16 Marking of Stairs

5.2.16.1 Enclosed stairs serving four or more stories shall comply with the following:

- i. The stairs shall be provided with special signage within the enclosure at each floor landing
- ii. The signage shall indicate the floor level
- iii. The signage shall indicate the terminus of the top and bottom of the stair enclosure
- iv. The signage shall indicate the identification of the stair enclosure
- v. The signage shall indicate the floor level of, and the direction to exit discharge
- vi. The signage shall be located inside the enclosure approximately 1525 mm above the floor landing in a position that is visible when the door is in the open or closed position.



Figure 3.24- Example of a stairway marking sign



- 5.2.16.2** The sign should be visible under all likely lighting conditions
- 5.2.16.3** Wherever an enclosed stair requires travel in an upward direction to reach the level of exit discharge, special signs with directional indicators showing the direction to the level of exit discharge shall be provided at each floor level landing from which upward direction of travel is required.
- 5.2.16.4** The sign shall be painted or stenciled on the wall or on a separate sign securely attached to the wall 1.6m from the finished floor level.
- 5.2.16.5** The stairway identification letter shall be located at the top of the sign in minimum 25 mm high lettering.
- 5.2.16.6** Roof access or the lack thereof shall be designated by a sign that reads ROOF ACCESS or NO ROOF ACCESS and located under the stairway identification letter. Lettering shall be a minimum of 25 mm high.
- 5.2.16.7** The floor level number shall be a minimum of 125 mm high numbers. Mezzanine levels shall have the letter "M" or other appropriate identification letter preceding the floor number, while basement levels shall have the letter "B" or other appropriate identification letter preceding the floor level number.
- 5.2.16.8** Identification of the lower and upper terminus of the stairway shall be located at the bottom of the sign in minimum 25 mm high letters or numbers.

5.2.17 Floor Diagrams

- 5.2.17.1** A floor diagram shall be provided in staircase landings on the wall beside the exit door. Floor diagrams shall also be provided beside fire alarm panels, in smoke-free enclosures, in fire fighting lobbies and in individual rooms of hotels and health care occupancies
- 5.2.17.2** Floor diagrams shall show the actual floor layout, exit stairways locations, corridors, rooms, landing valves, hose reel, fire extinguishers, lift lobbies and other useful information for fire department as well as occupants.
- 5.2.17.3** Fire safety information shall be provided to each and every employee to make the decision to evacuate to the outside, to evacuate to an area of refuge, to remain in place, or to employ any combination of the three options.

5.2.18 Stair Pressurization

- 5.2.18.1** Every enclosed escape staircase in high rise buildings should be a smoke proof enclosure.



5.2.18.2 Every escape staircase serving buildings of 23 m in height or more must be made a smoke proof enclosure. The means of achieving a smoke proof enclosure should be by pressurization. See [Figures 3.25, 3.26](#) and [3.27](#) for examples of staircase pressurization.

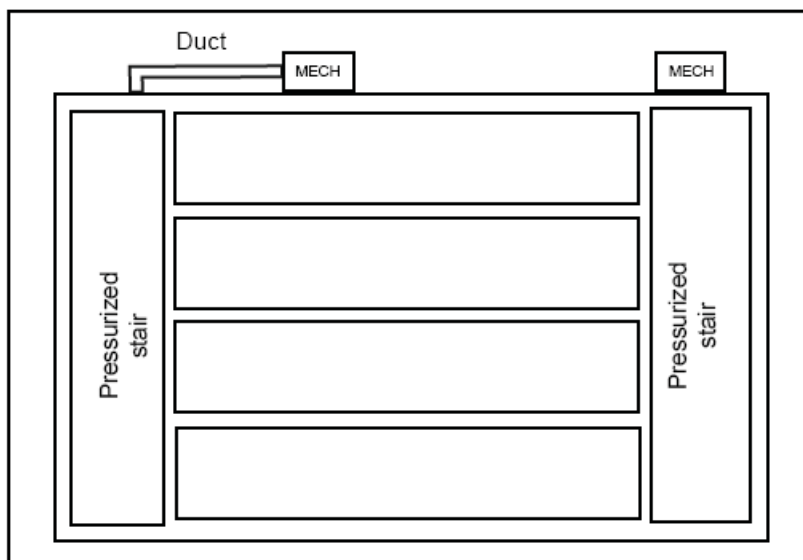


Figure 3.25: Example 1 of Staircase Pressurization

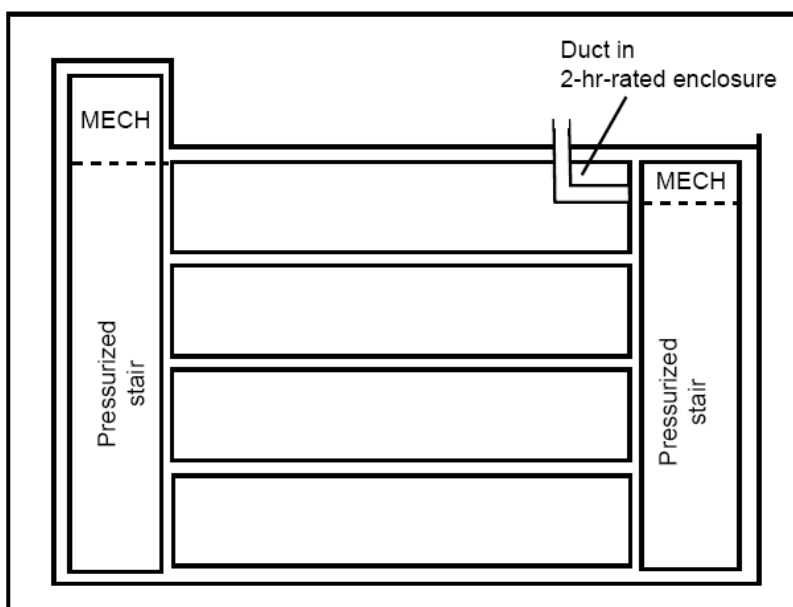


Figure 3.26: Example 2 of Staircase Pressurization



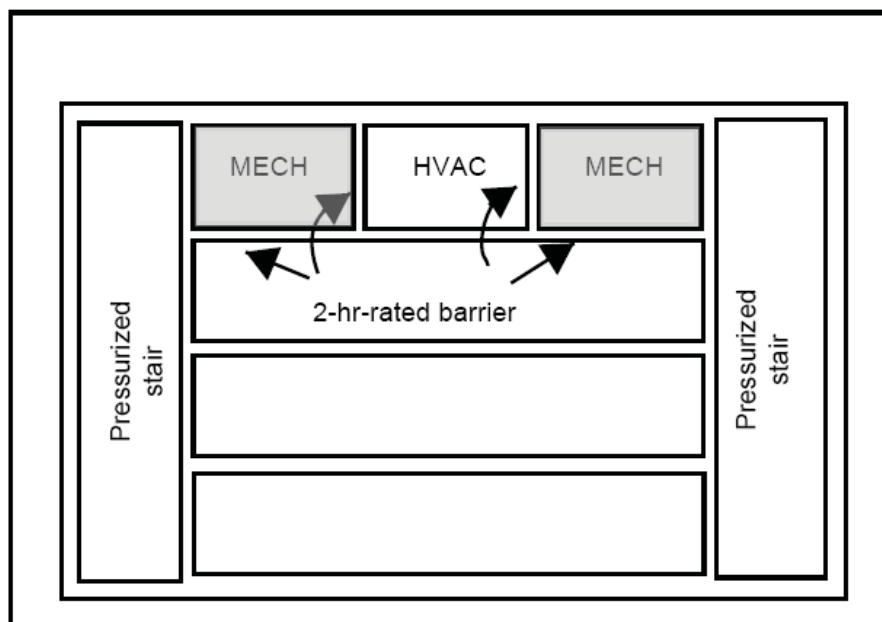


Figure 3.27: Example 3 of Staircase Pressurization

5.2.18.3 Equipment and ductwork for stair pressurization shall be located in accordance with one of the following specifications:

- i. Exterior to the building and directly connected to the stairway by ductwork enclosed in noncombustible construction.
- ii. Within the stair enclosure with intake and exhaust air vented directly to the outside or through ductwork enclosed by a 2-hour fire-resistive rating.
- iii. Where the building, including the stairway enclosure, and the equipment and ductwork are separated from the remainder of the building, including other mechanical equipment, by not less than a 1-hour fire-resistive rating.
- iv. Openings into the required fire resistance-rated construction shall be limited to those needed for maintenance and operation and shall be protected by self-closing fire protection-rated devices.
- v. For pressurized stair enclosure systems, the activation of the systems shall be initiated by a smoke detector installed in an approved location within 3050 mm of the entrance to the smoke proof enclosure.

5.2.18.4 The required mechanical system shall operate upon the activation of the smoke detectors and by manual controls accessible to the fire department. The required system also shall be initiated by the following, if provided:



- i. Water flow signal from an automatic sprinkler system.
- ii. General evacuation alarm signal.

5.2.19 Smoke Proof Enclosure

- 5.2.19.1** A smoke proof enclosure shall be enclosed from the highest point to the lowest point by barriers having 2-hour fire resistance ratings.
- 5.2.19.2** Where a vestibule is used, it shall be within the 2-hour-rated enclosure and shall be considered part of the smoke proof enclosure.
- 5.2.19.3** Every smoke proof enclosure shall discharge into a public way, into a yard or court having direct access to a public way, or into an exit passageway. Such exit passageways shall be without openings, other than the entrance to the smoke proof enclosure and the door to the outside yard, court, or public way.
- 5.2.19.4** The exit passageway shall be separated from the remainder of the building by a 2-hour fire resistance rating.
- 5.2.19.5** Smoke proof enclosures shall use an approved engineered smoke management system with a design pressure difference across the barrier of not less than 12.5 N/m² and shall be capable of maintaining these pressure differences under likely conditions of stack effect or wind. The pressure difference across doors shall not exceed that which allows the door to begin to be opened by a force of 133 N. See [Figure 3.28](#) and [3.29](#) for examples of smoke proof enclosures.
- 5.2.19.6** Staircase ventilation for non-highrise buildings shall be provided with natural, mechanical ventilation or by providing smoke proof enclosures.



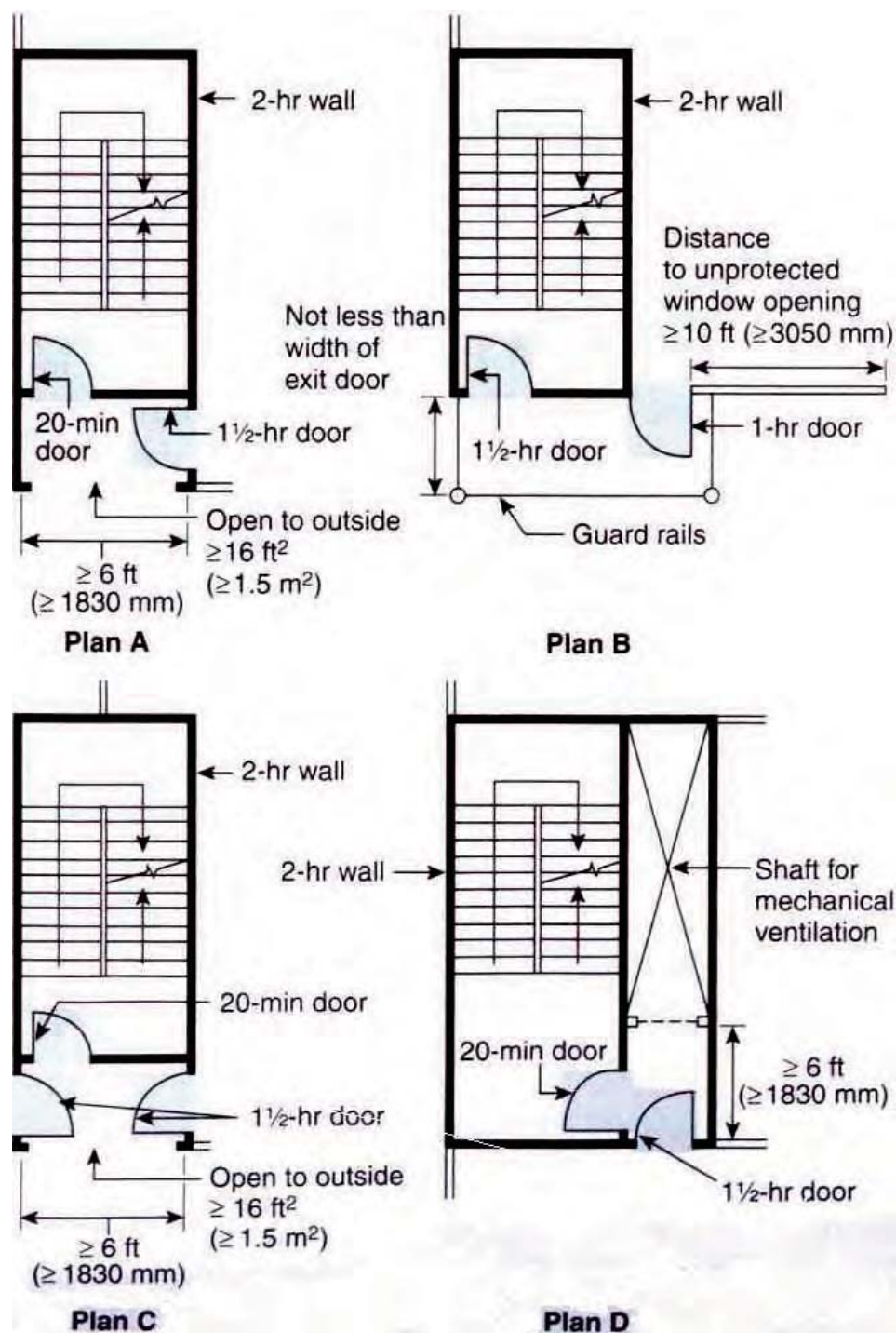


Figure 3.28: Examples of Smoke-proof Enclosures

5.2.19.2 Refer to [Chapter 10. MECHANICAL VENTILATION AND SMOKE CONTROL SYSTEM](#) for further details.



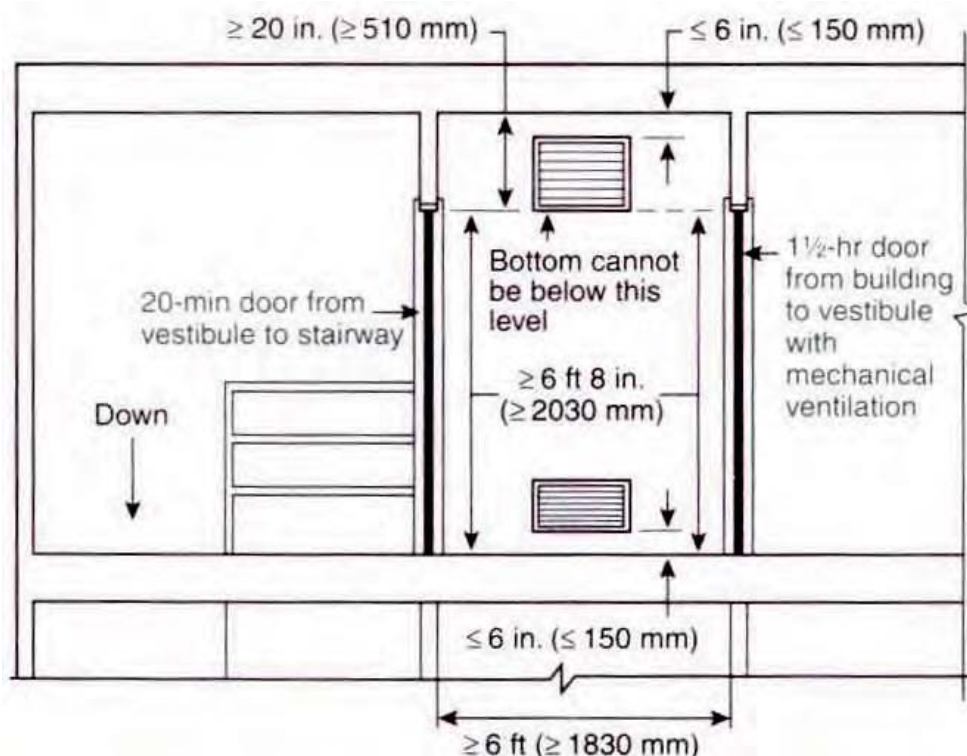


Figure 3.29 – Smoke Proof Enclosures Dimensions

5.2.20 Horizontal Exit

5.2.20.1 A way of passage from one building to an area of refuge in another building on approximately the same level, or a way of passage through or around a fire barrier to an area of refuge on approximately the same level in the same building that affords safety from fire and smoke originating from the area of incidence and areas communicating therewith. Only Health care type of occupancy is allowed for Horizontal Exits.

5.2.20.2 Only one horizontal exits shall be permitted to be substituted for other exits where the total egress capacity of the other exits (stairs, ramps, doors leading outside the building) is not less than half that required for the entire area of the building or connected buildings, and provided that none of the other exits is a horizontal exit. Horizontal exits shall only be applied along with smoke control system and CFD analysis. See Figure 3.30 for example of Horizontal Exit.



5.2.20.3 Horizontal Exits shall be situated at 2 hour Fire rated wall with 90 minutes Fire rated Door assemblies.

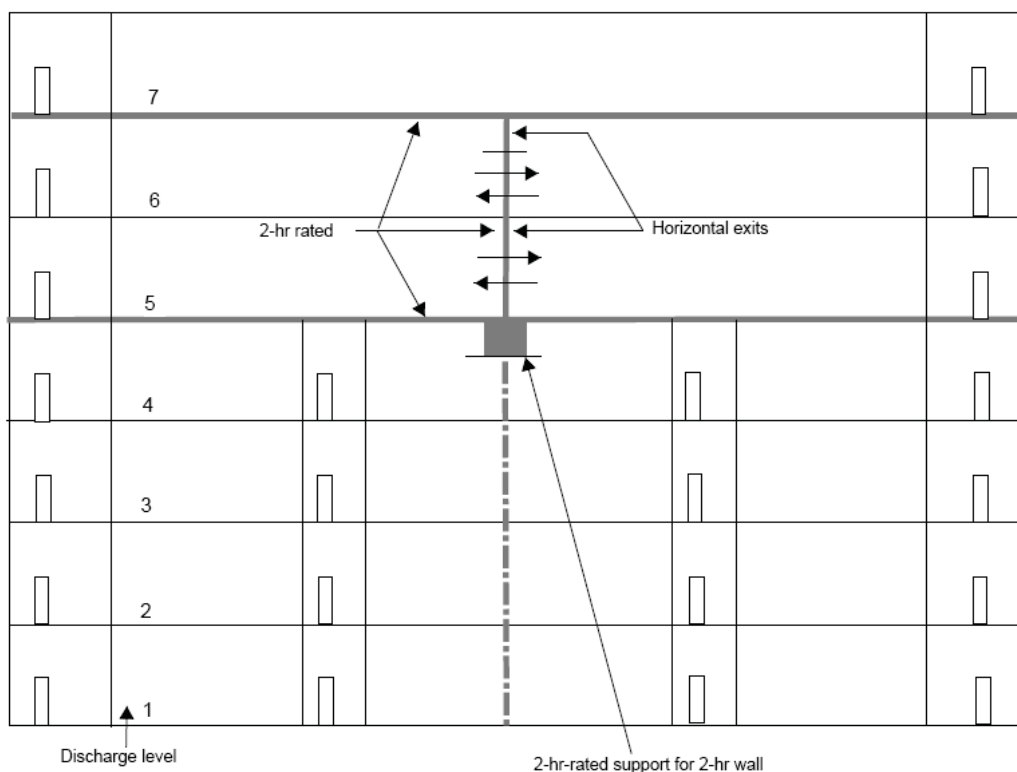


Figure 3.30: Example of Horizontal Exit

5.2.21 Bridges and Balconies

5.2.21.1 Each bridge or balcony used in conjunction with horizontal exits shall have guards and handrails.

5.2.21.2 Every bridge or balcony shall be not less than the width of the door to which it leads and shall be not less than 1200 mm wide for new construction.

5.2.21.3 Where the bridge or balcony serves as a horizontal exit in one direction, the horizontal exit door shall be required to swing only in the direction of egress travel.

5.2.21.4 Where the bridge or balcony serves as a horizontal exit in both directions, doors shall be provided in pairs that swing in opposite directions.

5.2.22 Elevators

5.2.22.1 One hundred percent of the egress capacity shall be provided independent of the elevators.



5.2.23 Elevator Lobby

- 5.2.23.1** Every floor served by the elevator shall have an elevator lobby. Barriers forming the elevator lobby shall have a fire resistance rating of not less than 1 hour and shall be arranged as a smoke barrier. Or else, pressurization of lift shaft is required.

6. Exit Discharge

- 6.1** Exit discharge or Discharge from exit is defined as providing building occupants with a safe path of travel from an exit to a public way. This path of travel might be inside or outside a building and can be achieved through an exit passageway.

6.2 Exit Passageway

- 6.2.1** The width of an exit passageway shall be adequate to accommodate the aggregate required capacity of all exits that discharge through it.
- 6.2.2** Exits shall terminate directly, at a public way or at an exterior exit discharge.
- 6.2.3** Yards, courts, open spaces, or other portions of the exit discharge shall be of the required width, size and open to the sky above to provide all occupants with a safe access to a public way.
- 6.2.4** At least 50% of the building occupant capacity and 50% of the building exits should discharge directly to fresh air outside the building. 'Directly' in this context means horizontal travel of no more than distance mentioned in [Table 3.6A](#) and [3.6B](#). An exit passageway can be extended from the exit staircase shaft to qualify as direct discharge. See [Figure 3.31](#).

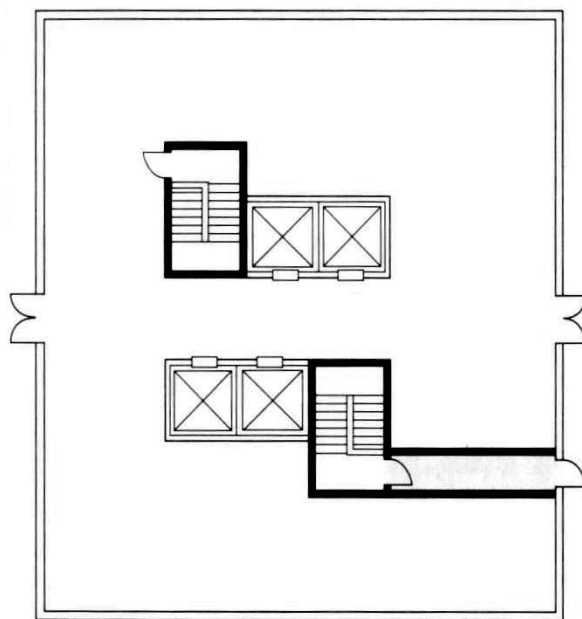


Figure 3.31: Extension of Exit Staircase to comply with Exit Discharge



- 6.2.5** Exit passageways can also be applied where necessary to prevent excessive travel distance to the exit staircase. See [Figure 3.32](#).

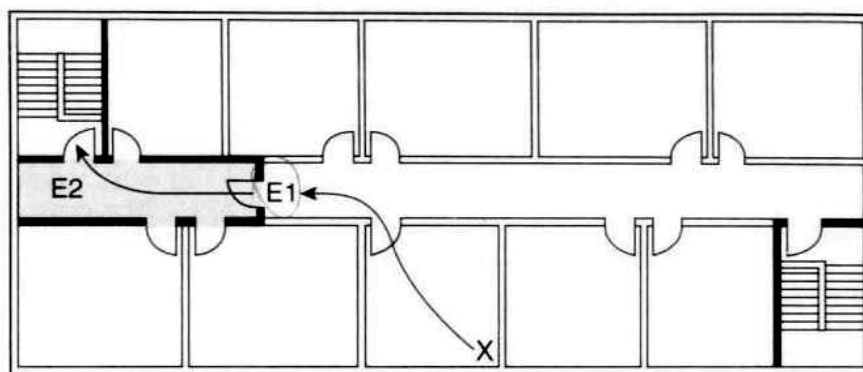


Figure 3.32: Extension of Exit Staircase to meet with travel distance requirements.

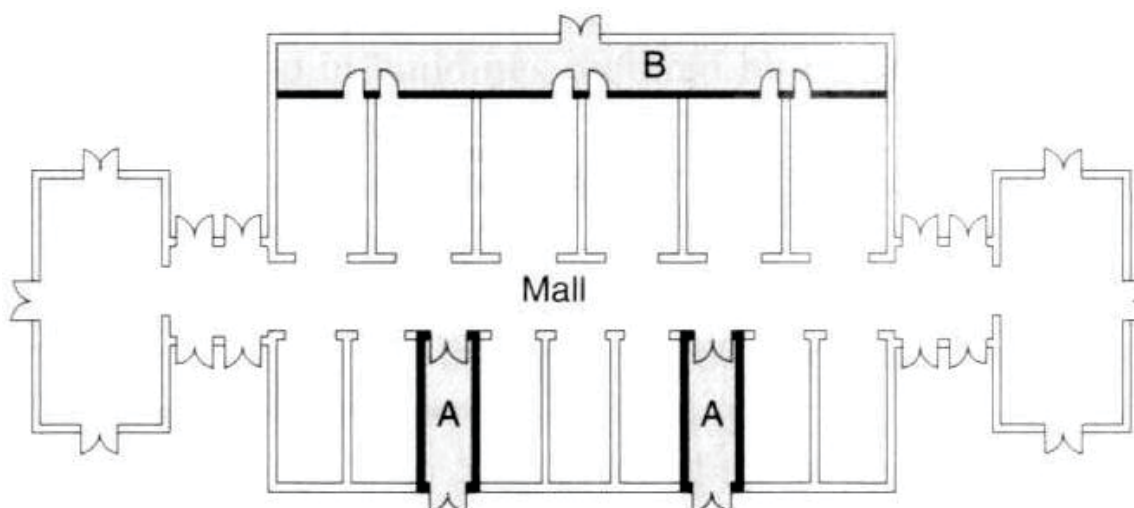


Figure 3.33: Exit Passageways in Malls

6.2.6 Construction

- 6.2.6.1** An exit passageway that serves as a discharge from a stair enclosure shall be separated from other parts of the building by non-combustible construction and shall have not less than the same fire resistance rating as those required for the stair enclosure.

6.3 Area of Refuge

- 6.3.1** All high rise buildings will be provided with an automatic supervised sprinkler system throughout. As such any floor area other than the floor of fire origin and not intimate with the fire can be considered as an area of refuge for those awaiting assistance to escape.



6.4 Discharge through Areas on Level of Exit Discharge

- 6.4.1** For sprinkler protected buildings, not more than 50 percent of the required number of exits, and not more than 50 percent of the required egress capacity, shall discharge through areas on the level of exit discharge.
- 6.4.2** The entire area on the level of discharge shall be separated from areas below by construction having a fire resistance rating not less than that required for the exit enclosure.
- 6.4.3** Levels below the level of discharge in an atrium shall be permitted to be open to the level of discharge where such level of discharge is appropriately protected by sprinklers, fire rated construction and smoke partitions or an engineered smoke control system designed to an internationally recognized guidance document or standard acceptable to Civil Defence. Exit discharge is illustrated in **Figure 3.34**.

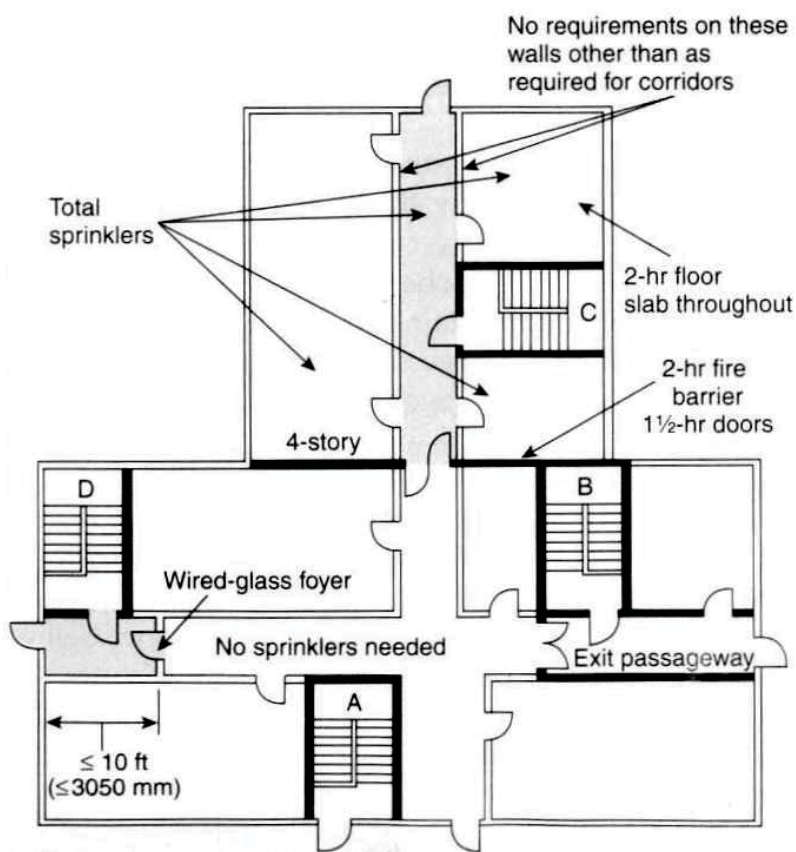


Figure 3.34: Examples of Exit Discharge

6.5 Arrangement and Marking of Exit Discharge

- 6.5.1** The exit discharge shall be arranged and marked to make clear the direction of egress to a public way. Stairs shall be arranged so as to make clear the direction of egress to a public way.



- 6.5.2** Stairs that continue more than one-half story beyond the level of exit discharge shall be interrupted at the level of exit discharge by partitions, doors, or other effective means. See [Figure 3.35](#).

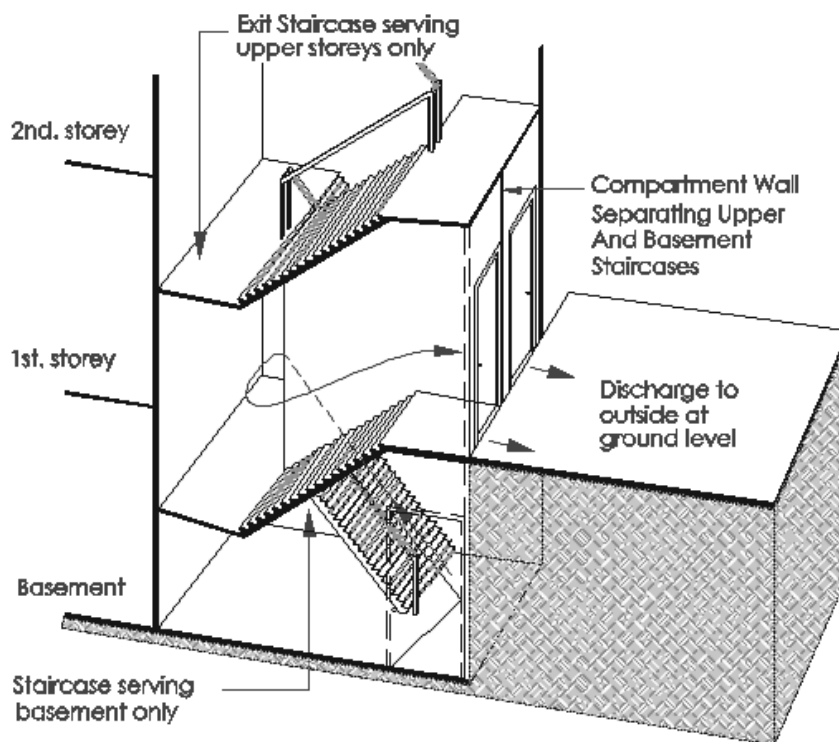


Figure 3.35: Separation between discharge from basement and above floors

7. Number of Exits

- 7.1** The number of means of egress shall be sufficient to accommodate the occupant load and complying with the travel distance requirements. Number of exits shall comply with [Table 3.4](#).

Table 3.4: Number of Exits

EXITS SPECIFICATION	
Item	Requirements
Minimum Number of Exits required on every story	2
Minimum number of separate Exits accessible from every part of every story	2
Minimum number of separate Exits accessible from every part of every story for 500-1000 people	3
Minimum number of separate Exits accessible from every part of every story for more than 1000 people	4



- 7.2** A single means of egress shall be permitted from a mezzanine, provided that the common path of travel does not exceed the distances in [Table 3.6A](#) and [3.6B](#).
- 7.3** Where more than one exit is required from a building or portion thereof, such exits shall be remotely located from each other and shall be arranged and constructed to minimize the possibility that more than one has the potential to be blocked by any one fire or other emergency condition.

7.4 Remoteness between two exits.

- 7.4.1** The minimum separation distance between two exits or exit access doors in a sprinklered building shall be not less than one-third the length of the maximum overall diagonal dimension of the building or area to be served. This distance shall be half the diagonal for non-sprinklered buildings. See [Figures 3.36, 3.37, 3.38](#) and [3.39](#) for examples.

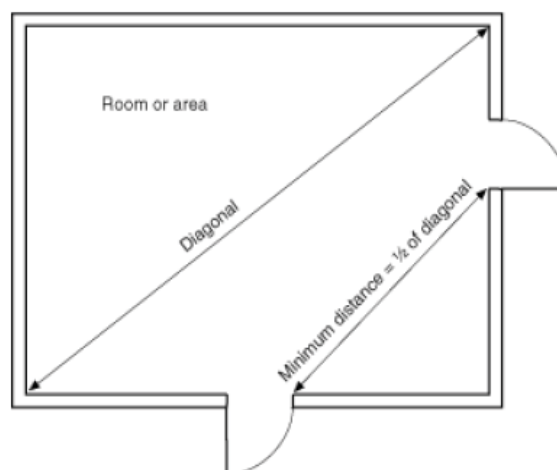


Figure3.36: Measurement of diagonal distance of room or space

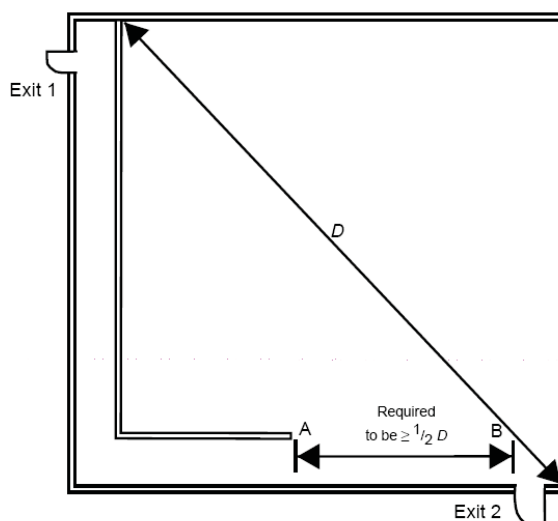


Figure 3.37: Half diagonal distance involving exit access corridor within a space



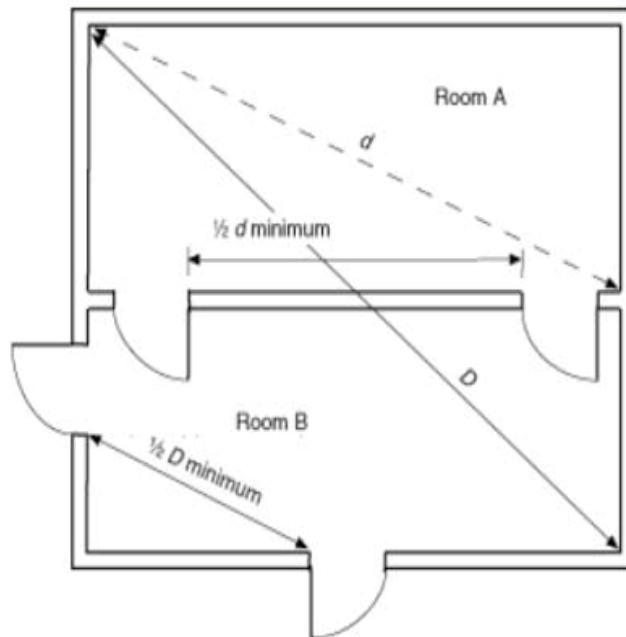


Figure 3.38: Measuring of diagonal distance involving two adjacent rooms

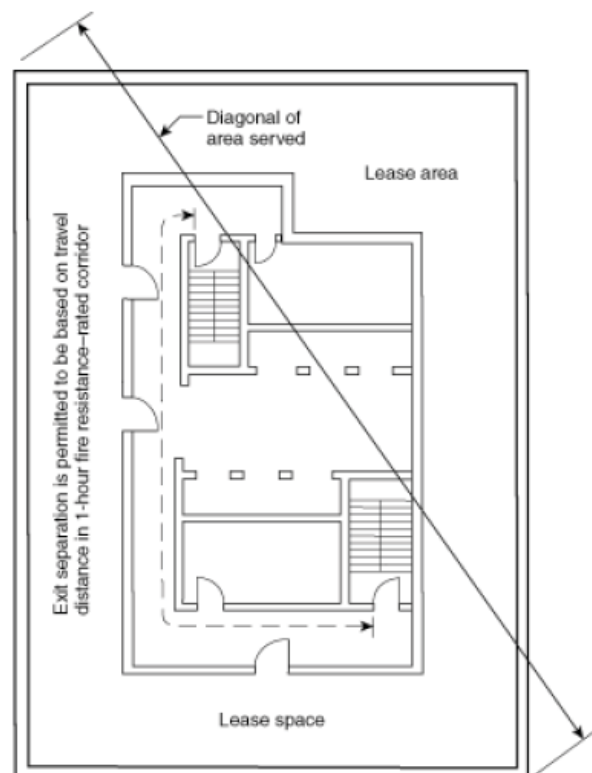


Figure 3.39: Example 4 for separation of exit along fire rated corridor



- 7.4.2** Where more than two exits or exit access doors are required, at least two of the required exits or exit access doors shall be arranged to comply with the minimum separation distance requirement.
- 7.4.3** The balance of the exits or exit access doors shall be located so that, if one becomes blocked, the others shall be available.
- 7.4.4** For highrise buildings, the measurement of the distance between the exits shall be a straight-line as shown in **figure 3.38**. For Non-highrise buildings, the measurement of the distance between two exits can be the walking path between the two measured exits as shown by the dotted line in **Figure 3.39**.

8. Walking Surfaces

- 8.1** Walking surfaces shall be in accordance with **Table 3.5**.

Table 3.5: Walking Surface in Means of Egress

WALKING SURFACE SPECIFICATIONS	
Item	Requirements
Walking surface	Shall be nominally level and slip resistant
Maximum slope in the direction of egress travel	1 in 20 (5%)
Maximum slope perpendicular to the direction of egress travel	1 in 48 (2%)
Maximum abrupt changes in elevation	6.3 mm
If change in elevation is between 6.3 mm – 13 mm	Shall be beveled 1 to 2
If change in elevation exceed 13 mm	Shall be achieved with a Ramp or a Stair

9. Interior Finish in Means of Egress

- 9.1** Interior Wall, Floor and Ceiling Finishes in Exit Enclosures in exit enclosures, interior wall and ceiling finish materials shall be non combustible and non toxic. The standards acceptable to the CIVIL DEFENCE are listed in the standards section of this code.

10. Measurement of Means of Egress

- 10.1** The width of means of egress shall be measured in the clear at the narrowest point of the egress component under consideration.



- 10.2** Projections within the means of egress of not more than 114 mm on each side shall be permitted at a height of 965 mm and below.

11. Arrangement of Means of Egress

- 11.1** Exits shall be located and exit access shall be arranged so that exits are readily accessible at all times.
- 11.2** Where exits are not immediately accessible from an open floor area, continuous passageways, aisles, or corridors leading directly to every exit shall be maintained and shall be arranged to provide access for each occupant to not less than two exits by separate ways of travel.
- 11.3** Exit access from rooms or spaces shall be permitted to be through adjoining or intervening rooms or areas, provided that such rooms or areas are accessory to the area served. Foyers, lobbies, and reception rooms constructed as required for corridors shall not be construed as intervening rooms. Exit access shall be arranged so that it is not necessary to pass through any hazardous area.

11.4 Travel Distance to Exits

- 11.4.1** **Figure 3.44** describes (a) Common path of travel, (b) Dead end travel, (c) Combined common & dead end path of travel.

11.5 Measurement of Travel Distance to Exits

- 11.5.1** The travel distance to an exit shall be measured on the floor or other walking surface as follows:
- Along the centerline of the natural path of travel, starting from the most remote point subject to occupancy. See 1 to 2 to 3 to 4 in **Figure 3.40**.
 - Curving around any corners or obstructions, with a 305-mm clearance there from, terminating at one of the following:
 - Centre of the doorway
 - Other point at which the exit begins
- 11.5.2** Where open stairways or ramps are permitted as a path of travel to required exits, the distance shall include the travel on the stairway or ramp and the travel from the end of the stairway or ramp to an outside door or other exit in addition to the distance travelled to reach the stairway or ramp.
- 11.5.3** Where measurement includes stairs, the measurement shall be taken in the plane of the tread nosing. See 5 to 6 in **Figure 3.40**.



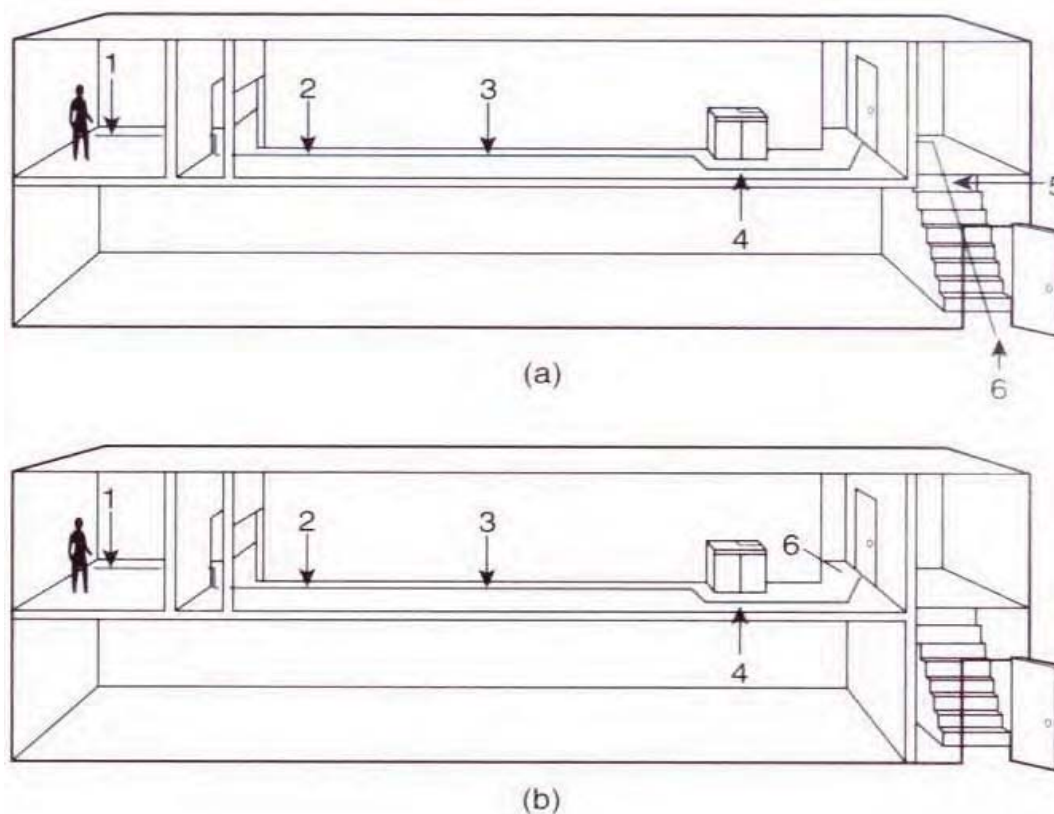


Figure 3.40: Measuring of Travel Distance

11.6 Capacity of Exit Discharge

11.6.1 The total capacity of the means of egress for any story, balcony, tier, or other occupied space shall be sufficient for the occupant load thereof.

11.6.2 Exits Serving More than One Story

11.6.2.1 Where an exit serves more than one story, only the occupant load of each story considered individually shall be used in calculating the required capacity of the exit at that story, provided that the required egress capacity of the exit is not decreased in the direction of egress travel.

11.6.3 Egress Capacity from a Point of Convergence

11.6.3.1 Where means of egress from a story above and a story below converge at an intermediate story, the capacity of the means of egress from the point of convergence shall be not less than the sum of the capacity of the two means of egress.



11.6.4 Egress Capacity from Balconies and Mezzanines

- 11.6.4.1** Where any required egress capacity from a balcony or mezzanine passes through the room below, that required capacity shall be added to the required egress capacity of the room below. See [Figure 3.41](#).

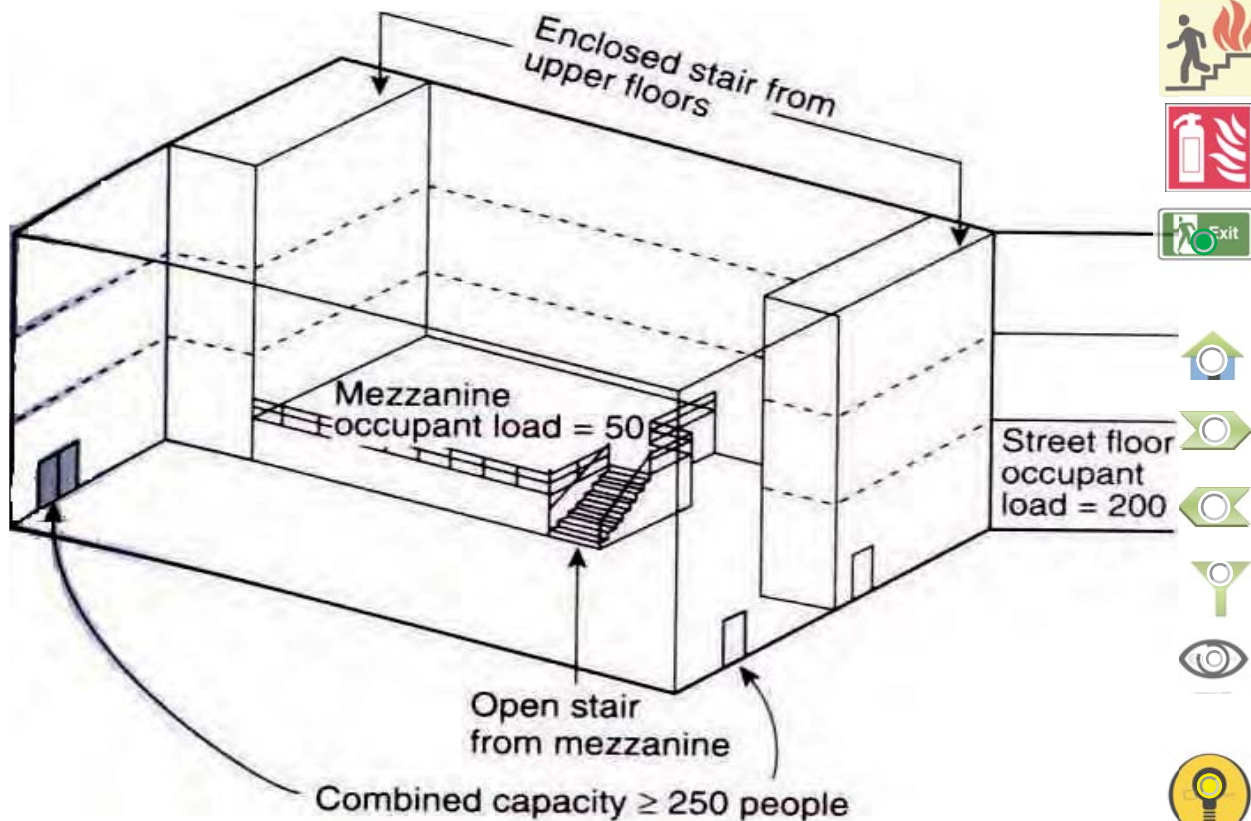


Figure 3.41: Egress Capacity for Mezzanine



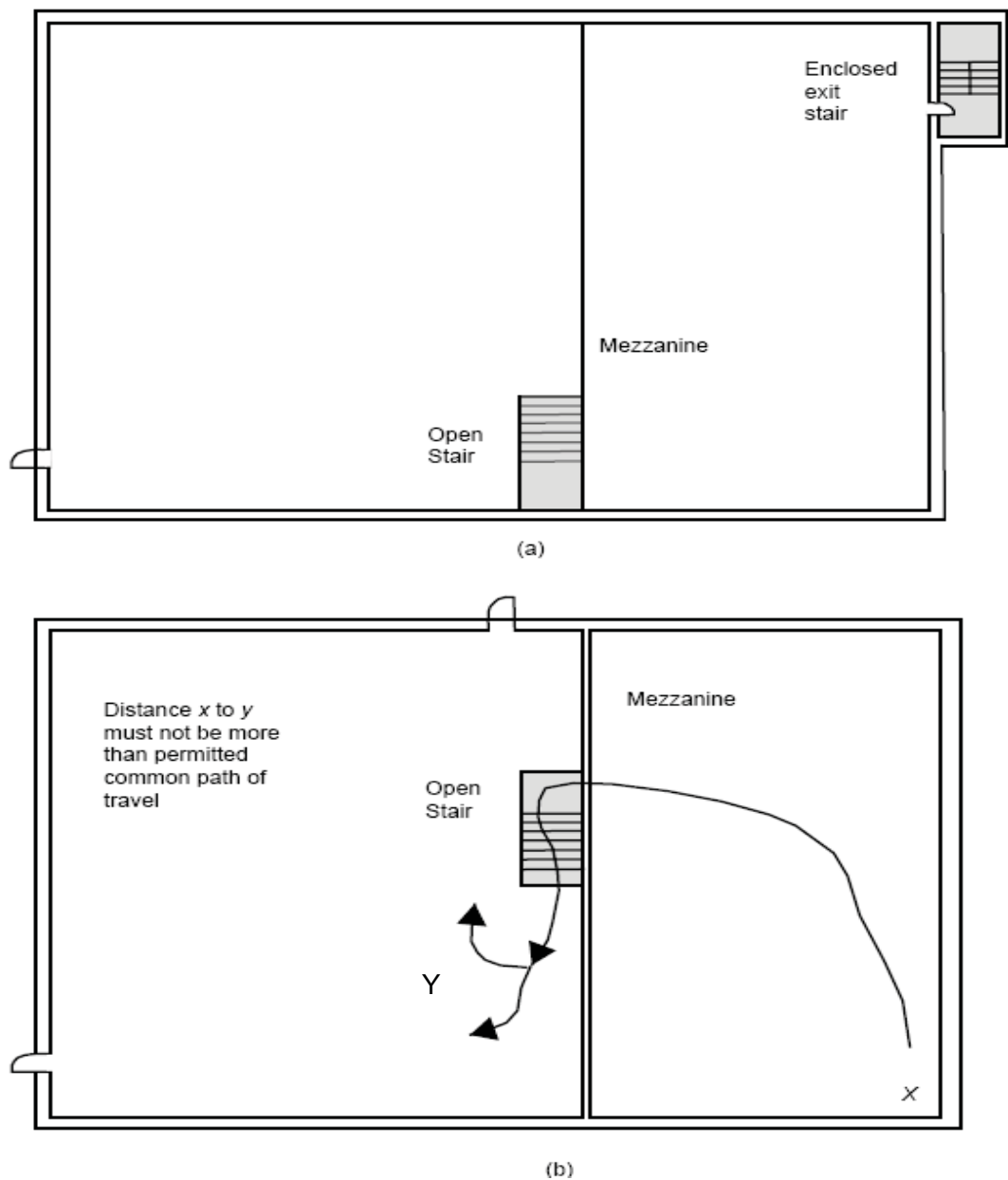


Figure 3.42: Distance x to y meets common path of travel, if not an enclosed exit staircase is required from the mezzanine level.

11.6.5 Egress Capacity for Corridor

- 11.6.5.1** The required capacity of a corridor shall be the occupant load that utilizes the corridor for exit access divided by the required number of exits to which the corridor connects, but the corridor capacity shall be not less than the required capacity of the exit to which the corridor leads.

- 11.6.5.2** The clear width of any corridor or passageway serving an occupant load of 50 or more shall be not less than 1200 mm.

11.6.6 Egress Capacity for single exit access

- 11.6.6.1** Where a single exit access leads to an exit, its capacity in terms of width shall be not less than the required capacity of the exit to which it leads.

11.6.7 Egress Capacity for more than one exit access

- 11.6.7.1** Where more than one exit access leads to an exit, each shall have a width adequate for the number of persons it accommodates.

11.6.8 Egress Capacity for street floor exit

- 11.6.8.1** Street floor exits shall be sufficient for the occupant load of the street floor plus the required capacity of stairs and ramps discharging through the street floor.

11.7 Obstructions at the exit or Impediments to Egress

- 11.7.1** Any device or alarm installed to restrict the improper use of a means of egress shall be designed and installed so that it cannot, even in case of failure, impede or prevent emergency use of such means of egress.
- 11.7.2** Access to an exit shall not be through kitchens, storerooms, or other rooms or spaces subject to locking.
- 11.7.3** Means of egress shall be continuously maintained free of all obstructions or impediments to full instant use in the case of fire or other emergency. See **Figure 3.43** for example of a deficient exit access corridor.

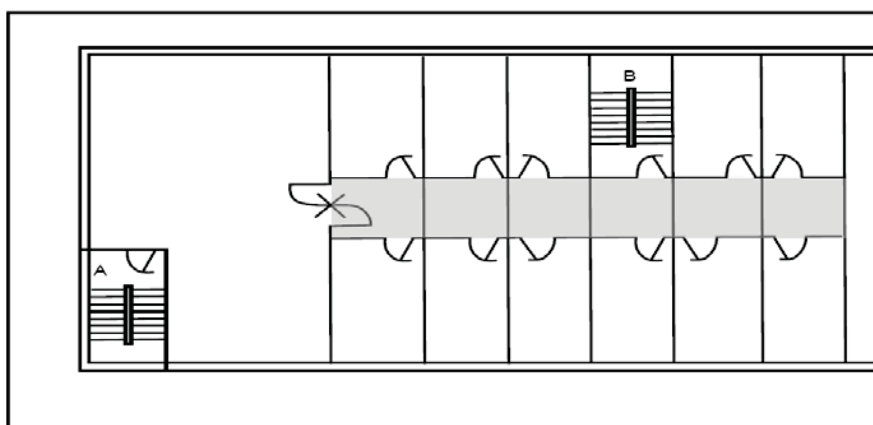


Figure 3.43: Example of a deficient exit access corridor



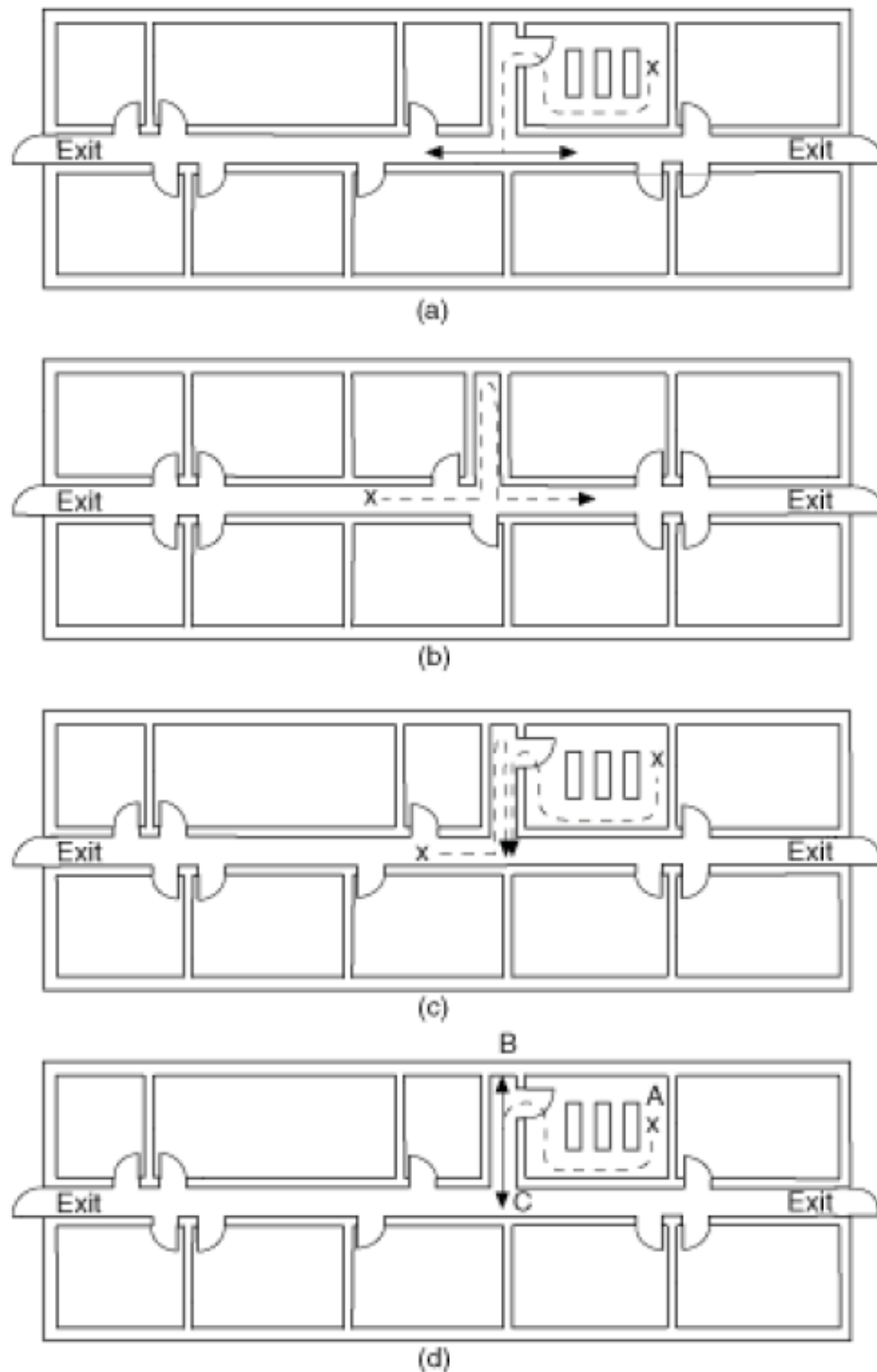


Figure 3.44: (a) Common path of travel, (b) Dead end travel, (c) Combined common & dead end path of travel, (d) Common path of travel



11.8 - Table 3.6A: Requirements for Arrangement of Means of Egress

OCCUPANCY	OCCUPANT LOAD (M ² PER PERSON)	WITH SPRINKLER PROTECTION			WITHOUT SPRINKLER PROTECTION			EXIT DISCHARGE CAPACITIES			
		DEAD END (MAXIMUM)	COMMON PATH (MAXIMUM)	TRAVEL DISTANCE (MAXIMUM)	DEAD END (MAXIMUM)	COMMON PATH (MAXIMUM)	TRAVEL DISTANCE (MAXIMUM)	STAIRS MM PER PERSON	RAMPS MM PER PERSON	CORRIDORS MM PER PERSON	
Business	9.3 m ²	15 m	30 m	91 m	6.1m	23m	61m	7.6	5	5	
Medical Clinics	9.3 m ²	15 m	30 m	91 m	6.1m	23m	61m	7.6	5	5	
Education	1.9 net	15m	30m	61m	6.1m	23m	45m	7.6	5	5	
Classroom	4.6 net	15m	30m	61m	6.1m	23m	45m	7.6	5	5	
Labs, others	0.65 net	6.1m	23m	76m	6.1m	23m	45m	7.6	5	5	
Concentrated.	1.4 net	6.1m	23m	76m	6.1m	23m	45m	7.6	5	5	
Less Concentrated.	1person/455 linear mm	6.1m	23m	76m	6.1m	23m	45m	7.6	5	5	
Bench seating.	Number of fixed seats	6.1m	23m	76m	6.1m	23m	45m	7.6	5	5	
Fixed seating.	0.28	6.1m	23m	76m	6.1m	23m	45m	7.6	5	5	
Waiting spaces.	9.3	6.1m	23m	76m	6.1m	23m	45m	7.6	5	5	
Kitchens.	9.3	6.1m	23m	76m	6.1m	23m	45m	7.6	5	5	
Library stacks areas.	4.6 net	6.1m	23m	76m	6.1m	23m	45m	7.6	5	5	
Library reading rooms.	4.6 (water surface)	6.1m	23m	76m	6.1m	23m	45m	7.6	5	5	
Swimming pool.											

11.8 - Table 3.6A: Requirements for Arrangement of Means of Egress

OCCUPANCY	OCCUPANT LOAD (M ² PER PERSON)	WITH SPRINKLER PROTECTION			WITHOUT SPRINKLER PROTECTION			EXIT DISCHARGE CAPACITIES			
		DEAD END (MAXIMUM)	COMMON PATH (MAXIMUM)	TRAVEL DISTANCE (MAXIMUM)	DEAD END (MAXIMUM)	COMMON PATH (MAXIMUM)	TRAVEL DISTANCE (MAXIMUM)	STAIRS MM PER PERSON	RAMPS MM PER PERSON	CORRIDORS MM PER PERSON	
Swimming pool decks.	2.8	6.1m	23m	76m	6.1m	23m	45m	7.6	5	5	
Exercise room with equipment.	4.6	6.1m	23m	76m	6.1m	23m	45m	7.6	5	5	
Exercise room without equipment.	1.4	6.1m	23m	76m	6.1m	23m	45m	7.6	5	5	
Stages.	1.4 net	6.1m	23m	76m	6.1m	23m	45m	7.6	5	5	
Lighting & access catwalks.	9.3 net	6.1m	23m	76m	6.1m	23m	45m	7.6	5	5	
Casinos and gaming areas.	1	6.1m	23m	76m	6.1m	23m	45m	7.6	5	5	
Skating rings.	4.6	6.1m	23m	76m	6.1m	23m	45m	7.6	5	5	
Healthcare											
Inpatient treatment.	22.3	9.1m	30m	61m	9.1m	30m	45m	7.6	5	5	
Sleeping.	11.1	9.1m	30m	61m	9.1m	30m	45m	7.6	5	5	
Ambulatory health care.	9.3	9.1m	30m	61m	9.1m	30m	45m	7.6	5	5	
Mercantile											
Sale area on street floor.	2.8	15m	30m	76m	6.1m	23m	45m	7.6	5	5	

11.8 - Table 3.6A: Requirements for Arrangement of Means of Egress

OCCUPANCY	OCCUPANT LOAD (M ² PER PERSON)	WITH SPRINKLER PROTECTION			WITHOUT SPRINKLER PROTECTION			EXIT DISCHARGE CAPACITIES			
		DEAD END (MAXIMUM)	COMMON PATH (MAXIMUM)	TRAVEL DISTANCE (MAXIMUM)	DEAD END (MAXIMUM)	COMMON PATH (MAXIMUM)	TRAVEL DISTANCE (MAXIMUM)	STAIRS MM PER PERSON	RAMPS MM PER PERSON	CORRIDORS MM PER PERSON	
Sale area on 2 or more street floor.	3.7	15m	30m	76m	6.1m	23m	45m	7.6	5	5	
Sale area on floor below street floor.	2.8	15m	30m	76m	6.1m	23m	45m	7.6	5	5	
Detention and correctional	11.1	6.1m	30m	61m	6.1m	15m	45m	7.6	5	5	
Residential	18.6	15m	38m	61m	10.7m	23m	45m	7.6	5	5	
Dormitory,	18.6	15m	38m	61m	10.7m	23m	45m	7.6	5	5	
Apartment Buildings	18.6	15m	38m	61m	10.7m	23m	45m	7.6	5	5	
Large Board and Care occupancy	18.6	15m	38m	61m	10.7m	23m	45m	7.6	5	5	
Day-Care Use	3.3	15m	30m	61m	6.1m	23m	45m	7.6	5	5	
Labor Accommodation	3 (not exceeding 120m ² per room)	15m	30m	76m	6.1m	23m	45m	10	5	5	

11.8 - Table 3.6A: Requirements for Arrangement of Means of Egress

OCCUPANCY	OCCUPANT LOAD (M ² PER PERSON)	WITH SPRINKLER PROTECTION			WITHOUT SPRINKLER PROTECTION			EXIT DISCHARGE CAPACITIES			
		DEAD END (MAXIMUM)	COMMON PATH (MAXIMUM)	TRAVEL DISTANCE (MAXIMUM)	DEAD END (MAXIMUM)	COMMON PATH (MAXIMUM)	TRAVEL DISTANCE (MAXIMUM)	STAIRS MM PER PERSON	RAMPS MM PER PERSON	CORRIDORS MM PER PERSON	
Hotel /Staff Accommodation											
	18.6	15m	38m	99m	10.7m	23m	53m	7.6	5	5	
Industrial											
General	9.3	15 m	30 m	76m	15 m	15 m	61m (GI)	7.6	5	5	
Special Process	9.3	15 m	30 m	122m	15 m	15 m	91m (SPI)	18	10	10	
High Hazard	9.3	15 m	30 m	23m	15 m	15 m					
Storage with Ordinary Hazard											
	27.9	30m	30m	122m	15m	15m	61m	7.6	5	5	
Storage with High Hazard											
	27.9	15m	15m	30 m	15m	15m	23m	18	10	10	
Open Parking Structures											
	27.9	15m	15m	122m	15m	15m	91m	7.6	5	5	
Enclosed Parking Structures											
	27.9	15m	15m	60m	15m	15m	45	7.6	5	5	

11.8 - Table 3.6A: Requirements for Arrangement of Means of Egress

OCCUPANCY	OCCUPANT LOAD (M ² PER PERSON)	WITH SPRINKLER PROTECTION			WITHOUT SPRINKLER PROTECTION			EXIT DISCHARGE CAPACITIES			
		DEAD END (MAXIMUM)	COMMON PATH (MAXIMUM)	TRAVEL DISTANCE (MAXIMUM)	DEAD END (MAXIMUM)	COMMON PATH (MAXIMUM)	TRAVEL DISTANCE (MAXIMUM)	STAIRS MM PER PERSON	RAMPS MM PER PERSON	CORRIDORS MM PER PERSON	
Animal Housing Facilities	11.1	6.1m	30m	61m	6.1m	15m	45m	10	5	5	

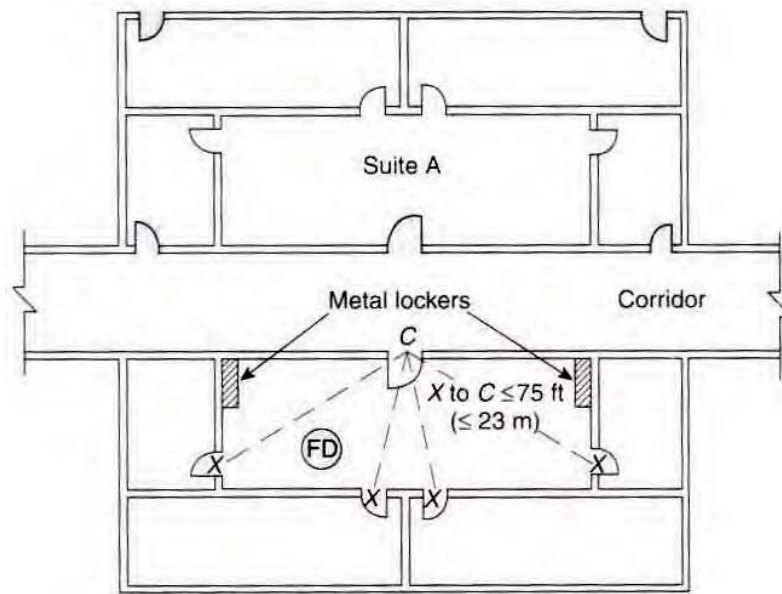
GI: General Industry, SPI: Special Process Industry

11.8 - Table 3.6B: Requirement for Arrangement of Means of Egress

OCCUPANCY	MIN CORRIDOR OR PASSAGEWAY WIDTH (MM)	ROOM SIZE WHICH NEEDS MINIMUM OF 2 EXITS (M ²)	TRAVEL DISTANCE THROUGH INTERVENING ROOMS (M)
Assembly	1200mm	280 m ²	-
Education (see Figure 3.45)	1830mm	93 m ² per classroom	23 from intervening room to exit door into corridor
Day Care (see Figure 3.46)	1200mm (without projections) 1830mm (with projections)		15 from any point in sleeping room to room door 30 (46 if sprinklered) from sleeping room exit door to staircase. 46 (61 if sprinklered) from any point in sleeping room to exit staircase.
Health Care (see Figure 3.47)	1830mm (with projections) 1200mm for non housing, non treatment or non inpatient areas.	93 m² for sleeping room 460 m² for Sleeping suites 460 to 700 Sleeping suites require visual supervision 230 to 930 for Non sleeping suites	15 from any point in sleeping room to exit access door. 30 for 1 intervening room 15 for 2 intervening rooms
Ambulatory Health Care (see Figure 3.48)	1200mm	232 m ²	30 (46 if sprinklered) from room door to exit staircase 46 (61 if sprinklered) from any point in room to staircase
Detention and correctional (see Figure 3.49)	1220mm	280 m ²	15 from room to room door 30 from open dorm to door 30(46 if sprinklered and smoke controlled) from room door to exit staircase 61 (76 if sprinklered and smoke controlled) from dorm to exit staircase
One-And-Two Family Dwelling	-	-	-
Lodging and Rooming House	1200mm	185	23 from room to exit staircase
Hotel and Dormitory (see Figure 3.50)	1200	185	23 (38 if sprinklered) from room to room door 30 (61 if sprinklered) from room door to exit staircase

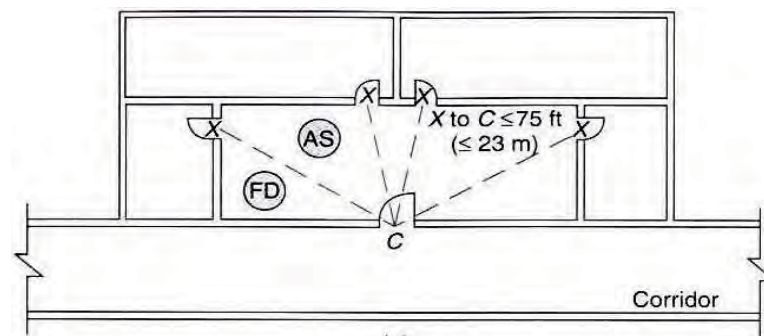
OCCUPANCY	MIN CORRIDOR OR PASSAGEWAY WIDTH (MM)	ROOM SIZE WHICH NEEDS MINIMUM OF 2 EXITS (M ²)	TRAVEL DISTANCE THROUGH INTERVENING ROOMS (M)
Apartment (see Figure 3.50)	1200		• 23 (38 if sprinklered) from room to door • 45 (61 if sprinkler) from room to exit
Residential Board and Care (see Figure 3.50)	1525	185	• 23 (38 if sprinklered) from room to door • 45 (61 if sprinkler) from room to exit
Labor Accommodation	See Section 14 for details on means of egress arrangement		
Mercantile	• 1675 • 1525 (Exit aisle)	-	-
Business	1200	280 m ²	-
Industrial	1200	-	-
Storage	1200	-	-



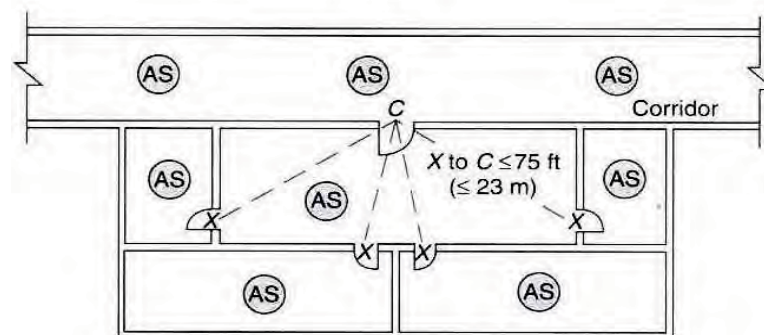


FD — Smoke detection or heat detection

Intervening room with smoke or heat detector



(a)



(b)

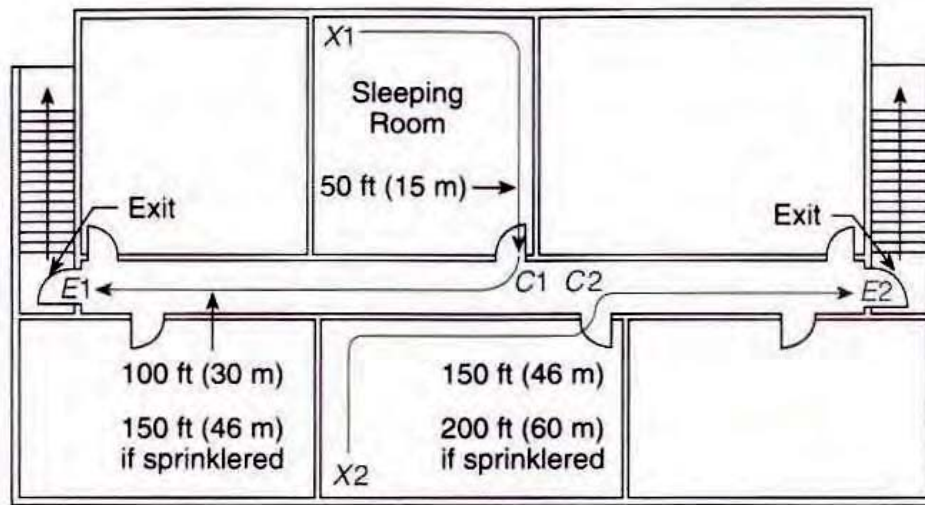
AS — Automatic sprinklers

FD — Smoke detection or heat detection

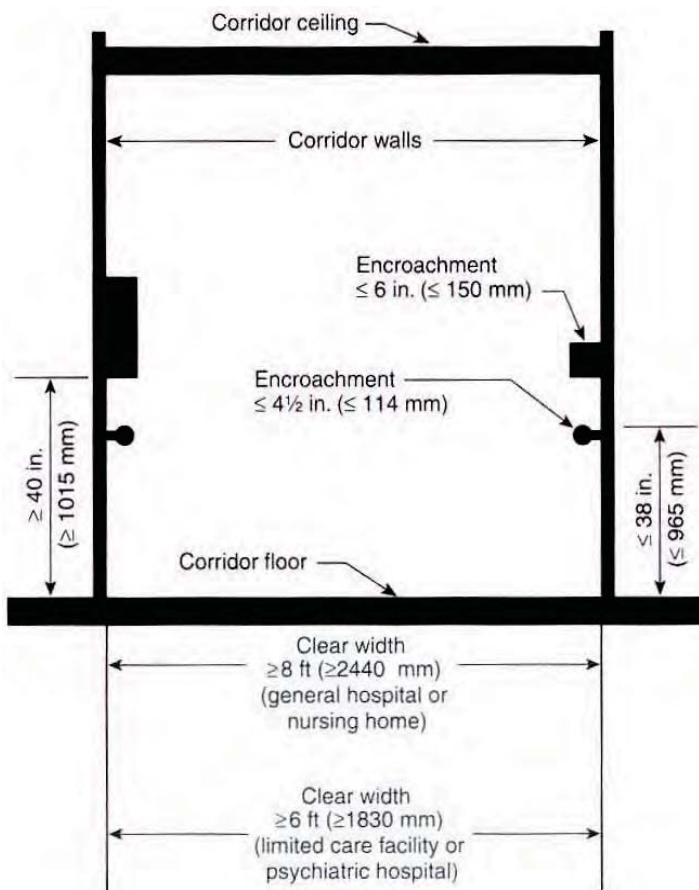
Intervening room with automatic sprinklers

Figure 3.45: Egress arrangement for Educational Occupancy





Travel distance from sleeping room to exit staircase



Limitation of projections along corridor

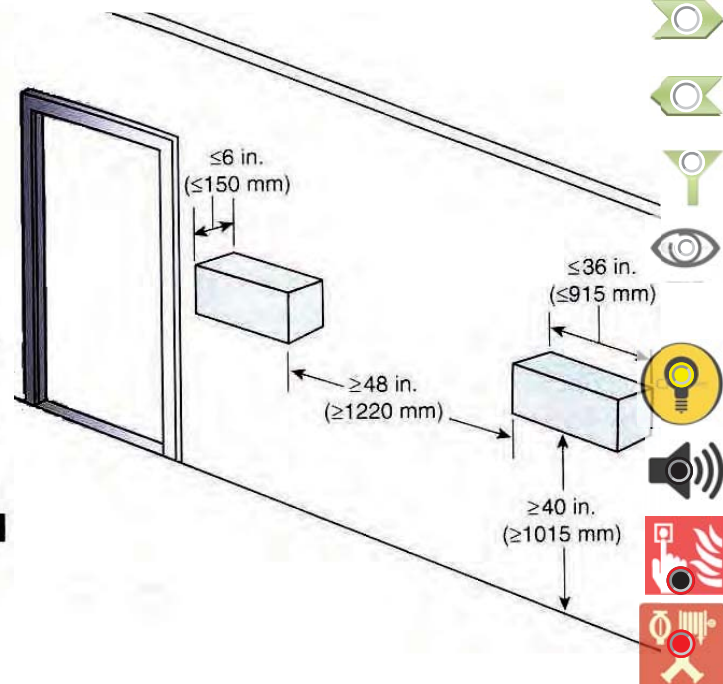
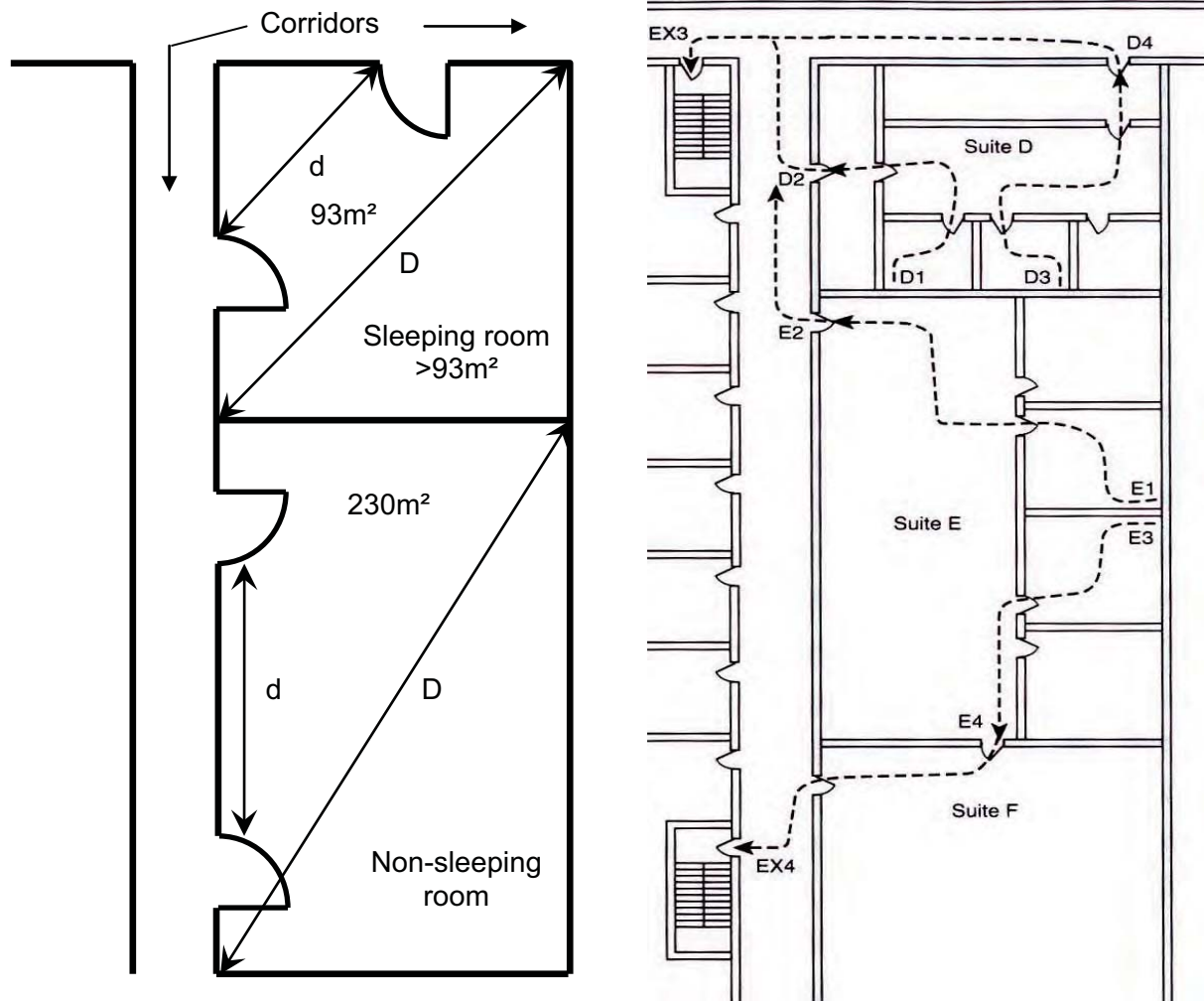
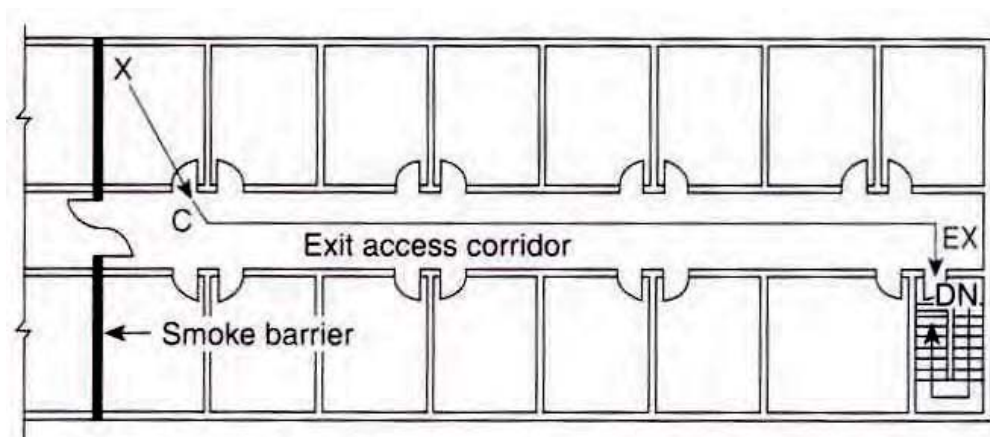


Figure 3.46: Egress arrangement Day Care Occupancy



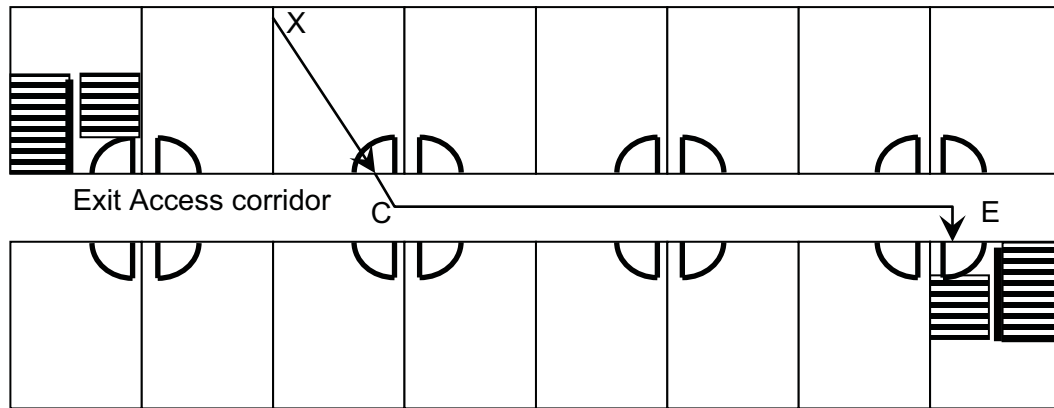


Number of exit for different rooms and travel distance through intervening room
(E1 to E2 $\leq 30m$, D3 to D4 $\leq 15m$)



Travel distance from sleeping room to exit staircase (X to C $\leq 15m$, C to EX $\leq 46m$)

Figure 3.47: Egress arrangement for Health Care Occupancy



Maximum distance:
 C to E - $\leq 30\text{m}$ ($\leq 46\text{m}$ with sprinklers)
 X to E - $\leq 46\text{m}$ ($\leq 61\text{m}$ with sprinklers)

1 hr partitions complete from floor to floor or roof deck above.

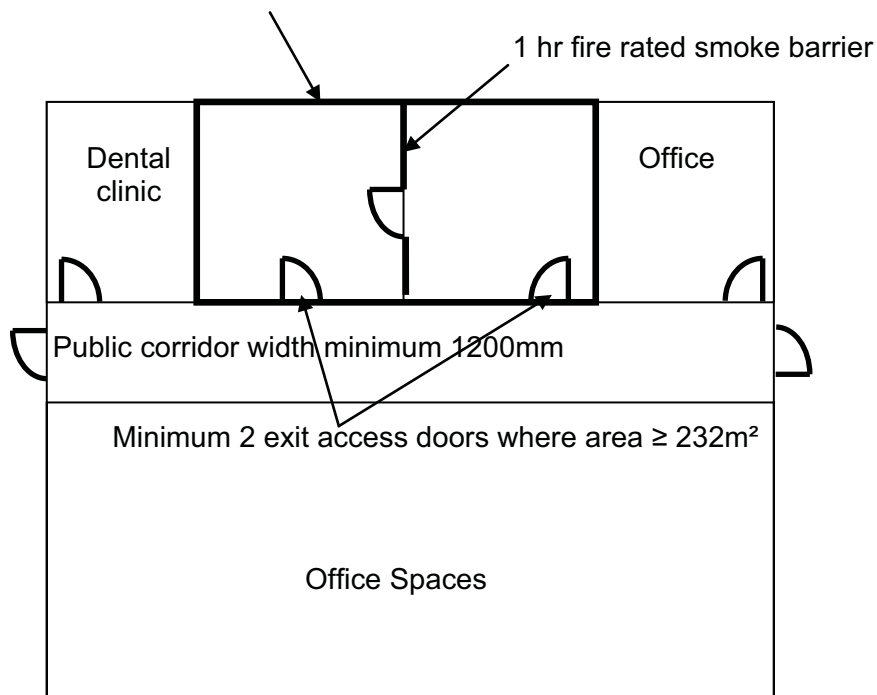
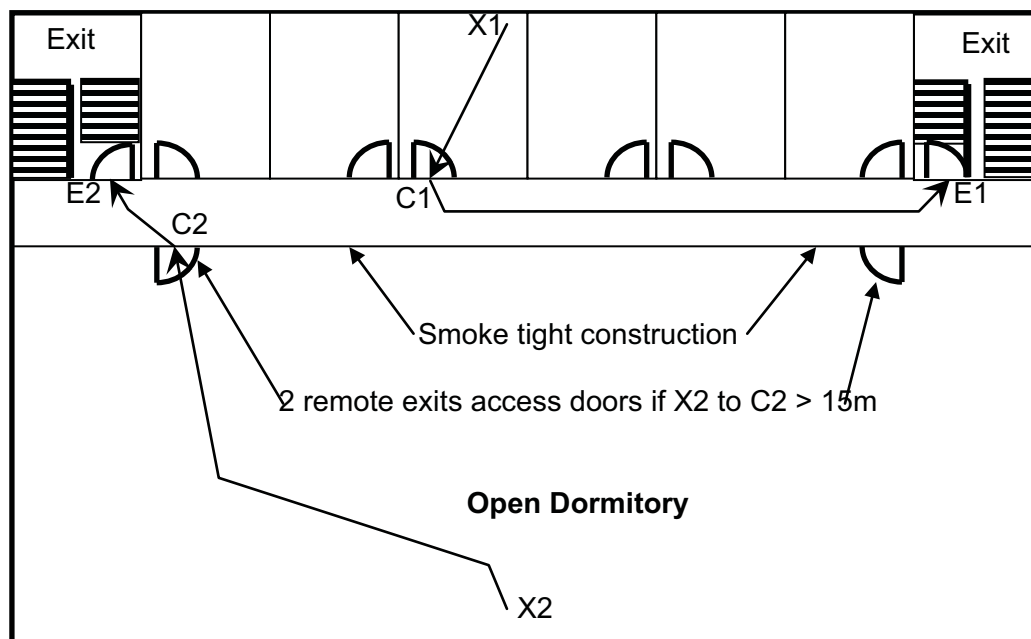


Figure 3.48: Egress arrangement for Ambulatory Health Care Occupancy





Maximum distance:

X1 to C1 - $\leq 15\text{m}$

X2 to C2 - $\leq 30\text{m}$

C1 to E1 - $\leq 30\text{m}$ ($\leq 46\text{m}$ with sprinklers)

C2 to E2 - $\leq 30\text{m}$ ($\leq 46\text{m}$ with sprinklers)

X1 to E1 - $\leq 46\text{m}$ ($\leq 61\text{m}$ with sprinklers)

X2 to E2 - $\leq 61\text{m}$ ($\leq 76\text{m}$ with sprinklers)

Figure 3.49: Detention and Correctional Occupancy



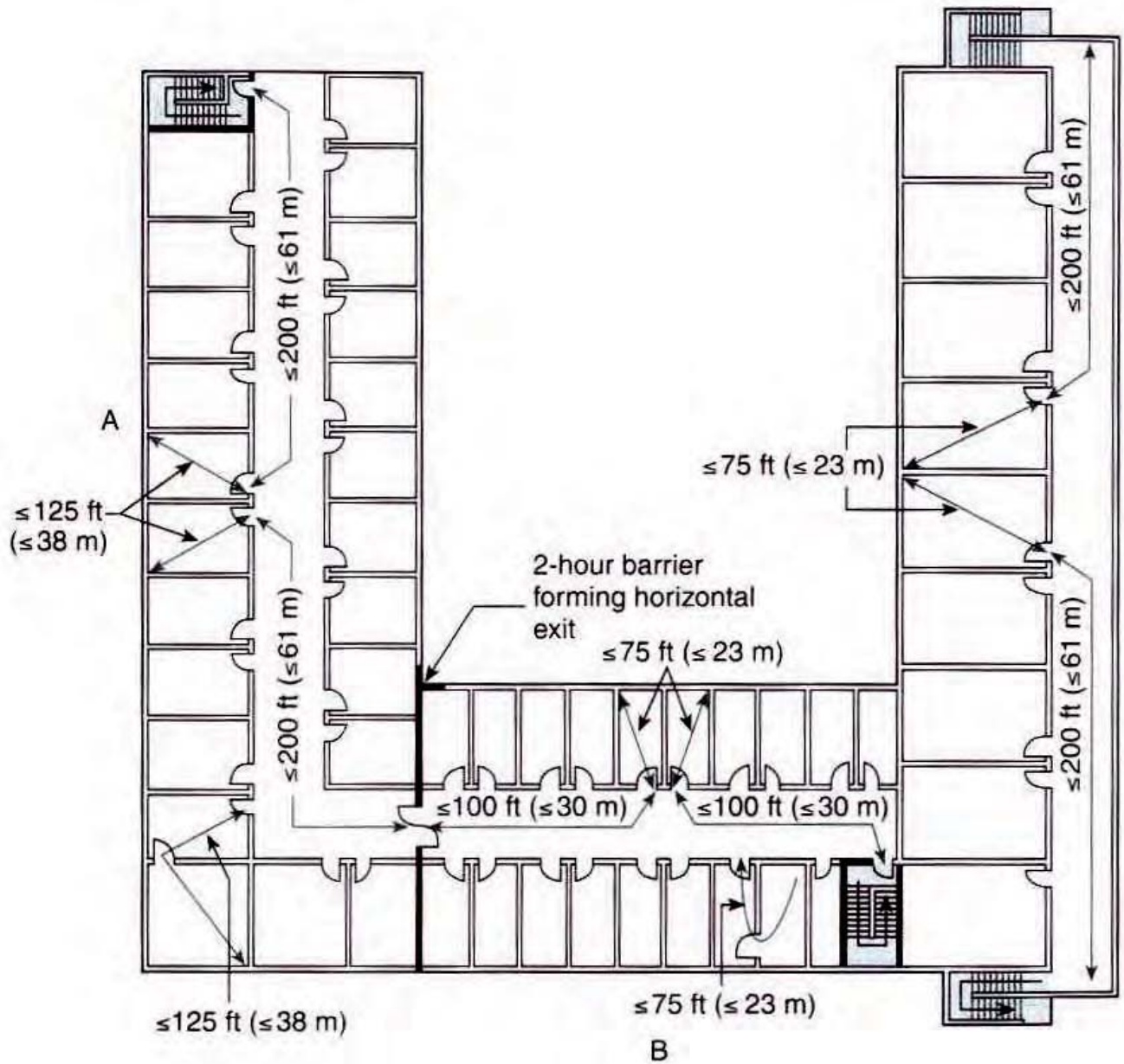


Figure 3.50: Egress arrangement for Hotel and Dormitory, Apartment, Residential Board and Care

12. Single Exit Staircase Requirements

12.1 Apartment Building

- 12.1.1** Any non-sprinklered dwelling unit shall be permitted to have a single exit, provided that one of the following criteria is met:
- The dwelling unit has an exit door opening directly to the street or yard at ground level.
 - The dwelling unit has direct access to an outside stair and serves a maximum of two units, both of which are located on the same floor.
 - The dwelling unit has direct access to an interior stair that serves only that unit and is separated from all other portions of the building by fire barriers having a minimum 1-hour fire resistance rating, with no opening therein.
 - Travel distance from the anywhere in the unit shall not exceed 23m to the final discharge. See [Figure 3.51](#).

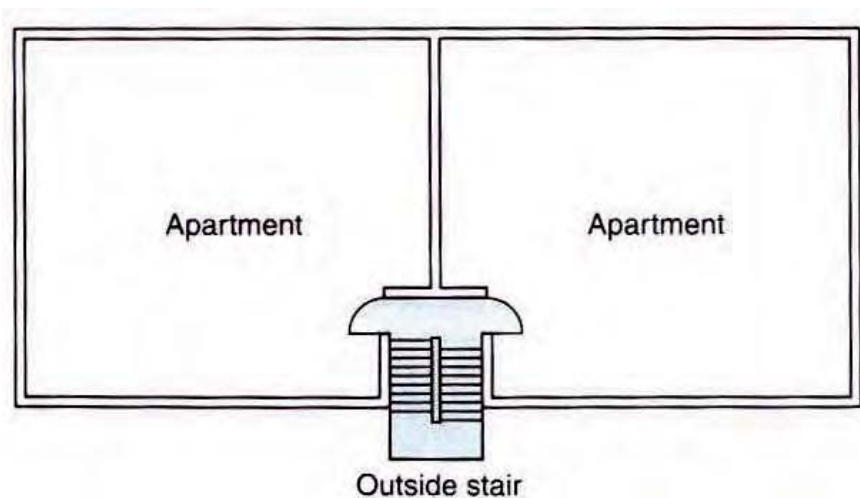


Figure 3.51: Single Exit Staircase for 2 unit apartment building

- 12.1.2** Any building that is protected throughout by an approved, supervised automatic residential sprinkler system having maximum building height of 15m (Low Rise) and has not more than six dwelling units per story can be permitted to have a single interlocking exit staircase (scissor staircase), provided that all of the following conditions apply:
- The stairway is separated from the rest of the building by barriers having not less than a 2-hour fire resistance rating, with self-closing 1½-hour fire door assemblies.



- ii. The stairway does not serve more than one-half story below the level of exit discharge.
- iii. All corridors serving as access to exits have a minimum 1-hour fire resistance rating with 1 hour fire doors assemblies.
- iv. There is not more than 14m from the most remote point of unit to unit exit door and not more than 9 m of travel distance from the entrance door of any dwelling unit to the exit staircase.
- v. One hour fire-rated horizontal and vertical separation between dwelling units is provided.
- vi. Smoke check doors shall be provided between the two entrances into the scissor staircase for internal corridor arrangement.
- vii. Maximum total area per floor is 500m².

12.1.3 The interlocking staircase requirement can be replaced with a single exit staircase (having one entrance into exit staircase shaft) if the number of units per floor is kept to a maximum of four dwelling units. See [Figure 3.52](#) and [Figure 3.53](#) for illustrations.

12.1.4 External exit passageways, smoke proof enclosures and external exit staircases can also be adopted for the egress arrangement of residential apartments with provision of single exit staircase. See [Figures 3.54](#) to [3.60](#) for examples of scissors and single exit staircase arrangement for residential apartments limited to the conditions in [clauses 12.1.1](#), [12.1.2](#) and [12.1.3](#).

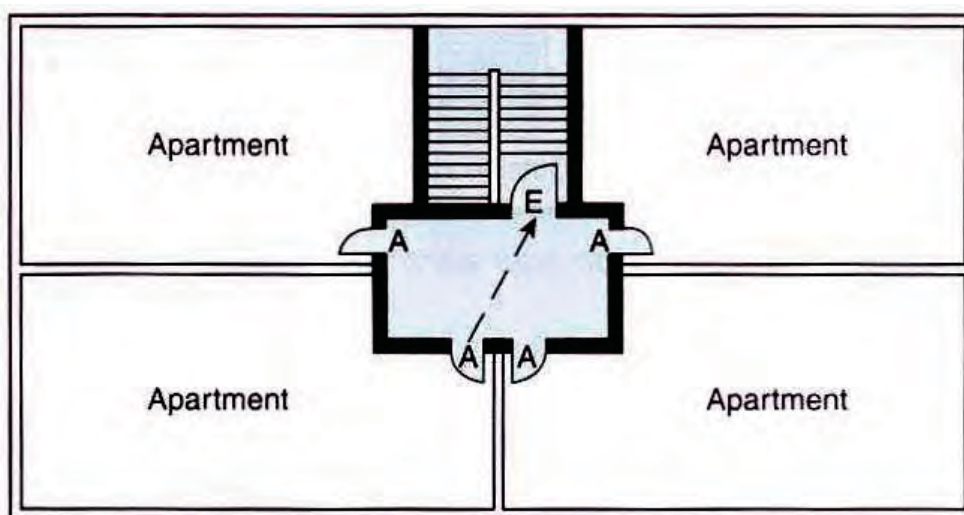


Figure 3.52: Single exit staircase replacing interlocking staircase for 4 unit apartment building (A to E ≤ 9m)



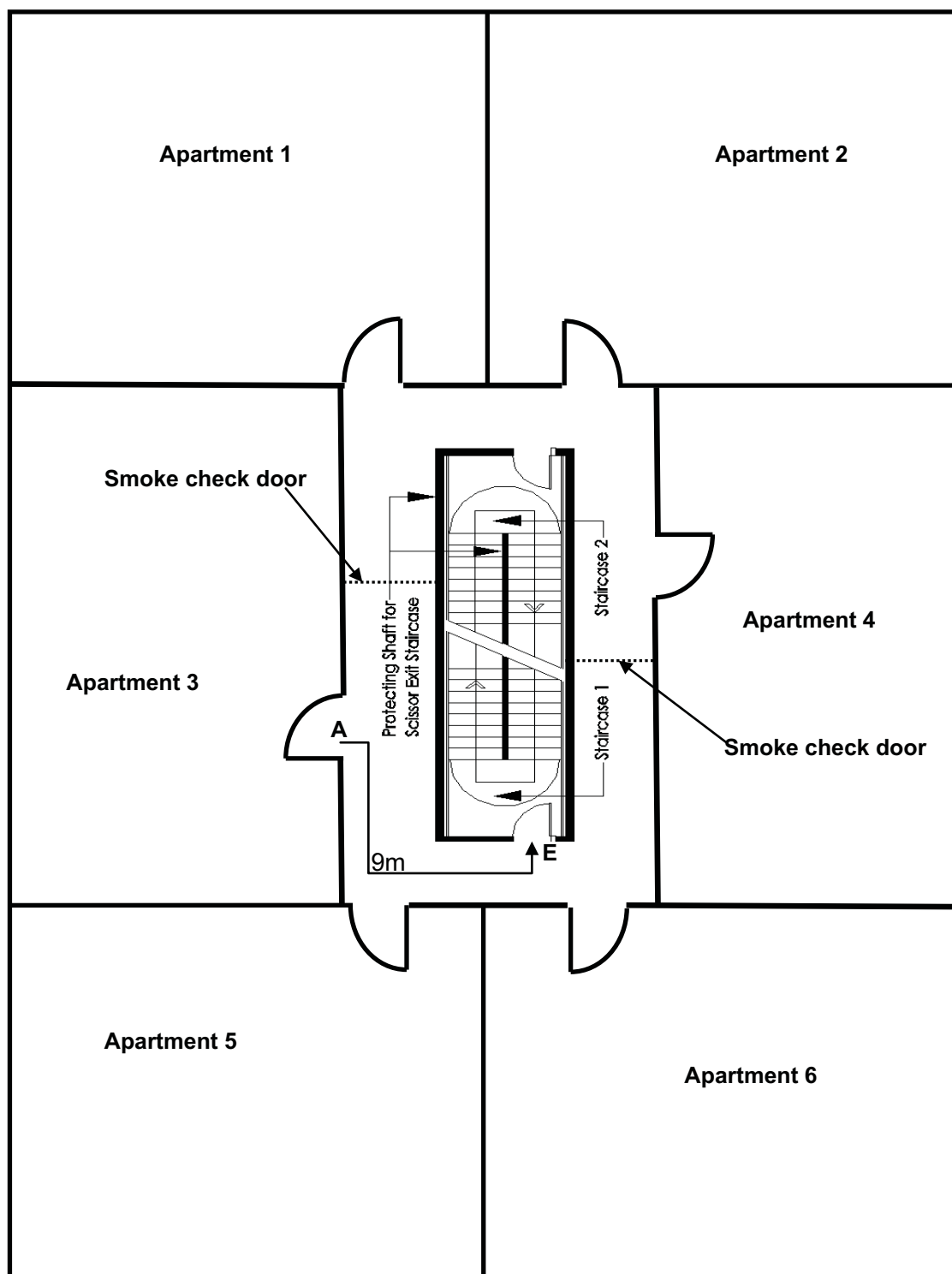


Figure 3.53: Interlocking staircase arrangement for Residential Apartment Building (6 units per floor, 500m² per floor area, less than 15m building height. (A to E ≤ 9m)



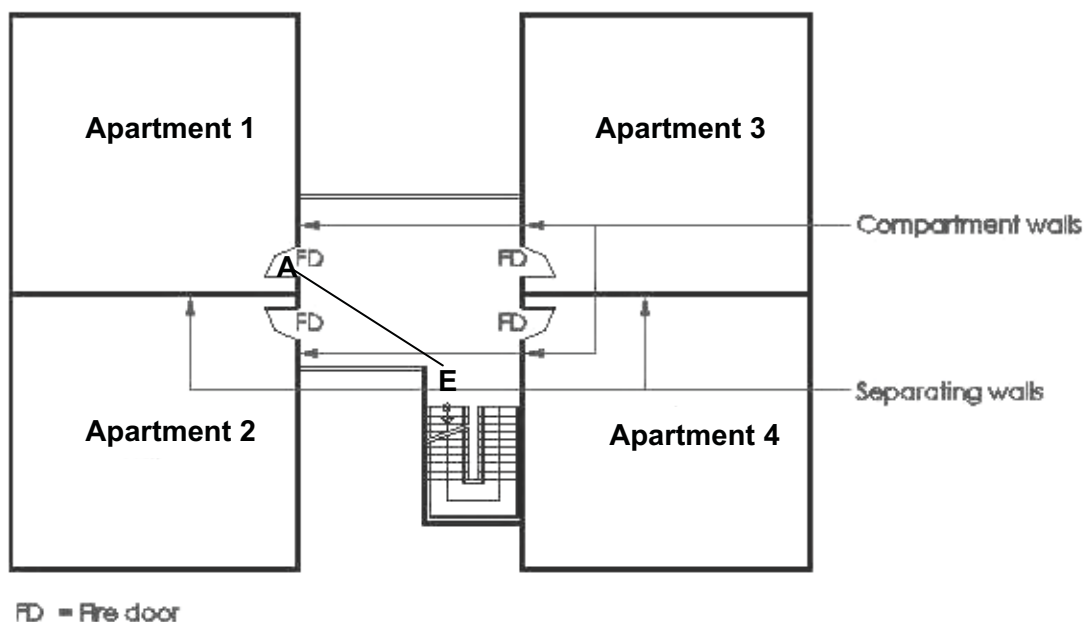


Figure 3.54- Single external exit staircase with external passageway or smoke proof enclosure arrangement for Residential Apartment Building (4 units per floor, 500m² per floor area, less than 15m building height, A to E ≤ 9m)

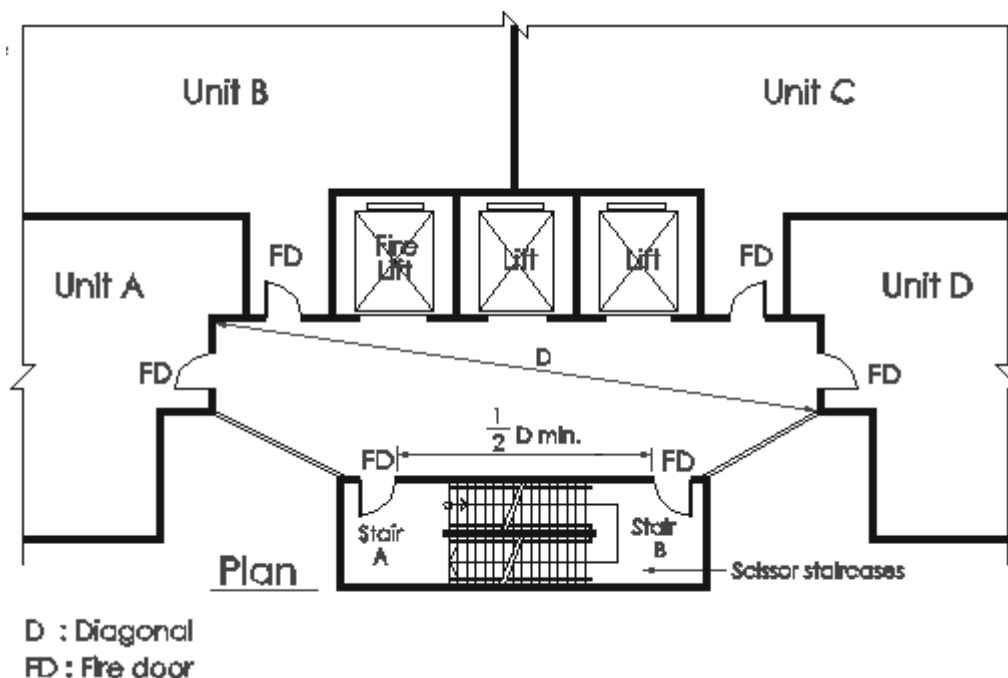


Figure 3.55- Scissors exit staircase with external passageway or smoke proof enclosure arrangement for Residential Apartment Building (4 units per floor, 500m² per floor area, less than 15m building height, unit exit door to nearest staircase ≤ 9m, 1/2 D ≥ 7m)



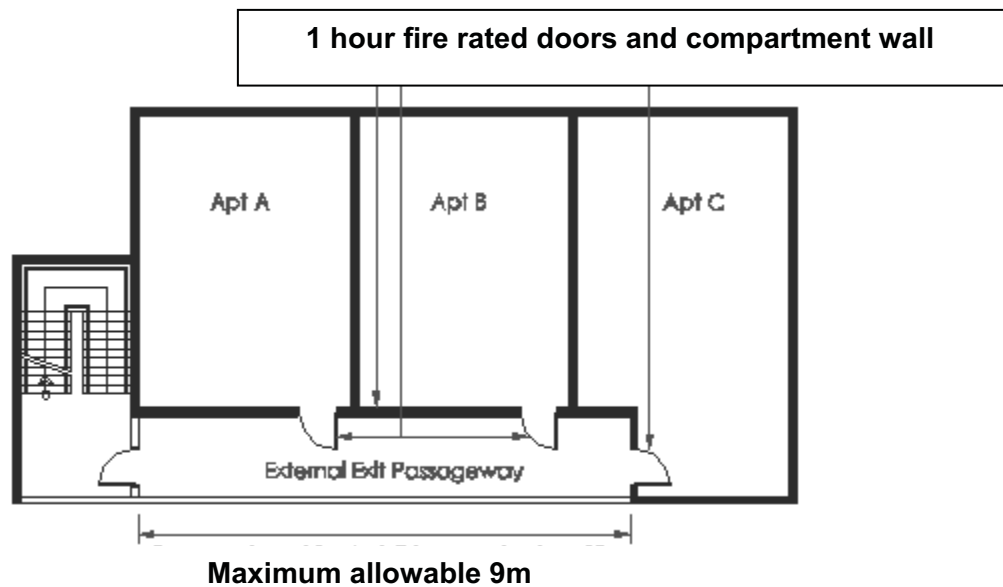


Figure 3.56- Single exit staircase with external passageway and external staircase for Residential Apartment Building (4 units per floor, 500m² per floor area, less than 15m building height, unit exit door to staircase $\leq$ 9m)

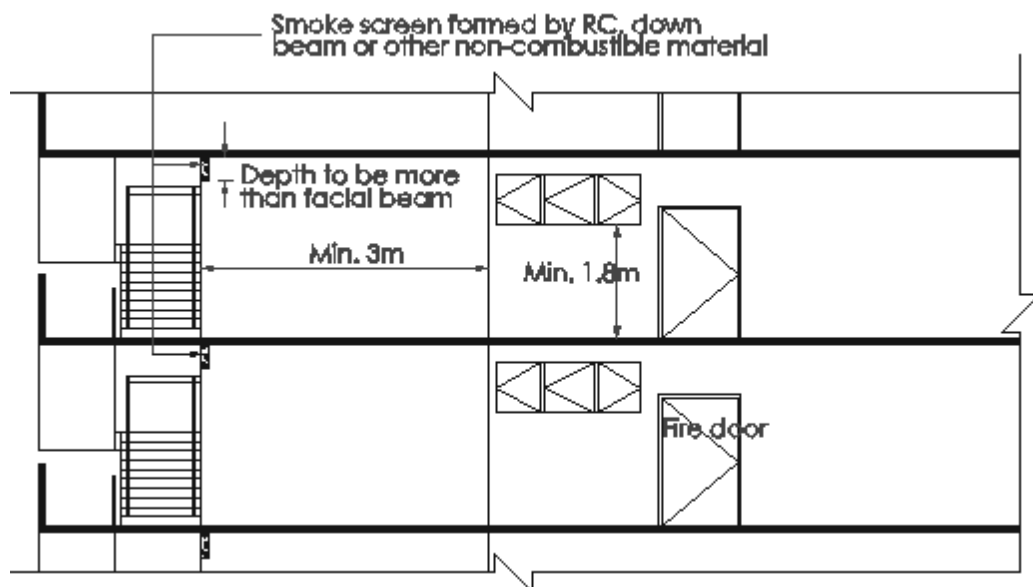


Figure 3.57- Separation distance of unprotected opening to staircase and height of unprotected opening from floor level.

Acceptable

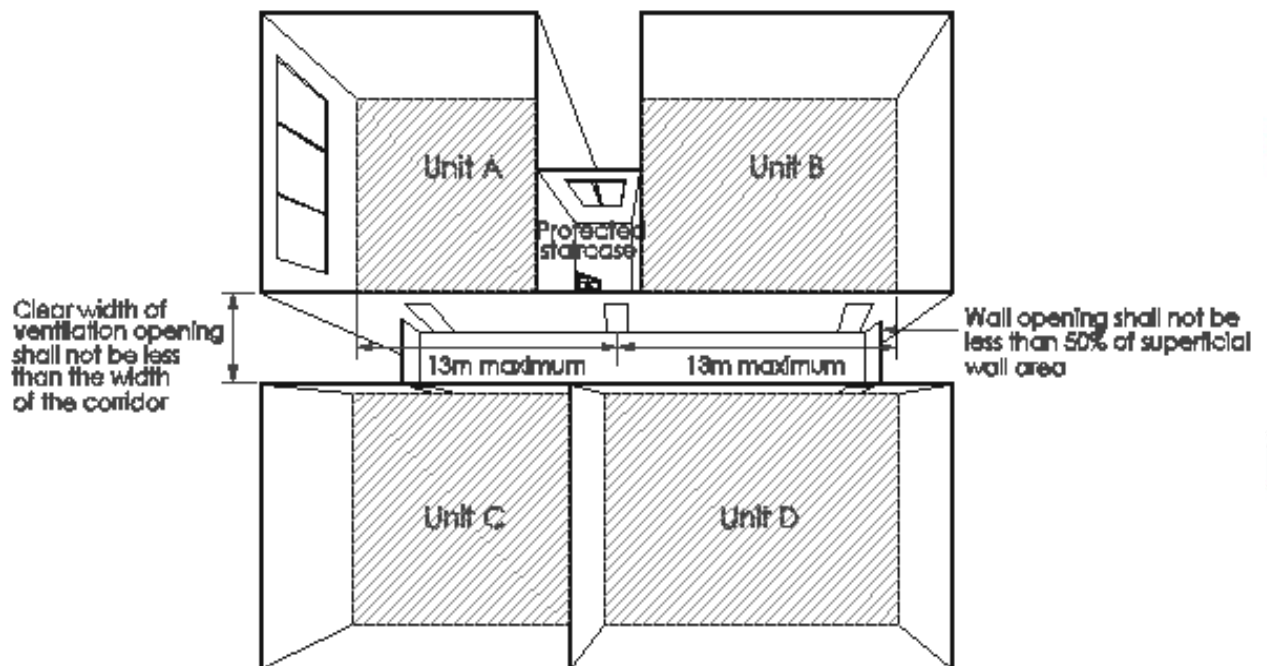


Figure 3.58- Maximum allowable distance and minimum permanent opening for naturally ventilated corridor.

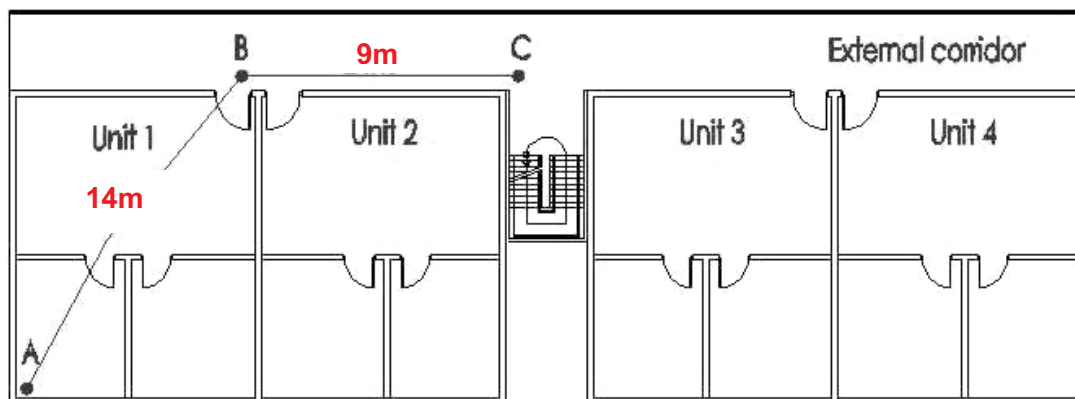


Figure 3.59- Maximum allowable distance from apartment unit to unit door and to exit staircase.



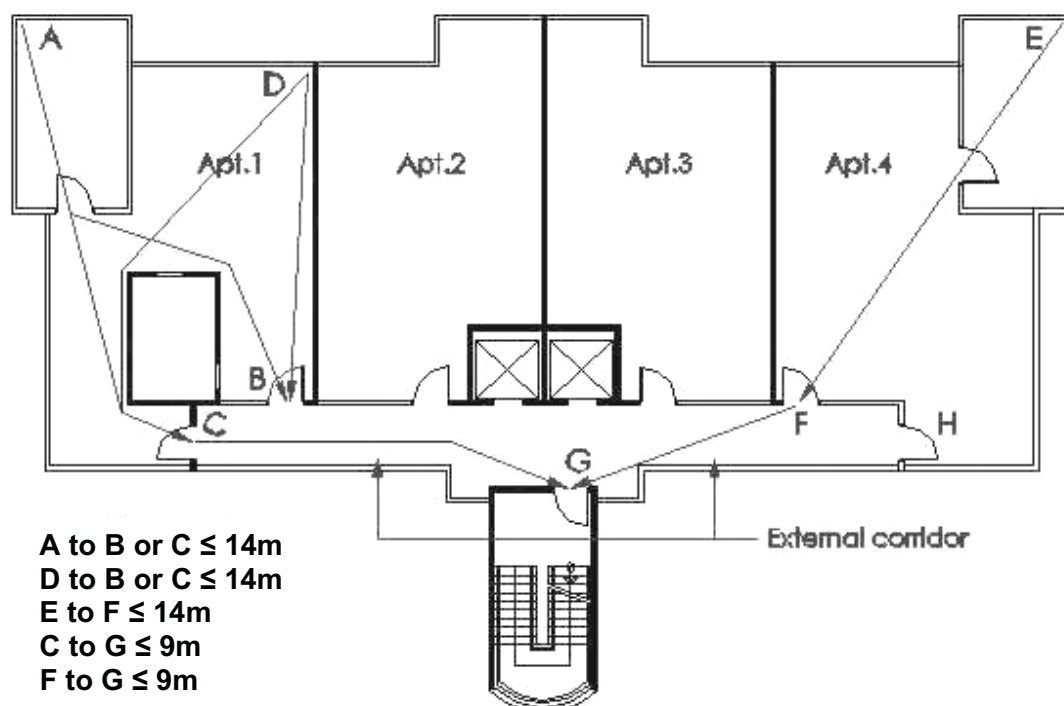


Figure 3.60- Example of travel distances from apartment unit to unit door and to exit staircase.

12.2 Business

- 12.2.1** A single exit shall be permitted for a room or area with a total occupant load of fewer than 100 persons, provided that the following criteria are met:
- The exit shall discharge directly to the outside at the level of exit discharge for the building. See [Figure 3.61](#).
 - The total distance of travel from any point, including travel within the exit, shall not exceed 100 ft (30 m).
 - The total distance of travel shall be on the same floor level or, if traversing of stairs is necessary, such stairs shall not exceed 15 ft (4570 mm) in height, and the stairs shall be provided with complete enclosures to separate them from any other part of the building, with no door openings therein.
 - A single outside stair shall be permitted to serve all floors permitted within the 4570 mm vertical travel limitation. See [Figure 3.62](#) for a basement example for vertical travel limitation.



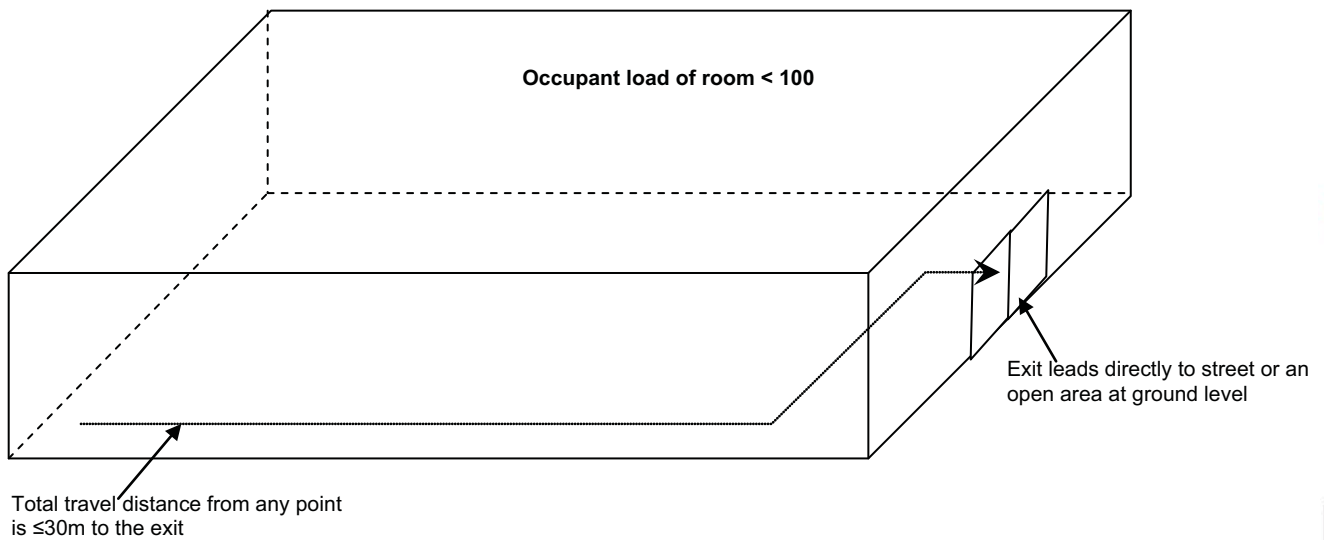


Figure 3.61- Single exit staircase for business occupancy with less than 100 occupants

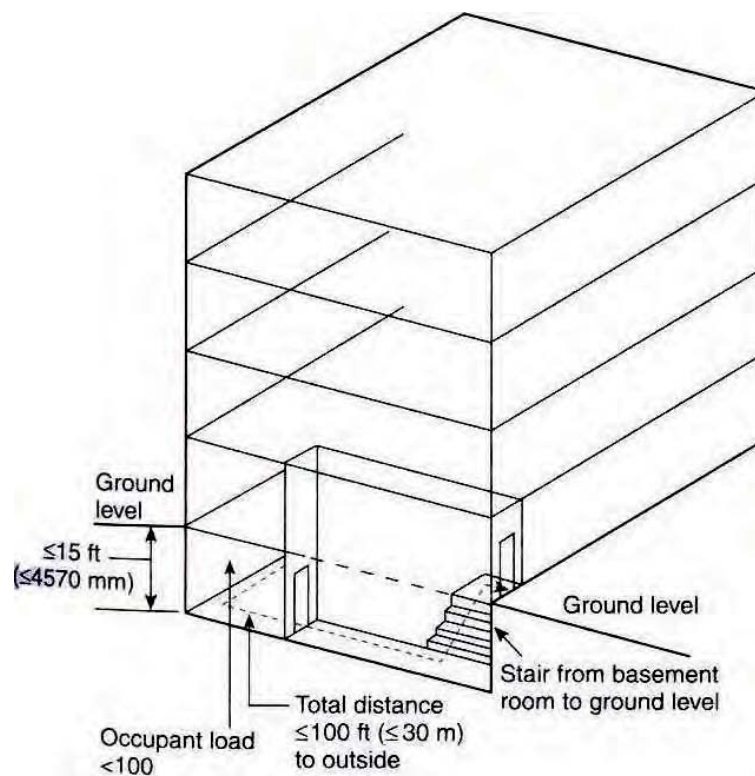


Figure 3.62- Vertical travel limitation



- 12.2.2** Any business occupancy not exceeding three stories, and not exceeding an occupant load of 30 people per floor, shall be permitted a single separate exit to each floor, provided that the following criteria are met:
- This arrangement shall be permitted only where the total travel distance to the outside of the building does not exceed 30 m and where the enclosed exit serves no other levels, and discharges directly to the outside.
 - A single outside stair shall be permitted to serve all floors.
- 12.2.3** A single means of egress shall be permitted from a mezzanine within business occupancy, provided that the common path of travel does not exceed 23 m, or 30m if protected throughout by an approved, supervised automatic sprinkler system.
- 12.2.4** A single exit shall be permitted for a maximum two-story, single-tenant space/building that is protected throughout by an approved, supervised automatic sprinkler system and where the total travel to the outside does not exceed 30 m. See [Figure 3.62](#) and [Figure 3.63](#) for illustration.

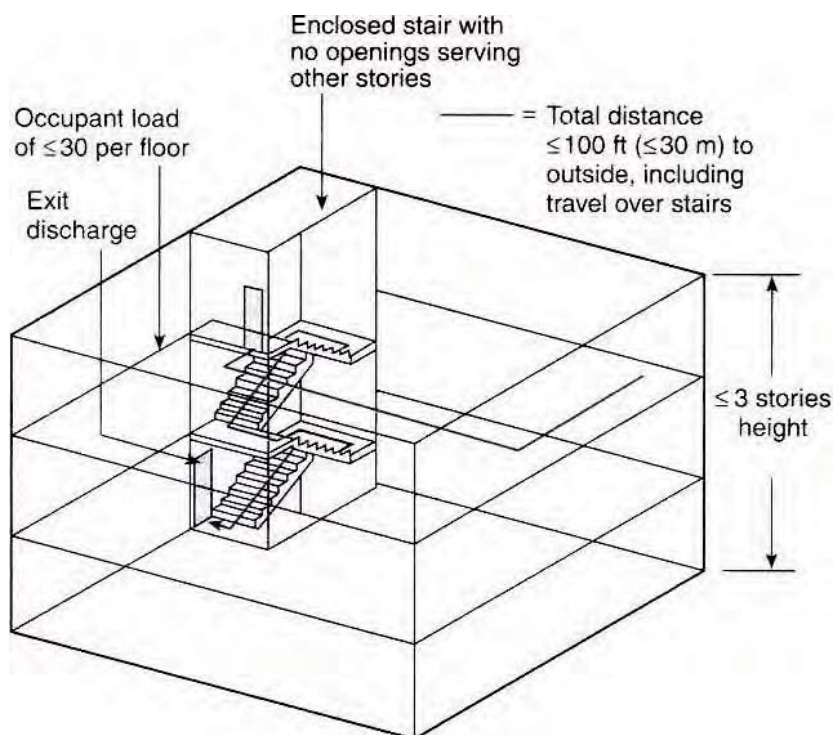


Figure 3.63- Single exit staircase for business occupancy not exceeding 3 stories.



13. Requirements for Assembly Occupancies and Places of Public Interest

13.1 General

13.1.1 This guideline states the requirements for the following assembly occupancies.

- i. Assembly halls
- ii. Auditoriums
- iii. Cinema
- iv. Concert Halls
- v. Theatre

13.1.2 This guideline also applies to special structures and constructions that caters for or accommodates assembly type of occupancies as well as places of public interest.

13.2 Occupant load

13.2.1 The number of people whom which means of egress is to be provided shall be based on the occupant load factor shown in [Table 3.6A](#) and [3.6B](#).

13.3 Waiting Spaces.

13.3.1 In theaters and other assembly occupancies where seats are not available, persons are allowed to wait in a lobby or similar space until seats or space is available, the following requirements shall apply:

- i. Such use of a lobby or similar space shall not encroach upon the required clear width of exits.
- ii. The waiting spaces shall be restricted to areas other than the required means of egress.
- iii. Exits shall be provided for the waiting spaces on the basis of one person for each 0.28 m² of waiting space area.
- iv. Exits for waiting spaces shall be in addition to the exits specified for the main auditorium area and shall conform in construction and arrangement to the general rules for exits given in this chapter.

13.4 Outdoor Facilities.

13.4.1 In outdoor facilities, the number of occupants whom means of egress are to be provided shall be based on the occupant load factor of 1.4 m² per person.



13.5 Means of Egress.

13.5.1 Doors

- 13.5.1.1** Assembly occupancies with occupant loads of 300 or less in malls shall be permitted to have horizontal or vertical security grilles or doors complying with on the main entrance/exits.
- 13.5.1.2** Any door in a required means of egress from an area having an occupant load of 100 or more persons shall be permitted to be provided with a latch or lock only if the latch or lock is panic hardware or fire exit hardware.
- 13.5.1.3** Doors in the means of egress shall be permitted to be equipped with an approved access control system and such doors shall not be locked from the egress side when the assembly occupancy is occupied. Such doors shall also be linked to the fire alarm system which allows the door to be used readily during fire alarm independent of the access control.
- 13.5.2** No turnstiles or other devices that restrict the movement of persons shall be installed in any assembly occupancy in such a manner as to interfere with required means of egress facilities.

13.6 Number and width of exit facilities

- 13.6.1** Number and minimum width of exits for assembly occupancies shall comply with the provisions tabulated as follows :

Table 3.7: Number and width of exits

NO OF OCCUPANTS	MIN NO OF DOORS	MINIMUM WIDTH OF AISLES
50 - 200	2	1120
201-500	2	1120
501-1000	3	1220
>1000 to 2000	4	1220



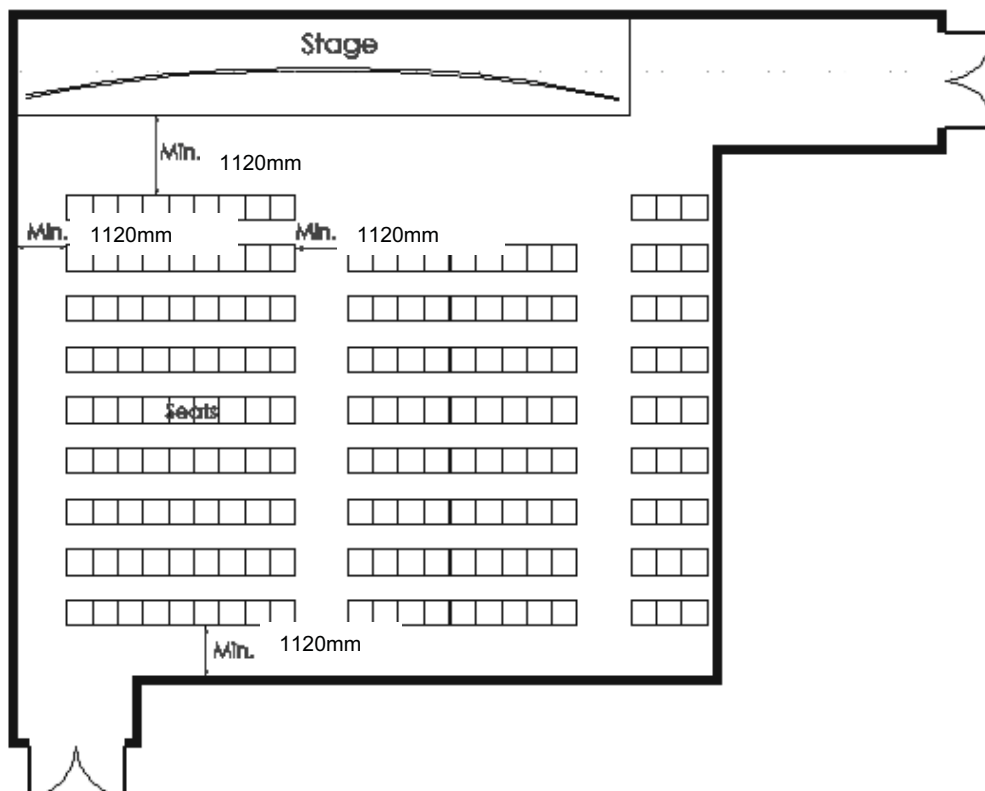


Figure 3.64- Minimum width of Aisle.

- 13.6.2** The total number of occupant load of the above auditorium is more than 50 persons, but not exceeding 200 persons. The clear width of each exit door shall be sufficient to receive at least half the occupant of the floor space. The clear width of the aisles or gangways shall not be less than 1120mm. The exit doors shall be sited remote from each other.

13.7 Assembly Occupancy with Fixed Seating: (Theatres, Cinemas, Auditoriums, Concert Halls etc)

13.7.1 Aisles and Gangways

- i. clear aisles or gangways of not less than the minimum width of corridors shall be provided around the auditorium, stalls and balconies leading to doors or exit doors, and
- ii. aisles or gangways shall be provided with intersecting rows of seating and the number of seats in a row shall be in accordance with the provisions tabulated as follows:



Table 3.8 Seating Arrangement

SEAT WAY WIDTH MM	MAXIMUM NO OF SEATS IN A ROW	
	Aisles on one side	Aisles on two sides
300 to 324	7	14
325 to 349	8	16
350 to 374	9	18
375 to 399	10	20
400 to 424	11	22
425 to 449	12	24
450 to 474	12	26
475 to 499	12	28
500 or more	12	Limited by Travel Distance mentioned in NFPA 101

- 13.7.2** The seat way shall be the minimum clear width between rows, which shall not be less than 300mm, measured as the clear horizontal distance from the back of the row ahead (including seats that tip up automatically) and the nearest projection of the row behind when the seats are in upright position. The seat way widths shall be constant throughout the length of the row.

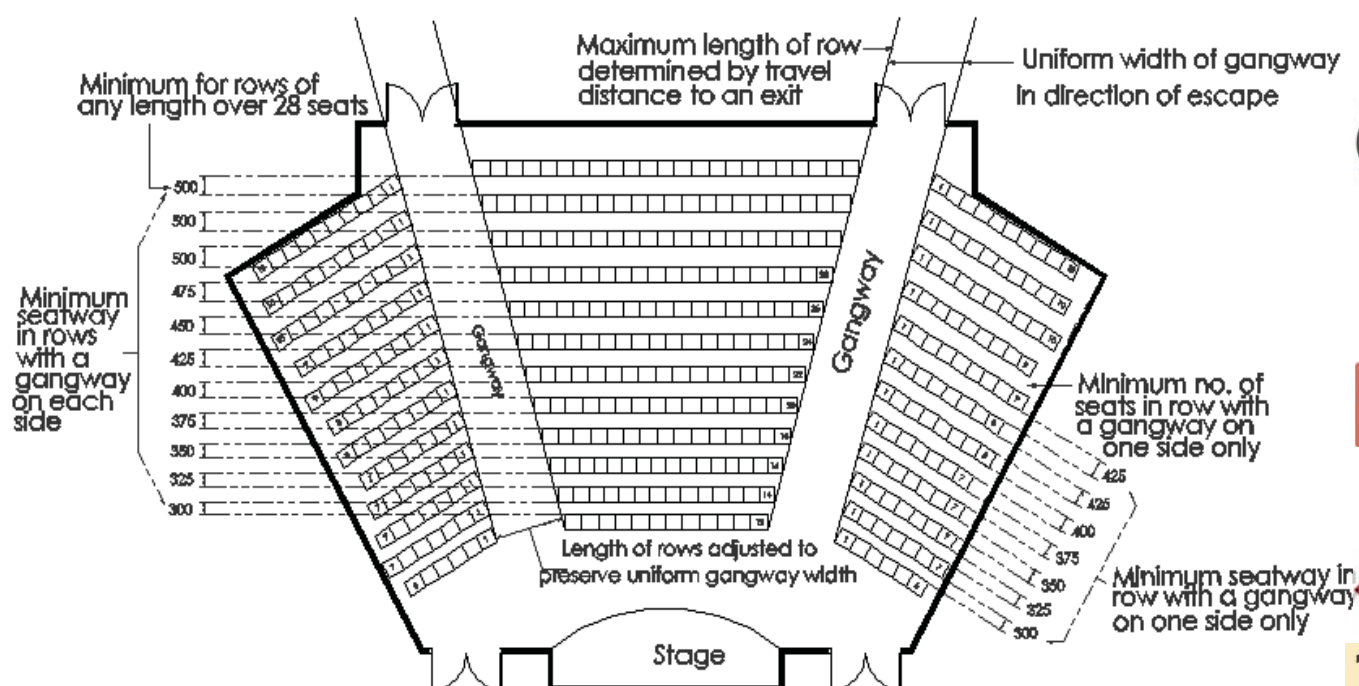


Figure 3.65- Seat way width and number of seats in row



13.7.3 The **Figure 3.65** illustrates uniform width of gangway in the direction of escape, where escape in opposite directions is available in the auditorium.

13.7.4 The seating materials, in all cinemas, theatres, concert halls, auditorium, etc are required to be type tested by a recognized testing laboratory.

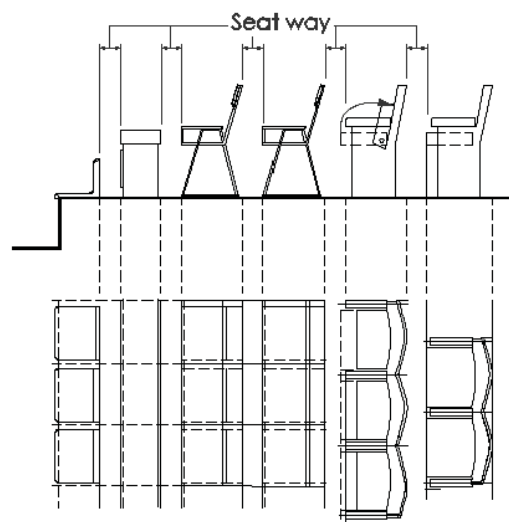


Figure 3.66- Determination of Seat Way width

13.7.5 Seat way widths should be not less than the tabulated seat way width in **Table 3.8** and should be constant throughout the length of the row.

13.8 Exit Component

13.8.1 For changes of level, steps shall not be used to overcome differences in level in aisles or gangways unless the slope of such gangways exceeds 1 in 10.

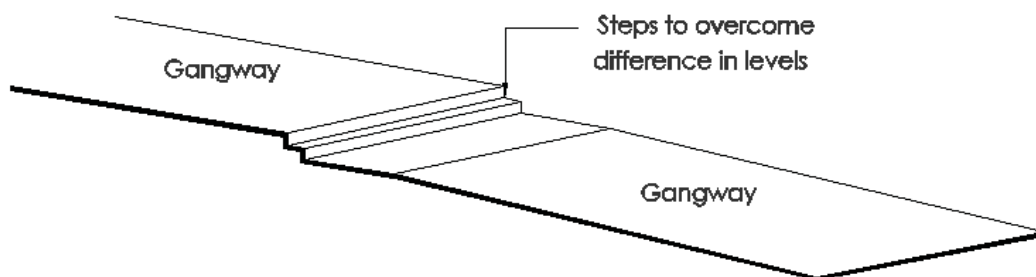


Figure 3.67- Change of level



- 13.8.2** Handrails shall be provided, where steps of a pitch exceeding 30 degrees or ramps of a slope exceeding 1 in 10 are provided in aisles or gangways flanking the seating.

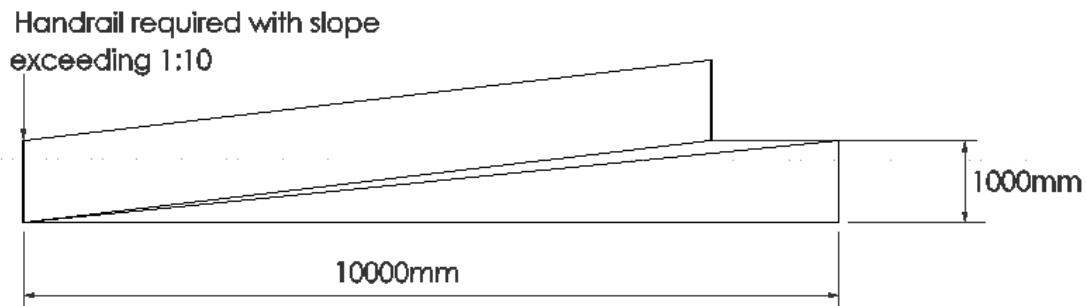


Figure 3.68- Handrails along ramp

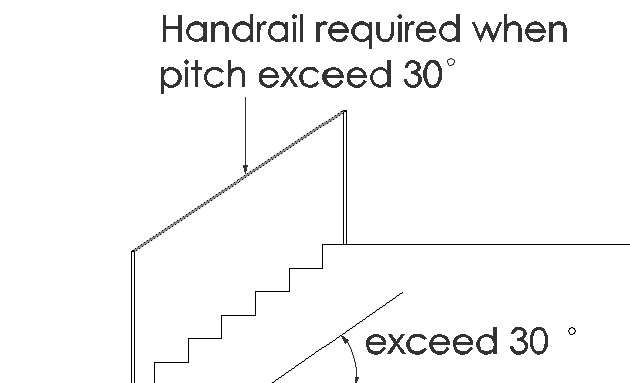


Figure 3.69- Handrails along steps

- 13.8.3** Flooring for the surface of steps and ramps forming the aisles or gangways shall be finished using non-slip materials.
- 13.8.4** Illumination of steps shall be such that each step is clearly visible when the general lighting is switched off.



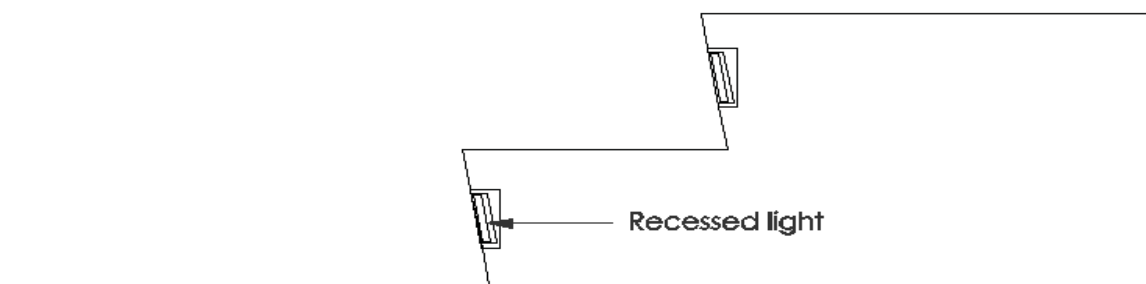


Figure 3.70- Illumination of steps

- 13.8.5** The rationale of illuminating the steps is intended to alert the public of the presence of steps. Such arrangement will help to prevent tripping. Where the emergency lighting of the hall or auditorium is able to provide sufficient lighting to the steps, separate emergency power supply to illuminate the steps would not be required.

13.9 Exits from a theatre, cinema or a concert hall

- 13.9.1** The number and capacity of exits from a theatre, cinema or concert hall shall be provided within its own compartment without having to take into account exits provided for its adjoining parts of the same building in which it is housed.
- 13.9.2** Exception may be permitted where the occupancy load does not exceed 200, in which case at least half the capacity of exits must be provided within the compartment.
- 13.9.3** The exits adjacent or attached to cinema, theatre or concert hall and the like can be shared as exits with the other parts of the building, subject to the following:
- the exits are accessible from the common circulation areas; and
 - the occupancy load of the cinema, theatre, concert hall and the like does not exceed 200 persons.

13.10 Seats Requirements

- 13.10.1** Self raising seats or automatic raising seats shall comply with ASTM F 851, Test Method for Self-Raising Seat Mechanism, or
- 13.10.2** BS5852 in respect of the following testing standard :
- Smoldering Ignition Source



- ii. Flaming Ignition Source 1
- iii. Crib Ignition Source 5

13.11 Internal Furnishings

- 13.11.1** Interior wall and ceiling materials shall be of Class A or B in all corridors and lobbies and shall be Class A in stairways.
- 13.11.2** Interior walls and ceilings materials shall be of Class A or B for occupant load of more than 300.
- 13.11.3** Interior walls and ceilings materials shall be of Class A, B or C for occupant load of less than 300.
- 13.11.4** Interior floor finish shall be not less than Class 2.

13.12 Standard for Interior wall and ceiling finishing.

- 13.12.1** Interior wall and ceiling finish shall be classified based on test results from NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials ASTM E 84 or UL 723. Flame retardant test shall meet NFPA 701 requirements.
 - i. **Class A:** Flame Spread, 0-25
Smoke Development, 0-450
No new propagation of fire in any element.
 - ii. **Class B:** Flame Spread, 26-75
Smoke Development, 0-450
 - iii. **Class C:** Flame Spread, 76-200
Smoke Development, 0-450

- 13.12.2** Curtain Fabrics shall not have smoke density more than 25.

13.13 Standards for Floor Finishing

- 13.13.1** Carpet and carpet like interior floor finishes shall comply with ASTM D 2859, Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials.
- 13.13.2** Interior Floor finish shall be classified accordance with NFPA 253, Standard method of test for critical radiant flux of floor covering systems using a radiant heat energy source.
 - Class 1: Critical radiant flux not less than 0.45W/cm²
 - Class 2: Critical radiant flux not less than 0.22W/cm²



13.14 Standard for Decoration and Scenery

- 13.14.1** Exposed foamed plastic materials and unprotected materials used for decorative purposes or stage scenery shall be in accordance with UL 1975, Standard for fire test for foamed plastic for decorative purposes.

14. Labor Accommodation

- 14.1** Labor accommodations include buildings or spaces in buildings where sleeping accommodation is provided for workers, with or without meals, but without individual cooking facilities. The phrase "without individual cooking facilities" refers to the absence of cooking equipment in any room or unit.

14.2 Size

- i. Each bedroom or unit shall not exceed 120m².
- ii. The occupant load shall be based on gross floor area on the basis of 3m² per person or based on the actual number of occupants for which each occupied space of the floor is designed as shown on the plan, whichever is greater.
- iii. There shall be at least two independent exit staircases or other exits from every storey of a building.
- iv. The travel distance, measured from the most remote point of the labour accommodation bedroom to the nearest exit staircase or other storey exit, shall not exceed the maximum travel distance permitted under this chapter.

- 14.3** Bedrooms with access through an internal corridor shall comply with the requirements as follows:

- i. Bedrooms shall be separated from the internal corridor by a wall having fire resistance of at least 1-hour; and
- ii. Doors opening into internal corridors shall have fire resistance of at least half an hour and fitted with automatic self-closing device.
- iii. Internal corridors shall be naturally ventilated with fixed openings in an external wall, such ventilation openings being not less than 15 percent of the floor area of the internal corridor, and
- iv. The ventilation openings in the external walls shall not be less than 3.5 m² and shall be unobstructed from parapet wall or balustrade level upwards and be positioned on opposite sides of the corridor such that they provide effective cross-ventilation throughout the entire space of the corridor, and
- v. The ventilation openings in the external walls shall not be more than 12 m from any part of the corridor, and



- vi. Other rooms or spaces which open into or form part of the bedroom corridor and which may prejudice the means of escape provision shall be required to be compartmented by 1-hour fire rated enclosures and ½-hour fire doors.

14.4 Bedrooms with access through an external corridor shall comply with the requirements as follows:

- i. Bedrooms shall be separated from the external corridor by a wall having fire resistance of at least 1 hour, except that ventilation openings of non-combustible construction may be fixed at or above a level of 1.1 m, measured from the finished floor level of the external corridor to the sill height of the opening, and
- ii. Doors opening into the external corridor shall not be required to have fire resistance rating, and
- iii. External corridors shall conform to the requirements of external exit passageway for minimum width, changes in floor level, roof protection and enclosure on the open side.

14.5 Entry into an exit staircase from any part of a building of more than 3 storeys above ground (> 15m, mid rise) level shall provide smoke proof enclosure to exit staircase. Pressurization of staircase in lieu of the provision of smoke stop lobby is permitted. See [Figure 3.71, 3.72, 3.73](#) and [3.74](#) for illustrations.

14.6 Smoke detectors shall be provided along internal corridors as well as inside each bedroom. Kitchens shall be provided with heat detectors.

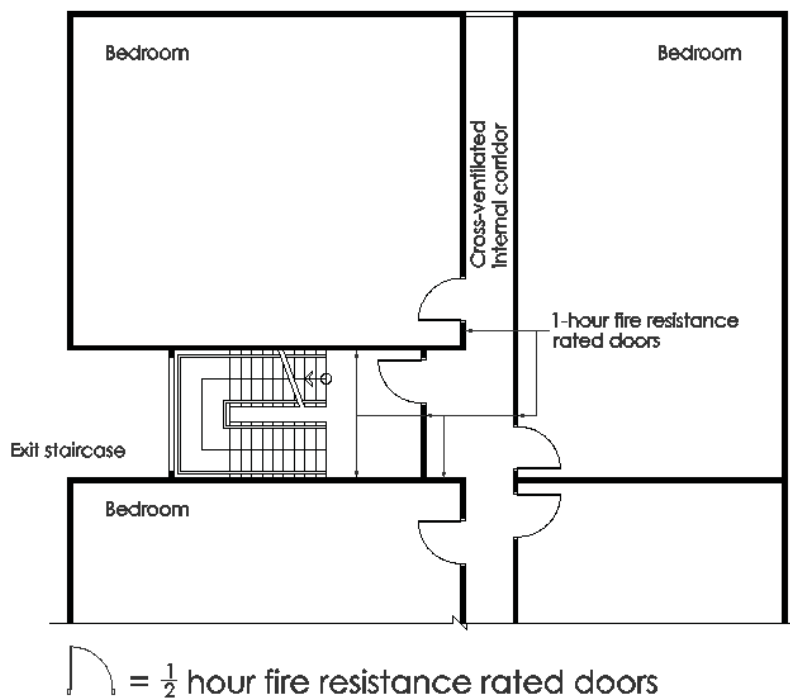


Figure 3.71- Interval corridor arrangement for labor accommodation



Ventilation of internal corridors to worker's dormitory

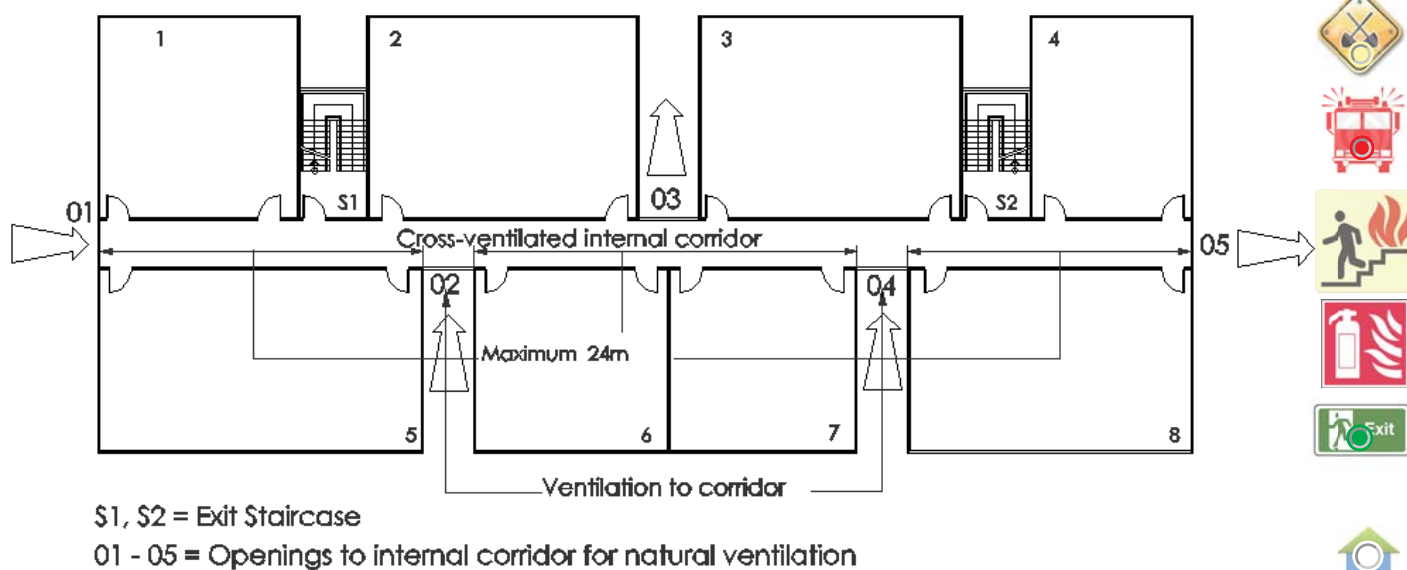


Figure 3.72- Cross ventilation opening for internal corridor.

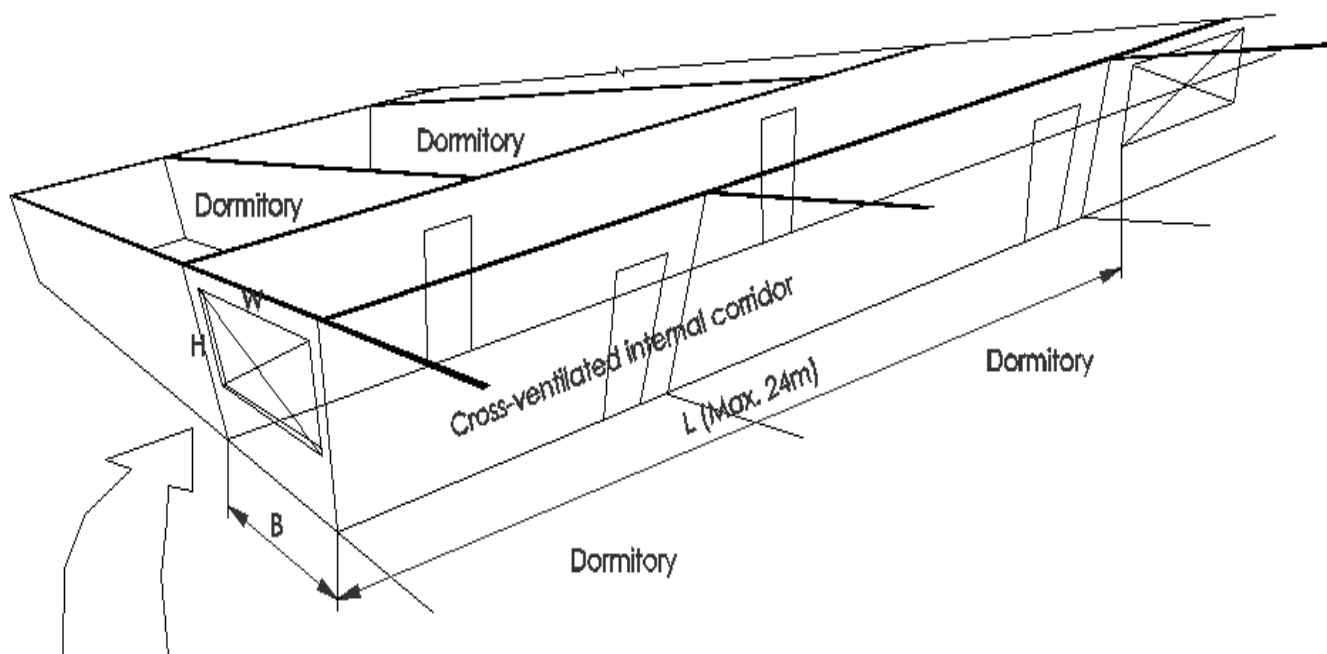


Figure 3.73- Maximum distance from natural ventilation opening

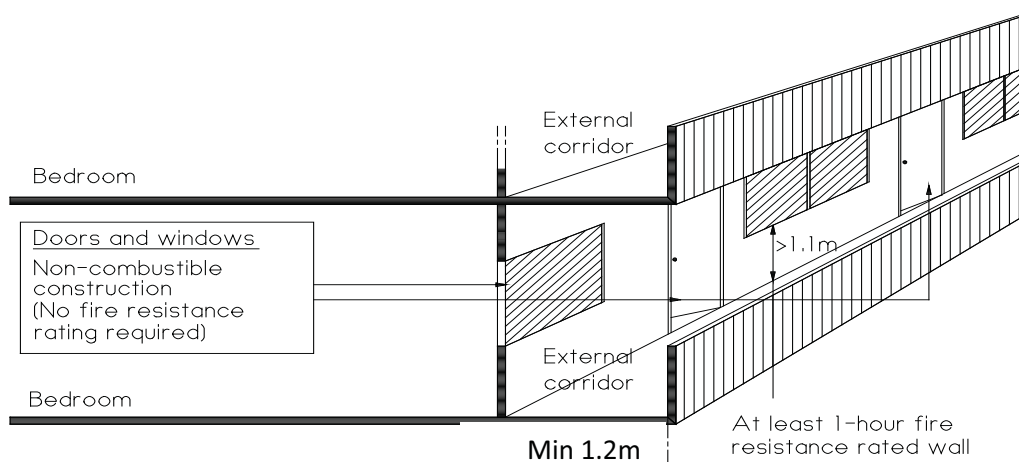


Figure 3.74- Passive protection for external corridor

15. Material Approval

- 15.1** All the Materials, Systems, Assemblies, equipment, Products and Accessories, referred to in this chapter with respect to Life Safety, Fire Safety and Emergency Services shall be Listed, Approved and Registered by the Civil Defence Material Approval Department.
- 15.2** The above requirement applies to all the products with or without international listing, registration or approval.

16. Further References

- 16.1** The following International Codes and Standards were referred, studied and consulted for this chapter. Further details where applicable can be referred to in these Codes and Standards. Also see **XV. ACKNOWLEDGEMENT OF INTERNATIONAL CODES AND STANDARDS**.

- NFPA 101: Life Safety Code
- NFPA 5000: Building Construction and Safety Code
- IBC: International Building Code



CHAPTER 4

PORTABLE FIRE EXTINGUISHERS

1. Definition

1.1. Portable Extinguisher

- 1.1.1.** A portable device, carried or on wheels and operated by hand, containing an extinguishing agent that can be expelled under pressure for the purpose of suppressing or extinguishing fire.

Table 4.1: Classes of Fires

CLASSES OF FIRES		
SL. NO.	CLASSIFICATION OF FIRES	DEFINITION
1.	Class – A  	The Fires involving ordinary combustibles such as wood, cloth, paper, rubber, and many other plastics.
2.	Class – B  	The Fires involving flammable liquids, combustible liquids, all petroleum based products, solvents, paints, chemicals and flammable gases.
3.	Class – C  	The Fires involving energized electrical equipments due to ignition of electrical nature.
4.	Class – D 	The Fires involving combustible metals, such as magnesium, titanium, zirconium, sodium, lithium, and potassium.
5.	Class – K	The Fires involving cooking appliances due to combustible cooking media such as vegetable oils and animal fats etc.

2. Application

- 2.1.** As a first line of defence during the initial stages of Fire, availability of portable fire extinguishers is mandatory for all occupancies for the use of occupants to extinguish the fire before the fire grows out of control. There are various classes and types of Portable fire extinguishers used for extinguishing the various classes of fires.



Table 4.2: Applicable Types of Fire Extinguishers

APPLICABLE TYPES OF FIRE EXTINGUISHERS		
SL. NO.	CLASSIFICATION OF FIRES	APPLICABLE EXTINGUISHERS
1.	Class – A  	• Water type • Multipurpose Dry Powder • Carbon Di-Oxide (CO2) • Foam
2.	Class – B  	• Dry Powder • Foam • Carbon Di-Oxide (CO2)
3.	Class – C  	• Carbon Di-Oxide (CO2) • Dry Powder
4.	Class – D 	• Special purpose Dry Powder
5.	Class – K	• Wet Chemical type

- 2.2.** Portable Fire extinguishers shall be provided for the protection of both the building structure and the occupancy hazards contained therein regardless of the presence of any fixed fire suppression systems.



3. Table 4.3: Selection and Location of Portable Fire Extinguishers

LOCATION	TYPE OF EXTINGUISHERS TO BE PROVIDED AS A SET	MAXIMUM TRAVEL DISTANCE TO NEAREST EXTINGUISHER SET
Offices	- Water Type, 9 Ltrs - CO2, 2 Kg	15 m
Common Circulation Areas Corridors, Lobby's, Passage ways	- Water Type, 9 Ltrs - CO2, 5 Kg	22.5 m
Electrical Rooms, Telephone Rooms Mechanical Plant Room, Lift Machine Room, Other service rooms	- Dry Powder Type, 4.5 Kg - CO2, 5 Kg	9 m
Parking areas	- Multipurpose (ABC) Dry Powder Type, 4.5 Kg - CO2, 5 Kg - FFP Foam Trolley Type, 20 Gal.	15 m 30 m along the drive way.
Transformer Room	- Dry Powder Type, 4.5 Kg - CO2, 5 Kg - Dry Powder Trolley Type, 25 Kg per transformer	9 m
HV / LV Room	- Dry Powder Type, 4.5 Kg - CO2, 5 Kg - CO2 Trolley Type, 12 Kg near exit	9 m
Diesel Generator Room	- Dry Powder Type, 4.5 Kg - CO2, 5 Kg - FFP Foam Trolley Type, 20 Gal. per DG set.	9 m
Garbage Collection Room	Dry Powder Type, 6 Kg	9 m
Library	- Water Type, 9 Ltrs - CO2, 2 Kg - Dry Powder Type, 4.5 Kg	15m
Laboratories	- Water Type, 9 Ltrs - CO2, 2 Kg - Dry Powder Type, 4.5 Kg	9m
Gymnasium	- Water Type, 9 Ltrs - Dry Powder Type, 4.5 Kg	15m
Theater	- Water Type, 9 Ltrs - CO2, 2 Kg - Dry Powder Type, 4.5 Kg	15m
Kitchen	- CO2, 2 Kg - Dry Powder Type, 4.5 Kg - Foam Extinguisher	9m
Patient Rooms	- Water Type, 9 Ltrs - CO2, 2 Kg - Dry Powder Type, 4.5 Kg	15m
Hotel	- Water Type, 9 Ltrs - CO2, 2 Kg - Dry Powder Type, 4.5 Kg	15m



4. Installation of Portable Fire Extinguishers

- 4.1. The wall mount type portable fire extinguishers shall be installed in such a way that the top of the fire extinguisher is not more than 1.5 mtrs above the floor and not less than 30 cm from the bottom of extinguisher to the finished floor.
- 4.2. Fire extinguishers shall be installed in an easily accessible location, immediate vicinity areas without obstructing the escape path.
- 4.3. All extinguishers shall be installed in such that the operating instructions are facing towards front side to read clearly.
- 4.4. In the corridor, passage way, lift lobby etc areas where aesthetic issue raises, the fire extinguishers can be installed inside the fire hose cabinet, recessed inside the wall. In such case, proper identification signs shall be placed on the cabinet and the front door shall be of partially wired glass door to view the fire extinguishers. The fire extinguishers placed inside the cabinets shall face towards front side to read the operating instructions clearly.
- 4.5. Fire extinguishers shall not be installed / placed in any areas where the temperatures outside of the listed temperature range shown on the fire extinguisher label. Generally the fire extinguishers are permitted to be installed in the areas where temperatures ranging from 4 deg. C to 49 deg. C.
- 4.6. Fire extinguishers cabinets shall not be kept locked in any case with in the facility. While installation, all the fire extinguishers shall be fully charged and ready for use in case of an emergency.

5. Inspection and Maintenance of Portable Fire Extinguishers

- 5.1. All fire extinguishers shall be inspected immediately after the installation and periodically at regular intervals not more than 30 days.
- 5.2. Inspection record shall be maintained at the facility by the management representative or the Civil Defence approved fire protection installation and maintenance contractor appointed by the management.
- 5.3. The persons conducting inspections shall maintain the record of all fire extinguishers installed in the facility including the fire extinguishers which requires corrective action and the date of action taken.
- 5.4. All the fire extinguishers shall be maintained by an approved maintenance company by the Civil Defence Authority. See NFPA 10 for detailed Inspection and Maintenance requirements.



6. Training of Portable Fire Extinguishers' Operation

- 6.1.** At least 10 % of the Security personnel, Occupants, Employees and Supervisory personnel of each occupancy shall be trained on basic fire awareness, types, use and operation of fire extinguishers in emergency situation.
- 6.2.** The training shall be conducted by an authorized agency by the Civil Defence or by the Civil Defence department personnel.

7. Material Approval

- 7.1.** All the Materials, Systems, Assemblies, equipment, Products and Accessories, referred to in this chapter with respect to Life Safety, Fire Safety and Emergency Services shall be Listed, Approved and Registered by the Civil Defence Material Approval Department.
- 7.2.** The above requirement applies to all the products with or without international listing, registration or approval.

8. Further References

- 8.1.** The following International Codes and Standards were referred, studied and consulted for this chapter. Further details where applicable can be referred to in these Codes and Standards. Also see **XV. ACKNOWLEDGEMENT OF INTERNATIONAL CODES AND STANDARDS.**
- NFPA 10: Standard for Portable Fire Extinguisher.



CHAPTER 5

EXIT SIGNS

1. Exit and Directional Signs

- 1.1. In all buildings, except for One-and-Two-Family Dwelling, the entrance to every exit on every floor shall be clearly indicated by an exit sign placed over the exit door. Such signs shall be placed so as to be clearly visible at all times.
- 1.2. In long corridors, in open floor areas, and in all situations where the location of the exits may not be readily visible, directional signs shall be provided to serve as guides from all portions of the corridors or floors. See [Figure 5.1](#).

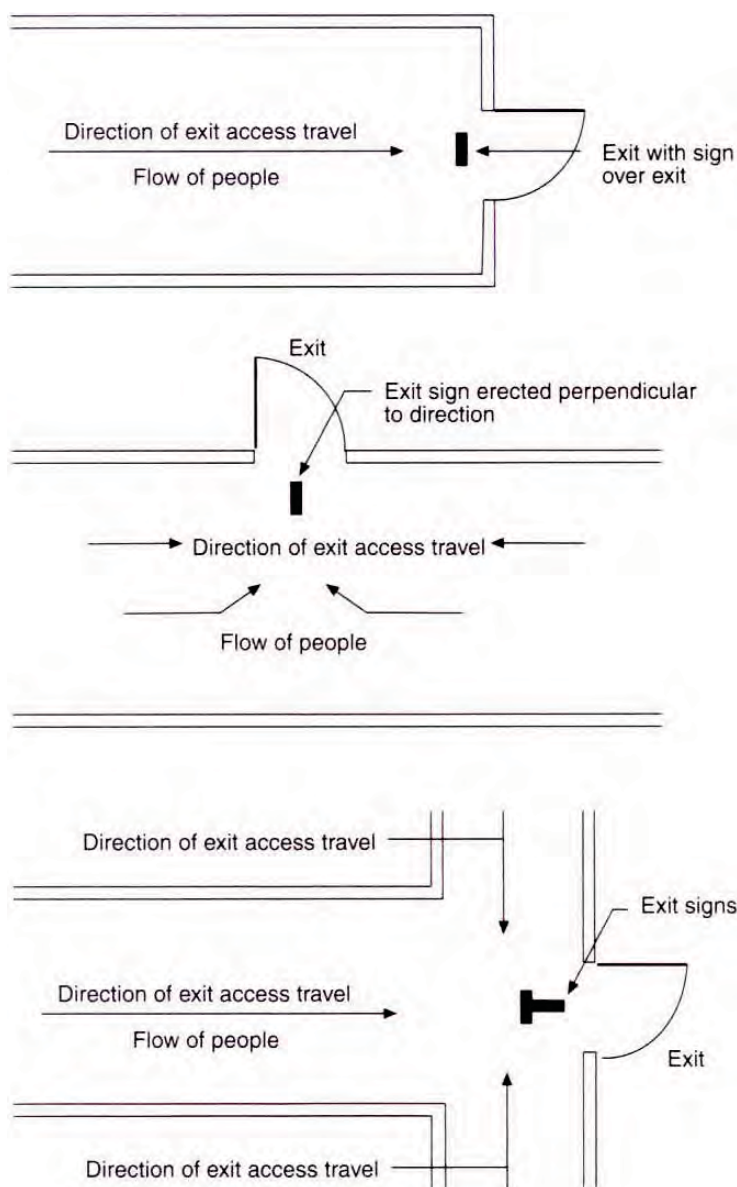


Figure 5.1: Location of Exit and Directional Signs



- 1.3. Additional low level or floor mounted exit and exit directional signs shall be provided in hotel accommodation floors including boarding houses.
- 1.4. Exits, other than main exterior exit doors that obviously and clearly are identifiable as exits, shall be marked by an approved sign that is readily visible from any direction of exit access.
- 1.5. Exit Door Tactile Signage shall be provided to meet the following Criteria.
 - i. Tactile signage shall be located at each exit door requiring an exit sign.
 - ii. Tactile signage shall read as follows: EXIT.
 - iii. Tactile signage shall comply with ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities*.

2. Exit Access

- 2.1. Access to exits shall be marked by approved, readily visible signs in all cases where the exit or way to reach the exit is not readily apparent to the occupants.
- 2.2. New sign placement shall be such that no point in an exit access corridor is in excess of the rated viewing distance or 30 m, whichever is less, from the nearest sign.

3. Floor Proximity Exit Signs.

- 3.1. Where floor proximity exit signs are required in such signs shall be located near the floor level in addition to those signs required for doors or corridors. The bottom of the sign shall be not less than 150 mm, but not more than 455 mm, above the floor.
- 3.2. For exit doors, the sign shall be mounted on the door or adjacent to the door, with the nearest edge of the sign within 100 mm of the door frame.

4. Floor Proximity Egress Path Marking.

- 4.1. Where floor proximity egress path marking is required, a listed and approved floor proximity egress path marking system that is internally illuminated shall be installed within 455 mm of the floor.
- 4.2. The system shall provide a visible delineation of the path of travel along the designated exit access and shall be essentially continuous, except as interrupted by doorways, hallways, corridors, or other such architectural features.
- 4.3. The system shall operate continuously or at any time the building fire alarm system is activated.



5. Visibility

- 5.1. Every sign required shall be located and of such size, distinctive color, and design that it is readily visible and shall provide contrast with decorations, interior finish, or other signs.
- 5.2. No decorations, furnishings, or equipment that impairs visibility of a sign shall be permitted. No brightly illuminated sign (for other than exit purposes), display, or object in or near the line of vision of the required exit sign that could detract attention from the exit sign shall be permitted.

6. Mounting Location.

- 6.1. The bottom of egress markings shall be located at a vertical distance of not more than 2030 mm above the top edge of the egress opening intended for designation by that marking.
- 6.2. Egress markings shall be located at a horizontal distance of not more than the required width of the egress opening, as measured from the edge of the egress opening intended for designation by that marking to the nearest edge of the marking. See Figure 5.2.

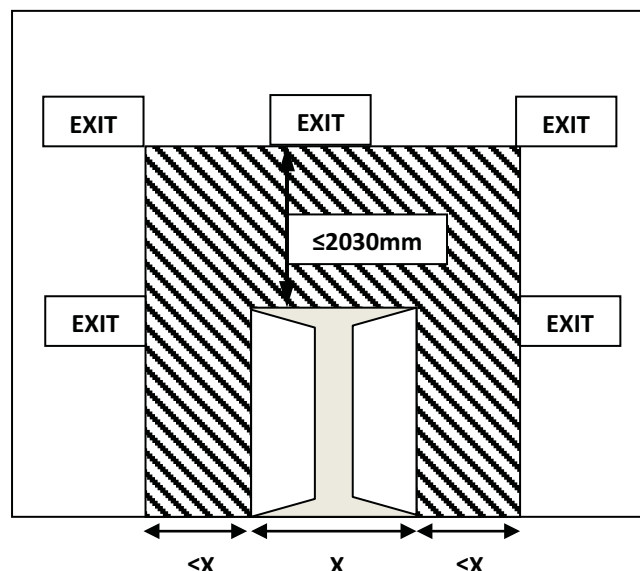


Figure 5.2: Mounting location of exit signs on exit door facade

7. Directional Signs

- 7.1. A directional sign shall be with a directional indicator showing the direction of travel shall be placed in every location where the direction of travel to reach the nearest exit is not apparent.



8. Sign Legend

- 8.1. Signs shall read as follows in plainly legible letters, or other appropriate wording shall be used:

EXIT

- 8.2. Clear Pictograms shall be permitted to be used. See [Figure 5.3](#).

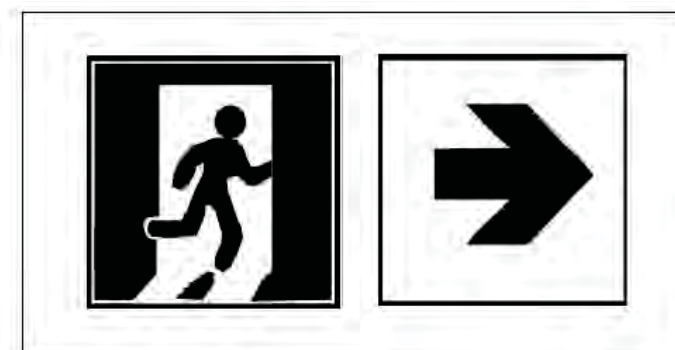


Figure 5.3: Pictorial and directional sign

9. Power Source

- 9.1. Where emergency lighting facilities are required, the signs, other than approved self-luminous signs and listed photo luminescent signs in accordance with shall be illuminated by the emergency lighting facilities.

10. Externally Illuminated Signs

- 10.1. Externally illuminated signs required, shall read EXIT or shall use other appropriate wording in plainly legible letters and shall be not less than 150 mm high, with the principal strokes of letters not less than 19 mm wide.

11. Size and Location of Directional Indicator

- 11.1. Directional indicators, shall comply with the following:
- The directional indicator shall be located outside of the EXIT legend, not less than 9.5 mm from any letter.
 - The directional indicator shall be of a chevron type.
 - The directional indicator shall be identifiable as a directional indicator at a distance of 12 m.
 - A directional indicator larger than the minimum shall be proportionately increased in height, width, and stroke.
 - The directional indicator shall be located at the end of the sign for the direction indicated.





Figure 5.4: Chevron-Type Indicator

12. Level of Illumination

- 12.1.** Externally illuminated signs shall be illuminated by not less than 5 ft-candles (54 lux) at the illuminated surface and shall have a contrast ratio of not less than 0.5. However, the level of illumination shall be permitted to decline to 60 percent at the end of the emergency lighting duration.

13. Internally Illuminated Signs

- 13.1.** Internally illuminated signs shall be listed in accordance with UL 924, Standard for Emergency Lighting and Power Equipment.

14. Photoluminescent Signs

- 14.1.** Adequate photoluminescent ‘**Evacuation Floor Plans**’ depicting the clear evacuation paths of each floor shall be furnished at respective floors.
- 14.2.** The face of a photoluminescent sign shall be continually illuminated while the building is occupied. The illumination levels on the face of the photoluminescent sign shall be in accordance with its listing. The charging illumination shall be a reliable light source. The charging light source shall be of a type specified in the product markings.

15. No Exit Sign

- 15.1.** Any door, passage, or stairway that is neither an exit nor a way of exit access and that is located or arranged so that it is likely to be mistaken for an exit shall be identified by a sign that reads as follows:

**NO
EXIT**



- 15.2.** The NO EXIT sign shall have the word NO in letters 51 mm high, with a stroke width of 9.5 mm, and the word EXIT in letters 25 mm high, with the word EXIT below the word NO, unless such sign is an approved existing sign.

16. Elevator Signs

- 16.1.** Signs concerning Elevators shall have a minimum letter height of 16 mm posted in every elevator lobby.
- 16.2.** Elevators dedicated as 'Fire Lift', shall have clear signage with the number of floors it is serving, identification of emergency overriding switches, emergency communicating devices, Telephone numbers of facility management personnel etc.

17. Material Approval

- 17.1.** All the Materials, Systems, Assemblies, equipment, Products and Accessories, referred to in this chapter with respect to Life Safety, Fire Safety and Emergency Services shall be Listed, Approved and Registered by the Civil Defence Material Approval Department.
- 17.2.** The above requirement applies to all the products with or without international listing, registration or approval.

18. Further References

- 18.1.** The following International Codes and Standards were referred, studied and consulted for this chapter. Further details where applicable can be referred to in these Codes and Standards. Also see **XV. ACKNOWLEDGEMENT OF INTERNATIONAL CODES AND STANDARDS.**
- NFPA 72: National Fire Alarm and Signaling Code
 - NFPA 70: National Electrical Code®
 - NFPA 110: Standard for Emergency and Standby Power Systems.
 - NFPA 111: Standard on Stored Electrical Energy Emergency and Standby Power Systems.
 - NFPA 170: Standard for Fire Safety and Emergency Symbols
 - IEC 60598-2.22 - Luminaires – Particular requirements: Luminaires for emergency lighting.
 - ISO3864 Graphical symbols -- Safety colours and safety signs -- Part 1: Design principles for safety signs in workplaces and public areas.



CHAPTER 6

EMERGENCY AND EXIT LIGHTING

1. General

- 1.1** Emergency lighting systems shall be designed and installed so that the failure of any individual lighting element, such as the burning out of a light bulb, cannot leave in total darkness any space that requires emergency illumination.
- 1.2** The objective of having emergency lighting during emergencies or when the normal lighting of the occupied building fails. The emergency light shall fulfill the following functions:
- To indicate clearly and unambiguously the escape routes.
 - To provide illumination along such routes to allow safe movement towards and through the exits provided.
 - To ensure that fire alarm call points and fire fighting equipment provided along escape routes can be readily located.
 - To permit operations concerned with safety measures

2. Emergency Lighting for Corridors and Lobbies

- 2.1** Emergency lighting shall be provided in all corridors, egress routes, lobbies and all the areas mentioned in this chapter of all buildings except for One-and-Two – Family-Dwelling.

3. Emergency Lighting for Occupied Areas

- 3.1** For all buildings except for One-and-Two-Family Dwelling, emergency lighting shall be provided in all occupancies in the following areas:
- along exit corridors, egress path, lobbies and exits staircases
 - Over area if there are no explicit paths leading to corridors, lobbies and exits.
 - In hotel rooms or suites.
 - Educational occupancies used as assembly, i.e. gymnasium, concert halls, auditoriums, theatres.
 - In office rooms more than 60m².
- 3.2** Notwithstanding the requirements in the clause above, emergency lighting shall be provided in the following locations:
- Lift cars
 - Emergency command centers
 - Generator rooms
 - Basement car parks
 - Fire pump rooms
 - Areas of refuge within the same building.



- 3.3** The delay between the failure of the electrical supply to normal lighting and the energization of the emergency lighting for occupied areas shall not exceed 1 second.
- 3.4** Where maintenance of illumination depends on changing from one energy source to another, a delay of not more than 10 seconds shall be permitted.

4. Performance of System

- 4.1** Emergency illumination shall be provided for not less than 3 hours in the event of failure of normal lighting.
- 4.2** Emergency lighting facilities shall be arranged to provide initial illumination that is not less than an average of 1 ft-candle (10.8 lux) and, at any point, not less than 0.1 ft-candle (1.1 lux), measured along the path of egress at floor level.
- 4.3** Illumination levels shall be permitted to decline to not less than an average of 0.6 ft-candle (6.5 lux) and, at any point, not less than 0.06 ft-candle (0.65 lux) at the end of the 1½ hours. A maximum-to-minimum illumination uniformity ratio of 40 to 1 shall not be exceeded.
- 4.4** New emergency power systems for emergency lighting shall be at least Type 10, Class 1.5, Level 1, in accordance with NFPA 110, *Standard for Emergency and Standby Power Systems*.
- 4.5** The emergency lighting system shall be arranged to provide the required illumination automatically in the event of any interruption of normal lighting due to any of the following:
- a. Failure of a public utility or other outside electrical power supply
 - b. Opening of a circuit breaker or fuse
 - c. Manual act(s), including accidental opening of a switch controlling normal lighting Facilities
- 4.6** Emergency generators providing power to emergency lighting systems shall be installed, tested, and maintained in accordance with International *Standard for Emergency and Standby Power Systems*.
- 4.7** Stored electrical energy systems, where required in this *Code*, shall be installed and tested in accordance with International, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*.
- 4.8** Unit equipment and battery systems for emergency luminaires shall be listed and approved by international testing laboratories.
- 4.9** Existing battery-operated emergency lights shall use only reliable types of rechargeable batteries provided with suitable facilities for maintaining them in properly charged condition. Batteries used in such lights or units shall be approved for their intended use.



- 4.10 Central Battery System where installed shall be automatically monitored and tested through the dedicated Control system which is also interfaced with Building Monitoring System and the fire alarm control unit.
- 4.11 When Central Battery system is provided it shall be provided with cross zoning arrangement. At least two circuits shall cover each area in a overlapping of light units.
- 4.12 If Self-contained Emergency lighting units are used, it shall be provided with automatic monitoring and testing through the dedicated Control system which is interfaced with Building Monitoring System and the fire alarm control unit. The circuits and self contained luminaires shall be monitored for the 'low battery', fault and the status. See [Fig 6.1](#). The batteries shall be able to function for at least 3 hours during power failure or emergency.
- 4.13 The Monitored self contained Emergency lighting system mentioned in 4.12 shall be an 'Approved System' wherein the Emergency luminaires, the Control Unit, Addressable Modules, Batteries etc shall be approved as an 'Assembly'.
- 4.14 The emergency lighting system shall be either continuously in operation or shall be capable of repeated automatic operation without manual intervention.
- 4.15 All components of the emergency light and its fittings shall be designed, tested and approved to be used for the purpose of emergency lighting.
- 4.16 The [Figure 6.2](#) and [6.3](#) shows the typical setup of central and self contained emergency lighting system with monitoring arrangement.

5. Emergency lighting for firefighting facilities

- 5.1 Fire alarm panels, fire alarm call points and firefighting equipment shall be adequately illuminated at all times so that they can be easily located.
- 5.2 The delay between the failure of the electrical supply to normal lighting and the energization of the emergency lighting for firefighting facilities shall not exceed 10 seconds.

6. Secondary Source of Power Supply

- 6.1 The delay for energization of the exit and emergency lighting systems between normal supply and the secondary source shall be as stipulated in the relevant clauses in Chapter 8.
- 6.2 Duration of the secondary source of power supply shall comply with the requirements in NFPA 110. Standard for Emergency and Standby Power Systems and NFPA 111, Standard on Stored Electrical Energy Emergency and Standby Power Systems.
- 6.3 Location, arrangement and control, installation of electrical wiring of the secondary source of supply, be it in the form of battery, standby generator,



inverter or other accepted equipment, shall comply with the requirements in NFPA 70.

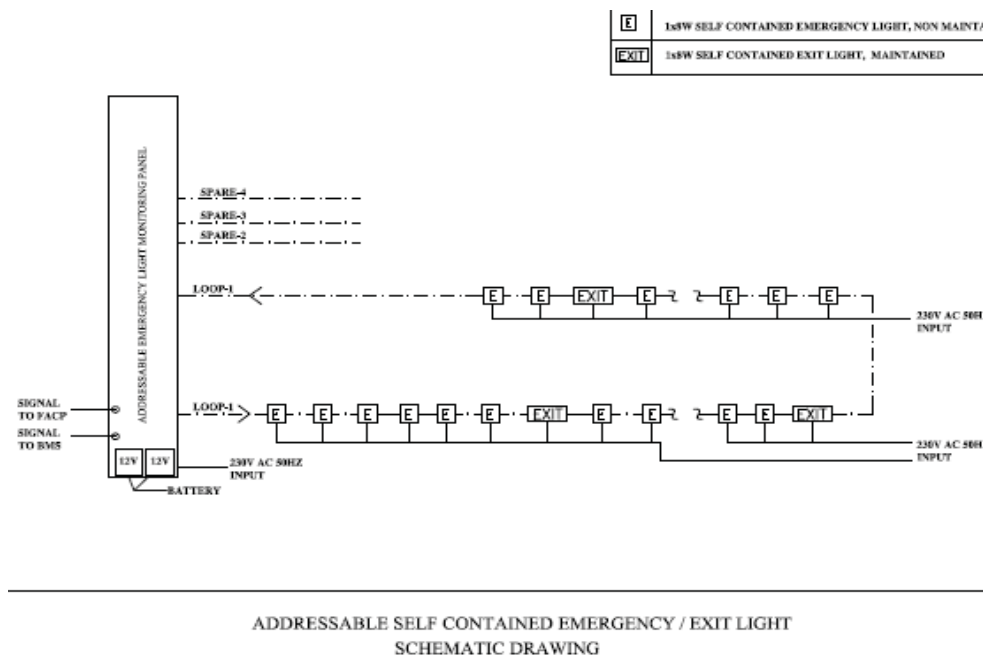


Figure 6.1: Self contained Emergency Lights Connected to Monitoring System

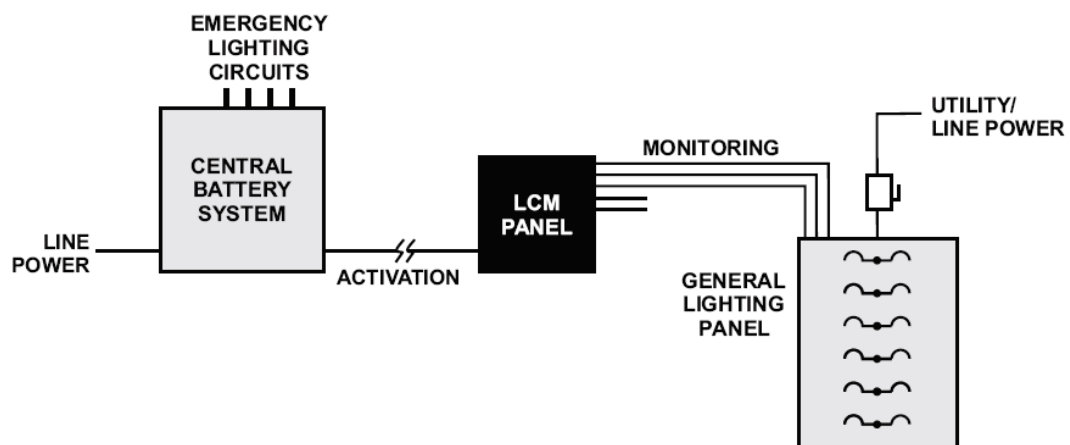


Figure 6.2: Emergency Lights Connected to Central Battery with Local Circuit Monitoring



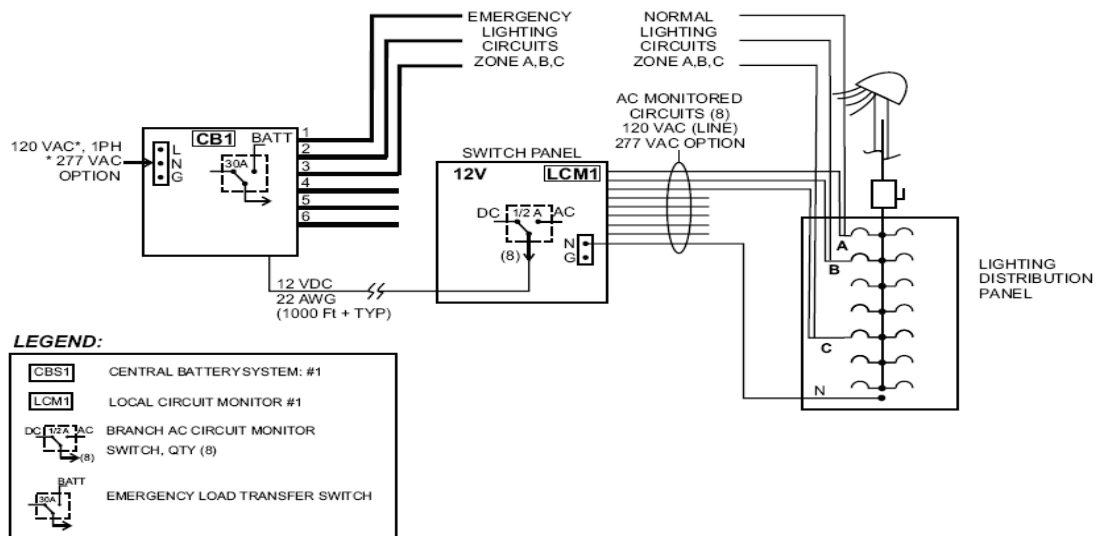


Figure 6.3: Typical Schematic of Emergency Lights Connected to Central Battery

7. Design Stages

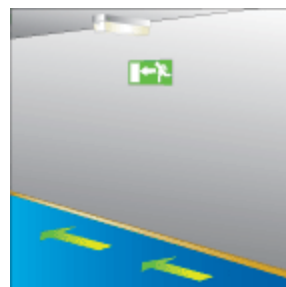
7.1 The following are the general design requirements for emergency and exit lightings.

7.1.1 Locating emergency lights at mandatory points

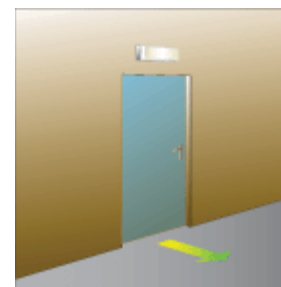
Identify specific locations where emergency lights shall be provided. See [Figure 6.3](#) for emergency lights mandatory points.



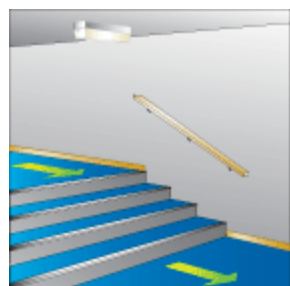
At each exit door



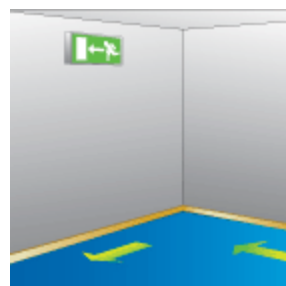
All safety exit signs



Outside and near each final exit ($\leq 2m$)



Near stairs so that each tread receives direct light ($\leq 2m$)



At each change of direction



Near each first aid post ($\leq 2m$)



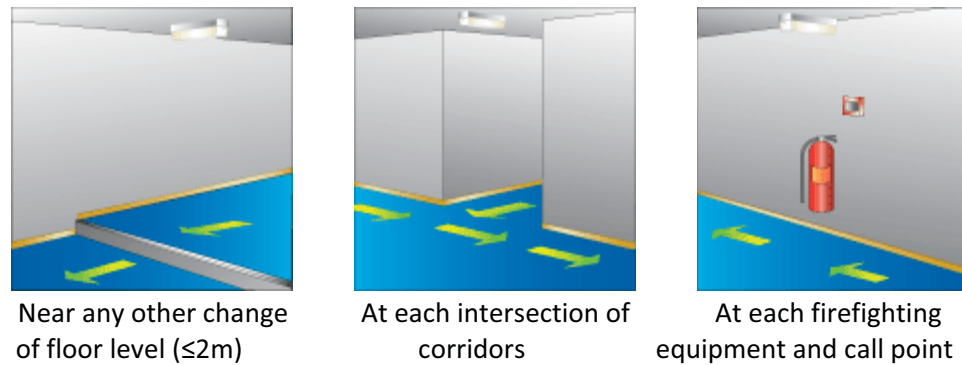


Figure 6.3: Specific locations where emergency lights must be provided

7.1.2 Format of Exit Signs

Ensure that the Exit Signs are of the correct format and size. Signs which are provided at all exits intended to be used in an emergency and along egress routes shall be illuminated to indicate unambiguously the route of escape to a point of safety. Where direct sight of an emergency exit is not possible, an illuminated directional sign (or series of signs) shall be provided to assist progression towards the emergency exit.

7.1.3 Locating luminaires at essential areas in the buildings.

- Lift cars - although only in exceptional circumstances will they be part of the egress route, do present a problem in that the public may be trapped in them in the event of a supply failure.
- Toilets - all toilets for the disabled and facilities exceeding 8m² floor area or without borrowed lights.
- Escalators - to enable users to get off them safely.
- Motor generator, control or plant rooms - require battery supplied emergency lighting to assist any maintenance or operating personnel in the event of failure.
- Covered car parks - the normal pedestrian routes should be provided with non-maintained luminaires of at least 3 hour duration.

7.1.3.1 These locations are not part of the escape route but because of their risk they require protection by emergency lighting.

7.1.4 Open areas

Open areas larger than 60m², with an egress route passing through them, or hazards identified by the building risk assessment all require emergency lighting.



7.1.5 High risk areas

Emergency lighting are required for high risk areas, such as kitchens, plant rooms area of refuge, first aid rooms and fire control equipment rooms. Typically the minimum recommended illumination level is 10.8 Lux.

8. Material Approval

- 8.1** All the Materials, Systems, Assemblies, equipment, Products and Accessories, referred to in this chapter with respect to Life Safety, Fire Safety and Emergency Services shall be Listed, Approved and Registered by the Civil Defence Material Approval Department.
- 8.2** The above requirement applies to all the products with or without international listing, registration or approval.

9. Further References

- 9.1** The following International Codes and Standards were referred, studied and consulted for this chapter. Further details where applicable can be referred to in these Codes and Standards. Also see **XV. ACKNOWLEDGEMENT OF INTERNATIONAL CODES AND STANDARDS.**

- NFPA 72: National Fire Alarm and Signaling Code
- NFPA 70: National Electrical Code®
- NFPA 110: Standard for Emergency and Standby Power Systems.
- NFPA 111: Standard on Stored Electrical Energy Emergency and Standby Power Systems.
- NFPA 170: Standard for Fire Safety and Emergency Symbols.
- BS EN 60 598-2-22: standard for luminaires
- BS EN 50171: standard for central battery systems.
- EN50172: Installation of emergency lighting.
- BS5266-1: Installation of emergency lighting.
- EN 1838 Lighting applications – emergency lighting.
- EN 4844-1 Graphical symbols – safety colours and safety signs.
- EN 4844-2 Safety marking .
- EN 50272-1 and -2: Safety requirements for secondary batteries and battery installations
- ISO3864 Graphical symbols -- Safety colours and safety signs -- Part 1: Design principles for safety signs in workplaces and public areas



CHAPTER 7

EMERGENCY VOICE EVACUATION AND COMMUNICATION SYSTEMS

1. General

- 1.1** This Section shall be used in the design and application of emergency voice/alarm communications. More details and information can be found in Chapter 8, Fire Detection and Alarm System.

2. Definition

- 2.1** Emergency Voice Communications (EVC)

A system that is interlinked with the fire alarm to give evacuation or emergency messages throughout the premises for all occupants.

3. Requirements for Emergency Voice Evacuation and Communication System

- 3.1** One way emergency voice evacuation and communication system as well as an emergency command centre shall be provided as follows:
- For all large buildings with gross floor area greater than 2800 m² or having a total occupant load exceeding 1000 persons and large industrial and warehouse buildings with gross floor area greater than 5000 m².
 - For all buildings which are categorized as high rise or an assembly.
 - For hotel or health care occupancies of less than 23m building height.
- 3.2** The emergency voice evacuation and communication system shall override any public address systems.
- 3.3** Speakers for emergency voice evacuation shall be provided in every lift lobby, staircase enclosure, corridors and other strategic positions within audible distance of all parts of all storeys of the building.
- 3.4** Speakers with flashers (strobe lights) shall be provided for basement carparks, mechanical or machine rooms, large machining areas of factories (more than 5000m²) and at locations where the ambient noise level is 75db or more.
- 3.5** Speakers used as alarm notification appliances on fire alarm systems shall also be permitted to be used for non-emergency purposes, provided that condition i or ii is met:
- The emergency command centre is constantly attended by trained personnel.



- ii. The speakers and associated audio equipment are installed or located with safeguards to resist tampering or maladjustments of those components essential for intended emergency notification.

3.6 Speakers used as alarm notification appliances on fire alarm systems shall also be permitted to be used for mass notification systems.

3.7 Fire alarm signals shall be distinctive, clearly recognizable, and, with the exception of mass notification inputs, take precedence over any other signal even when a non-fire alarm signal is initiated first and shall be indicated as follows in descending order of priority unless otherwise permitted by this Code:

- i. Signals associated with life safety
- ii. Signals associated with property protection
- iii. Trouble signals associated with life and/or property protection
- iv. All other signals

3.8 Live voice instructions originating from the protected premises fire or mass notification systems shall override all previously initiated signals and shall have priority over both of the following:

- i. Any subsequent automatically initiated signals on that channel
- ii. Remotely generated mass notification messages

4. Automatic Response.

4.1 The emergency voice/alarm communications system shall be used to provide an automatic response to the receipt of a signal indicative of a fire alarm or other emergency.

4.2 The system shall permit, where applicable, the application of an automatic evacuation signal to one or more evacuation signalling zones and, at the same time, shall permit manual voice paging to the other evacuation signalling zones selectively or in any combination.

5. Voice Evacuation Messages.

5.1 In response to an initiating signal indicative of a fire emergency, the system shall transmit a voice recorded message.

5.2 Evacuation messages shall be preceded and followed by a minimum of two cycles of the emergency evacuation signal.



6. Tones.

- 6.1** The tone preceding any message shall be permitted to be a part of the voice message or to be transmitted automatically from a separate tone generator.

7. Controls.

- 7.1** Controls for the emergency voice/alarm communication system shall be at the Emergency Command Centre or a central location accessible by building staff and emergency responders.
- 7.2** Controls shall be located or secured to allow access by only trained and authorized personnel.
- 7.3** Operating controls shall be clearly identified.
- 7.4** If there are multiple emergency voice/alarm communications control locations, only one shall be in control at any given time.
- 7.5** The location having control of the system shall be identified by a visible indication at that location.
- 7.6** Manual controls shall be arranged to provide visible indication of the on–off status for their associated evacuation signalling zone.
- 7.7** If live voice instructions are provided, they shall override previously initiated signals to the selected notification zone(s) and shall have priority over any subsequent automatically initiated signals to the selected zone(s).

8. Relocation and Partial Evacuation.

- 8.1** Systems shall be provided with manual voice transmission capabilities selectively to one or more zones or on an all-call basis.
- 8.2** Where the system is used to transmit relocation instructions or other non-evacuation messages, a continuous alert tone of 3-second to 10-second duration followed by a message (or messages where multi-channel capability is provided) shall be automatic, and the sequence shall be repeated at least three times to direct occupants in the evacuation signalling zone where the alarm initiation originated and other evacuation signalling zones in accordance with the building's fire evacuation plan.
- 8.3** Where provided, speakers in each enclosed stairway shall be connected to a separate notification zone for manual paging only.
- 8.4** Fire alarm systems used for partial evacuation and relocation shall be designed and installed such that attack by fire within an evacuation signalling zone shall not impair control and operation of the notification appliances outside the evacuation signalling zone.



9. Circuits

9.1 All circuits necessary for the operation of the notification appliances shall be protected until they enter the evacuation signalling zone that they serve. Any of the following methods shall be considered acceptable as meeting the requirements of this subsection:

- i. A 2-hour fire rated circuit integrity (CI) cable
- ii. A 2-hour fire rated cable system (electrical circuit protective system)
- iii. A 2-hour fire rated enclosure
- iv. Buildings fully protected by an automatic sprinkler system and with the interconnecting wiring or cables used for the operation of notification appliances installed in metal raceways

9.2 Where the separation of emergency voice/alarm control equipment locations results in the portions of the system controlled by one location being dependent upon the control equipment in other locations, the circuits between the dependent controls shall be protected against attack by fire using one of the following methods:

- i. A 2-hour fire rated circuit integrity (CI) cable
- ii. A 2-hour fire rated cable system (electrical circuit protective system)
- iii. Routing the cable through a 2-hour rated enclosure
- iv. Buildings fully protected by an automatic sprinkler system and with the interconnecting wiring or cables between the emergency voice/alarm communication control equipment locations installed in metal raceways.

9.3 Protection of circuits between redundant control equipment locations that are not mutually dependent shall not be required.

10. Evacuation Signal Zoning.

10.1 Undivided fire or smoke areas shall not be divided into multiple evacuation signalling zones.

10.2 If multiple notification appliance circuits are provided within a single evacuation signalling zone, all of the notification appliances within the zone shall be arranged to activate or deactivate simultaneously, either automatically or by actuation of a common, manual control.



11. Two-Way Communication Service.

- 11.1** Two-way telephone communications service, if provided, shall be for use by the fire service and collocated with the emergency voice alarm communications equipment.
- 11.2** Monitoring of the integrity of two-way telephone communications circuits shall be provided.
- 11.3** Two-way telephone communications service shall be capable of permitting the simultaneous operation of any five telephone stations in a common talk mode.
- 11.4** A notification signal at the control equipment, distinctive from any other alarm, supervisory, or trouble signal, shall indicate the off-hook condition of a calling telephone circuit. If a selective talk telephone communications service is supplied, a distinctive visible indicator shall be furnished for each selectable circuit so that all circuits with telephones off-hook are continuously and visibly indicated.
- 11.5** As a minimum for fire service use, two-way telephone systems shall be common talk (i.e., a conference or party line circuit), providing at least one telephone station or jack per floor and at least one telephone station or jack per exit stairway.
- 11.6** In buildings equipped with a fire pump(s), a telephone station or jack shall be provided in each fire pump room.
- 11.7** If telephone jacks are provided, at least two handsets shall be stored at each control centre for use by emergency responders.
- 11.8** All circuits necessary for the operation of two-way telephone communication systems shall be installed using one of the following methods:
 - i. A 2-hour fire rated circuit integrity (CI) cable
 - ii. A 2-hour fire rated cable system (electrical circuit protective system)
 - iii. A 2-hour fire rated enclosure
 - iv. Buildings fully protected by an automatic sprinkler with the wiring or cables installed in metal raceways

12. Material Approval

- 12.1** All the Materials, Systems, Assemblies, equipment, Products and Accessories, referred to in this chapter with respect to Life Safety, Fire Safety and Emergency Services shall be Listed, Approved and Registered by the Civil Defence Material Approval Department.
- 12.2** The above requirement applies to all the products with or without international listing, registration or approval.



13. Further References

13.1 The following International Codes and Standards were referred, studied and consulted for this chapter. Further details where applicable can be referred to in these Codes and Standards. Also see **XV. ACKNOWLEDGEMENT OF INTERNATIONAL CODES AND STANDARDS.**

- NFPA 72: National Fire Alarm and Signaling Code
- NFPA 70: National Electrical Code



CHAPTER 8

FIRE DETECTION AND ALARM SYSTEM

1. General

- 1.1.** This section covers recommendations to be followed for planning, designing, installing, operating and maintaining of fire detection and alarm systems in all occupancies. Systems included in the Code are Manual alarm systems and Automatic alarm systems. All types of occupancies shall be provided with automatic and manual fire alarm systems

2. Definitions and Terminology

2.1. Addressable System

A system, in which input and output devices have a unique address that can be read, recognized and controlled by the control panel.

2.2. Air-Sampling Type Smoke Detector or Aspirating Smoke Detector (ASD)

A smoke detection system in which an air sample is drawn from the protected area by a ventilator or pump to the central sensor which analyzes the air sample for presence of smoke particles.

2.3. Alarm Signal

A signal activated by the alarm system to warn of emergency conditions that require immediate action by all occupants of the affected area.

2.4. Alarm Warning

A signal activated by the alarm system to warn of emergency conditions that require action by particular people who may (or may not be) occupants of the affected area.

2.5. Alarm Zone

Geographical sub-division of the protected premises, in which the fire alarm warning or signal can be given separately, and independently, of a fire alarm warning or signal in any other alarm zone

2.6. Analogue Detector

A device that produces a quantitative signal as per status change in the protected zone, and it is unlike the traditional detectors that indicate the On/Off statuses only.



2.7. Analogue Addressable System

Addressable system that reports quantative status signals rather than two state signals.

2.8. Annunciator

A unit containing one or more indicator lamps, alphanumeric displays or other equivalent means of indication that provides status information about circuit, condition or location information from the main control panel.

2.9. Area of voice coverage

Area in which speech signal from voice alarm are sufficiently intelligible and warning signals from the system are sufficiently audible.

2.10. Automatic Alarm

Automatic alarm systems that activate auxiliary systems, such as fire fighting system, elevators and fire safety system.

2.11. Bell

An electro-Mechanical device used to produce audible signals.

2.12. Buzzer

A device used to produce low audible warning without causing panic.

2.13. Combination Detector

A combination that either responds to more that one of the fire phenomena or employs more than one operating principle to sense one of these phenomena. Typical examples are the combination of a heat detector with a smoke detector or a combination rate of rise and fixed temperature heat detector.

2.14. Combined System

An alarm system consists of conventional, addressable and analogue systems.

2.15. Control Panel

A component of the fire alarm system, provided with primary and secondary power source, which receive signals from initiating devices or other fire alarm control units, and processes these signals to determine part or all of the required fire alarm system output functions.



2.16. Decibel

Decibel (dB) is a measurement unit of sound pressure level, it equals one tenth of a Bell, which is the decimal logarithm of ratios between two quantities.

2.17. Emergency Voice Communications (EVC)

A system that is interlinked with the fire alarm to give evacuation or emergency messages throughout the premises for all occupants.

2.18. Evacuation system

A system intended to evacuate the building occupants to a safe refuge by broadcasting alert and evacuation messages.

2.19. Flame Detector

A device used for detecting infrared and ultraviolet rays emitting from flames.

2.20. Final Voltage of a Battery

The voltage at which the battery is considered depleted. This voltage may be at the point where the powered device no longer functions as intended by the manufacturer where further discharge may cause erratic operation or may cause irreversible damage to the battery or both.

2.21. Fixed Temperature Detector

A device that responds only when its sensitive element heated up reaches a predetermined temperature.

2.22. Heat Detector

A fire detector that detects either abnormally high temperature or rate of rise, or both.

2.23. Horn

A funnel-like device used for emitting audible signals different from bell sounds.

2.24. Line-Type Heat Detector

A device used for detecting heat in which sensing element is continuous line along a certain path.

2.25. Manual Call Point

Manual operation device used to activate the fire alarm.



2.26. Manual System

A system that does not contain automatic detectors and whereby the fire alarm may be activated only manually.

2.27. Mimic Diagram

A topographic diagram of the protected buildings and its affiliate departments. It consists of electric circuits that activate visual alarm signals connected fire system to indicate alarm location.

2.28. Multi-State Detector

A device that produces output signals (more than two), to include "Normal", "Fire Alarm" and other abnormal conditions.

2.29. Optical Beam-Type Smoke Detector

A smoke detector comprising a light source and a receiver to detect the obscuration of light as a result of smoke alone a line. The transmitter and receiver may be at opposite ends or they may be incorporated into a single housing with a reflector at the opposite end.

2.30. Phased evacuation

A system of evacuation in which different parts of the premises are evacuated in a controlled sequence of phases, those parts of the premises expected to be at greatest risk being evacuated first.

2.31. Rate-of-Rise Detector

A device that responds when the temperature rate of rises is more than a predetermined level.

2.32. Smoke Detector

A device used for detecting visible and invisible particles of smoke resulting from combustion. Several operating principles are used for detection; examples include; photoelectrical and Ionization spot-type detectors, Air-sampling type and optical beam-type smoke detectors.

2.33. Spot-Type Smoke Detector

A device in which sensitive element is fixed in a certain location.



2.34. Staged Alarm

A fire alarm system in which two or more stages of alarm warning can be given within a given alarm zone before an alarm signal for that zone is triggered.

2.35. Standby Supply

2.36. An electrical automatic power supply connected to the fire alarm system and operated in case of main supply failure.

2.37. Voice Alarm system

Dedicated manual or automatic system for originating and distributing of voice instructions, alert and evacuation signals for the safe evacuation of occupants. This system to be used for emergency situation like fire.

2.38. Zone

A part of the protected building which contains one or more fire detectors, the zone is defined by a unique alphanumeric which is indicated at the control panel.

3. System Design**3.1. General**

3.1.1. Buildings shall be divided into a number of detection zones for easy recognition and short search time. Fire alarm systems shall be designed to suite the fire plan procedures followed by occupants during emergency. Single open, short circuit or ground in one detection zone shall not affect the operation of other zones. In conventional systems each detection zone shall be supplied by a separate circuit. Whereas in addressable systems, several zones may be supplied by a single loop.

3.2. Detection Zones

- 3.2.1.** The area and the number of zones in a given building shall comply with the following:
- i. The area of any single open detection zone to which the building has been divided shall not exceed 2000 m²; except for a single, open plan area, which should not exceed 10 000 m².
 - ii. If any floor area is greater than 2000m², it shall be divided into separate detection zones of 2000m² or less, this subdivision may or may not be achieved by a physical barrier.



- iii. Search distance shall not exceed 60 m for conventional system; Search distance for addressable system is 100 m if building is protected by sprinklers.
- iv. If the floor area of a given building is less than 300 m² and height less than 15 m, a zone may cover more than a single story, therefore the entire building may be considered a single zone even if it is a multiple storey building.
- v. Whereas in case that the total building floor area exceeds 300 m², each detection zone shall be restricted to a single storey.
- vi. Automatic fire detectors within any enclosed stairwell lift shaft or other enclosed flu-like structure should be considered as a separate detection zone.
- vii. Indication of detection zone status on the control panel is by LED and/or graphical text indicator.
- viii. For voids above or below the floor area of a room, these may be included within same detection zone of the room, provided that the voids and the room constitute a single fire compartment and the floor area is less than 1000m².
- ix. Any remote indicator should be clearly labelled to indicate detectors located in voids. They should be sited and/or labelled in such a way as to assist in determining the location of the detectors that they serve.

3.3. Alarm Zones

- 3.3.1. Alarm zones shall be clearly defined in complex buildings where phased evacuation is required or in buildings where a stage alarm is to be provided
- 3.3.2. Alarm zone may include of several detection zones and not visa- versa.
- 3.3.3. Alarm zone boundaries shall match those of fire compartments and/or detection zones.
- 3.3.4. The extent of any overlap of signals between alarm zones shall not be sufficient to result in confusion of occupants in any area of the building.
- 3.3.5. At no time shall conflicting alarm warning or alarm signals be broadcast within one alarm zone.



3.4. Manufacturer Specifications

- 3.4.1. Along with recommendations of this chapter, approved Manufacturer's specifications should also be followed regarding spacing and installation details.
- 3.4.2. Metal conduits are not necessary for wires and cables which are having the proper fire rating. Metal conduits are required for use in corrosive environment.

3.5. Manual Call Points

- 3.5.1. The manual call points shall be used only for fire alarm initiation. In addition, all manual call points within an occupancy shall be of similar design. Deviation from single design shall be justified based on special needs and shall be approved by Civil Defence authorities.
- 3.5.2. Time from the operation of call point to the actuation of alarm signal shall not exceed (10) seconds.
- 3.5.3. Where call points are installed in combustible, explosive environments these devices shall be listed for the application.
- 3.5.4. Where manual call points are installed in food preparation environment, where breakable parts resulting from operation may cause risks, the designer consult with and conform to related approved standards.
- 3.5.5. The manual call points shall be installed on all escape routes and in particular all stairwell entrances and all exits to open air.
- 3.5.6. The manual call points shall be installed so that they are conspicuous, unobstructed and accessible.
- 3.5.7. Distribution of the manual call points should be such that travel distance should not be more than 45m to reach the nearest manual call point.
- 3.5.8. These figures to be reduced to 25m and 16m in limited mobility areas, and where processes of the area result in a likelihood of rapid fire development.
- 3.5.9. Manual Call Point shall be installed within 1.5m from exit door way opening and shall be mounted on both sides of grouped opening over 12.2m width and 1.5m each side of opening.
- 3.5.10. The manual call points shall be installed generally at the height of (1.1 – 1.4) m, above floor level and in plain, accessible, well lit and free-hindrances places.



- 3.5.11.** Where disable people are expected to operate, height to be lowered to (91cm-1.2m).

4. General Requirements for Smoke and Heat Detectors.

4.1. Recessed Mounting.

- 4.1.1.** Unless tested and listed for recessed mounting, detectors shall not be recessed into the mounting surface.

4.2. Detector Provision.

- 4.2.1.** Detectors shall be provided in all rooms, halls, storage areas, basements, attics, lofts, spaces above suspended ceilings, and other subdivisions and accessible spaces as well as the inside of all store rooms , elevator shafts, dumbwaiter shafts, and chutes.
- 4.2.2.** Where inaccessible areas contain combustible material, they shall be made accessible and shall be protected by a detector(s) unless otherwise specified in 4.2.3.
- 4.2.3.** Detectors shall not be required in combustible blind spaces if any of the following conditions exist:
- W here the ceiling is attached directly to the underside of the supporting beams of a combustible roof or floor deck.
 - W here the concealed space is entirely filled with a non-combustible insulation (In solid joist construction, the insulation shall be required to fill only the space from the ceiling to the bottom edge of the joist of the roof or floor deck.)
 - W here there are small concealed spaces over rooms, provided any space in question does not exceed 4.6 m² in area.
 - In spaces formed by sets of facing studs or solid joists in walls, floors, or ceilings where the distance between the facing studs or solid joists is less than 150 mm.
- 4.2.4.** Detectors shall not be required below open grid ceilings if all of the following conditions exist:
- Openings of the grid are 6.4 mm (¼ in.) or larger in the least dimension.
 - Thickness of the material does not exceed the least dimension.
 - Openings constitute at least 70 percent of the area of the ceiling material.



- 4.2.5.** Detectors shall not be required in concealed, accessible spaces above suspended ceilings that are used as a return air plenum provided that smoke detection is included at each connection from the plenum to the Air Conditioning and Ventilation System and is connected to the Control Panel. (e.g. In a system meeting the requirements of NFPA 90A, or by the use of Air-sampling type smoke detection at each extract from the plenum.
- 4.2.6.** Detectors shall not be required underneath accessible under-floor spaces (e.g. under open loading docks or platforms and their covers) if all of the following conditions exist:
- Space is not accessible for storage purposes or entrance of unauthorized persons and is protected against the accumulation of windborne debris.
 - Space contains no equipment such as steam pipes, electric wiring, shafting, or conveyors.
 - Floor over the space is tight.
 - No flammable liquids are processed, handled, or stored on the floor above.

5. Heat Detectors.

5.1. General

- 5.1.1.** Heat-sensing fire detectors of the fixed-temperature or rate-compensated, spot-type shall conform to latest publishing of either EN, ISO or UL .
- 5.1.2.** Line-type heat detectors shall conform to latest publishing of either EN, ISO or UL .
- 5.1.3.** UL detector shall be classified as to the temperature of operation and marked with a color code in accordance with [Table 8.1](#)



Table 8.1: Color Coding for Heat Detectors

TEMPERATURE CLASSIFICATION	TEMPERATURE RATING RANGE °C	MAXIMUM CEILING TEMPERATURE °C	COLOR CODE
Low	39 – 57	28	Uncolored
Ordinary	58 – 79	47	Uncolored
Intermediate	80 – 121	69	White
High	122 – 162	111	Blue
Extra High	163 – 204	152	Red
Very Extra High	205 – 259	194	Green
Ultra High	260 – 302	249	Orange

5.2. Location.

- 5.2.1.** Spot-type heat-sensing fire detectors shall be located on the ceiling not less than 100 mm from the sidewall or on the sidewalls between 100 mm and 300 mm from the ceiling. See [Figure 8.1](#).
- 5.2.2.** In the case of solid joist construction, detectors shall be mounted at the bottom of the joists.
- 5.2.3.** In the case of beam construction where beams are less than 300 mm in depth and less than 2.4 m on centre, detectors shall be permitted to be installed on the bottom of beams.
- 5.2.4.** Line-type heat detectors shall be located on the ceiling or on the sidewalls not more than 500 mm from the ceiling.
- 5.2.5.** In the case of solid joist construction, detectors shall be mounted at the bottom of the joists.
- 5.2.6.** In the case of beam construction where beams are less than 300 mm in depth and less than 2.4 m on center, detectors shall be permitted to be installed on the bottom of beams.
- 5.2.7.** Where a line-type detector is used in an application other than open area protection, the manufacturer's published instructions shall be followed.

5.3. Temperature.

- 5.3.1.** Detectors having fixed-temperature or rate-compensated elements shall be selected in accordance with [Table 8.1](#) for the maximum expected ambient ceiling temperature. The temperature rating of the detector shall be at least 11°C above the maximum expected temperature at the ceiling.



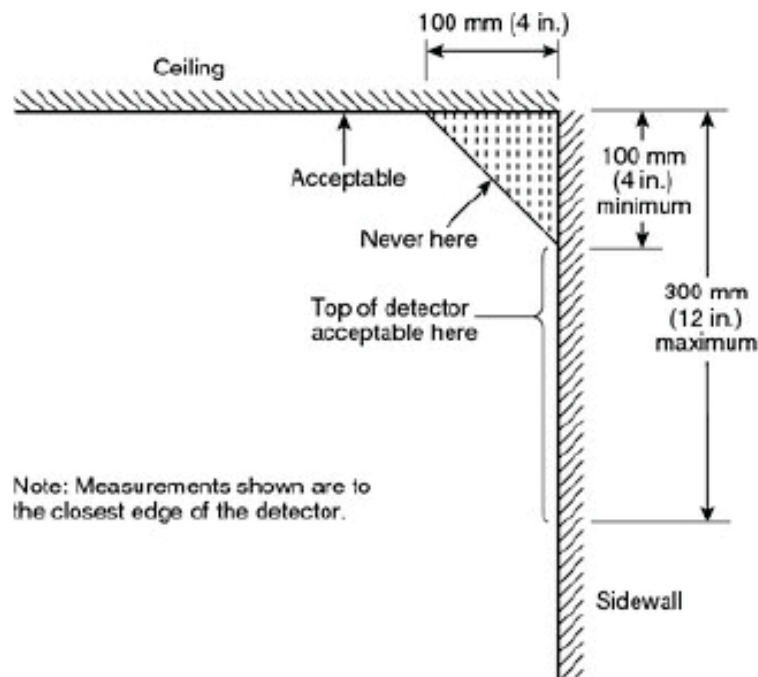


Figure 8.1: Location of spot-type detectors

5.4. Spacing.

5.4.1. Smooth Ceiling Spacing.

5.4.1.1. One of the following requirements shall apply:

- i. The distance between detectors shall not exceed their listed spacing, and there shall be detectors within a distance of one-half the listed spacing, measured at right angles from all walls or partitions extending upward to within the top 15 percent of the ceiling height.
- ii. All points on the ceiling shall have a detector within a distance equal to 0.7 times the listed spacing (0.7S). See [Figure 8.2](#) for Heat and Line Detectors respectively.



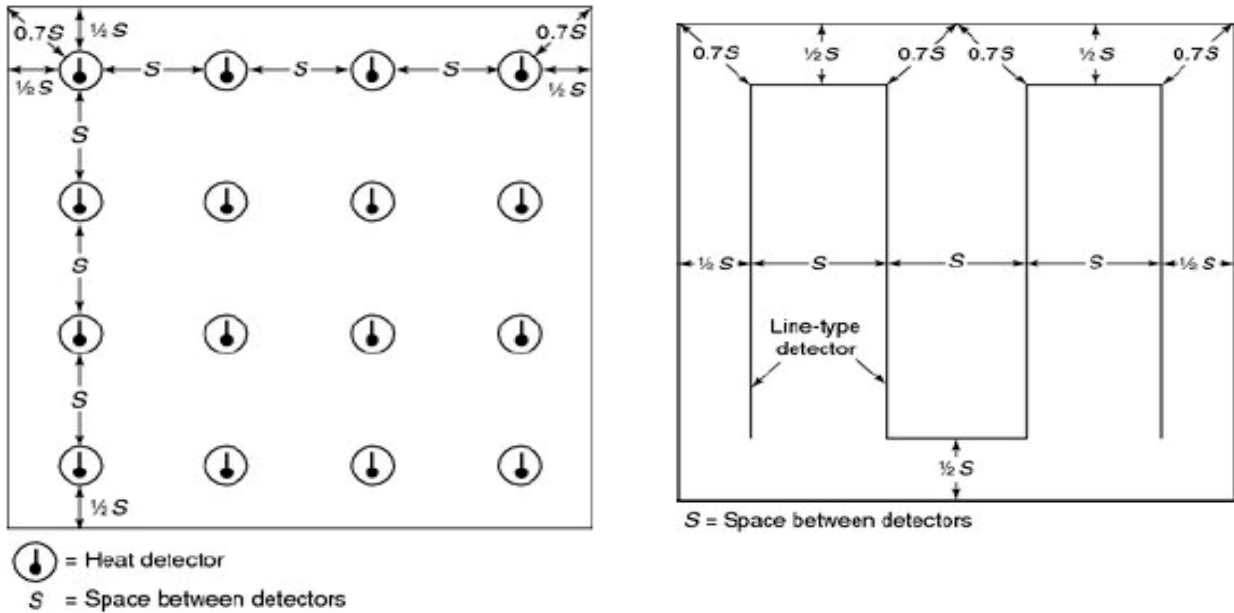


Figure 8.2: Spacing of Heat and line detectors on smooth ceiling

- 5.4.2. For irregularly shaped areas, the spacing between detectors shall be permitted to be greater than the listed spacing, provided the maximum spacing from a detector to the farthest point of a sidewall or corner within its zone of protection is not greater than 0.7 times the listed spacing. See [Figure 8.3](#).

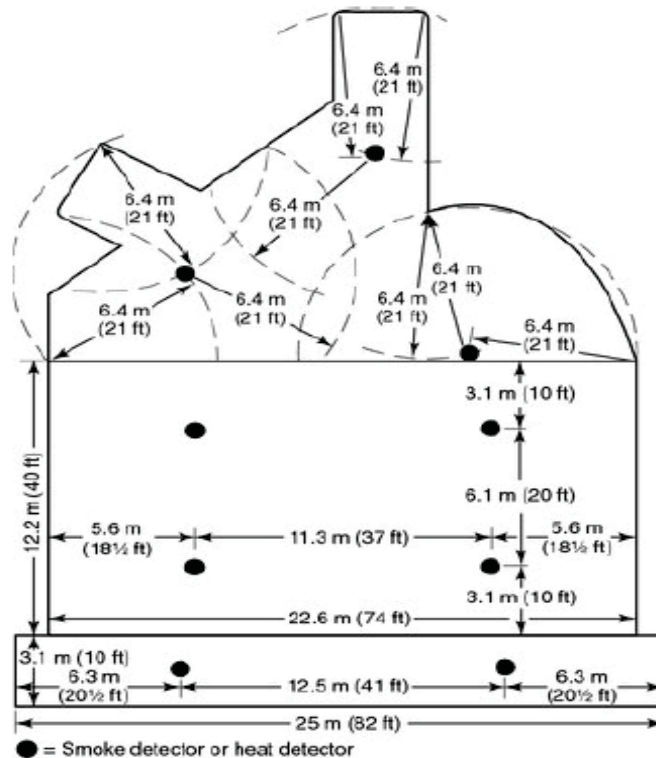


Figure 8.3: Location of smoke or heat detectors on irregular shape ceiling

5.5. Solid Joist Construction.

- 5.5.1.** The spacing of heat detectors, where measured at right angles to the solid joists, shall not exceed 50 percent of the smooth ceiling spacing. See [Figure 8.4](#).

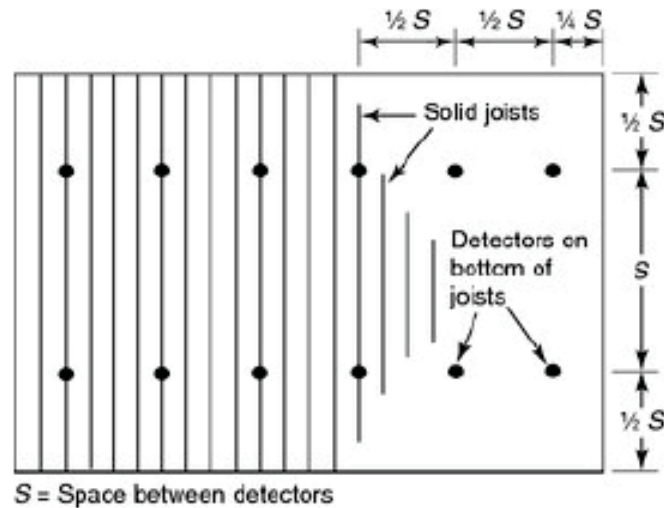


Figure 8.4: Location of heat detectors on ceiling with solid joist.

5.6. Beam Construction.

- 5.6.1.** A ceiling shall be treated as a smooth ceiling if the beams project no more than 100 mm below the ceiling.
- 5.6.2.** Where the beams project more than 100 mm below the ceiling, the spacing of spot-type heat detectors at right angles to the direction of beam travel shall be not more than two-thirds of the smooth ceiling spacing.
- 5.6.3.** Where the beams project more than 460 mm below the ceiling and are more than 2.4 m on center, each bay formed by the beams shall be treated as a separate area.

5.7. Sloping Ceilings.

5.7.1. Peaked

- 5.7.1.1.** A row of detectors shall first be spaced and located at or within 900 mm of the peak of the ceiling, measured horizontally. The number and spacing of additional detectors, if any, shall be based on the horizontal projection of the ceiling in accordance with the type of ceiling construction. See [Figure 8. 5](#).



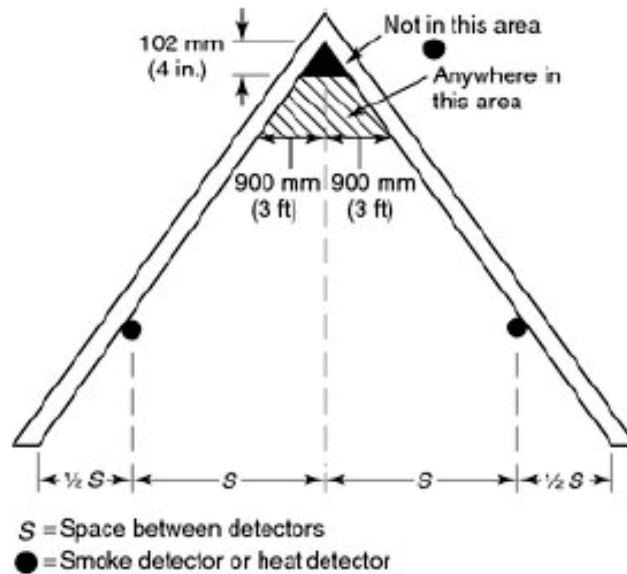


Figure 8.5: Location of smoke or heat detector on pitched ceiling

5.7.2. Shed

- 5.7.2.1.** Sloping ceilings shall have a row of detectors located on the ceiling within 900 mm (3 ft) of the high side of the ceiling measured horizontally, spaced in accordance with the type of ceiling construction. The remaining detectors, if any, shall be located in the remaining area on the basis of the horizontal projection of the ceiling. [See Figure 8.6.](#)

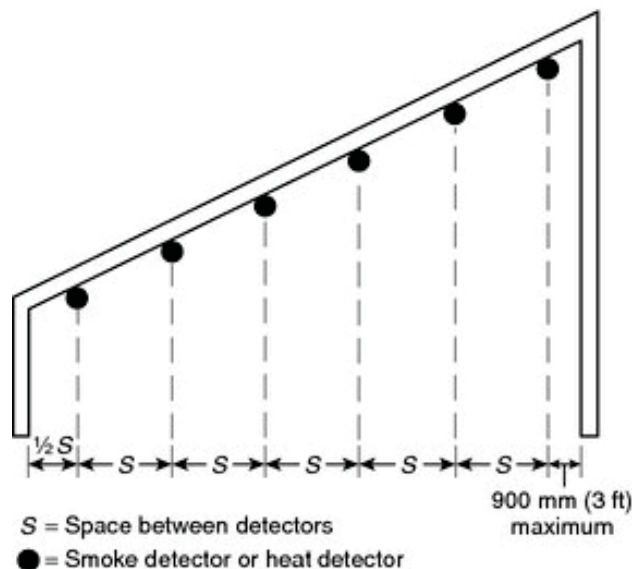


Figure 8.6: Location of smoke or heat detectors on shed ceilings.

5.7.3. Roof Slope Less Than 30 Degrees.

- 5.7.3.1.** For a roof slope of less than 30 degrees, all detectors shall be spaced using the height at the peak. For a roof slope of greater than 30 degrees, the average slope height shall be used for all detectors other than those located in the peak.

5.8. High Ceilings.

- 5.8.1.** On ceilings 3 m to 9.1 m high, heat detector linear spacing shall be reduced in accordance with **Table 8.2** prior to any additional reductions for beams, joists, or slope, where applicable.

Table 8.2: Ceiling Height and spacing reduction factor

CEILING HEIGHT (M)	MULTIPLE BY REDUCTION FACTOR OF
0 to 3.05	1
3.06 to 3.66	0.9
3.67 to 4.27	0.84
4.28 to 4.88	0.77
4.89 to 5.49	0.71
5.50 to 6.10	0.64
6.11 to 6.71	0.58
6.72 to 7.32	0.52
7.33 to 7.93	0.46
7.94 to 8.54	0.40
8.55 to 9.14	0.34

6. Spot-Type Smoke Detectors.**6.1. General**

- 6.1.1.** Spot-type smoke detectors shall conform to latest publishing of either EN, UL or ISO.
- 6.1.2.** The selection and placement of Spot-Type smoke detectors shall take into account both the performance characteristics of the detector and the areas into which the detectors are to be installed to prevent nuisance alarms or improper operation after installation.

- 6.2.** Unless specifically designed and listed for the expected conditions, spot-type smoke detectors shall not be installed if any of the following ambient conditions exist:



- i. Temperature below 0°C (32°F)
- ii. Temperature above 38°C (100°F)
- iii. Relative humidity above 93 percent
- iv. Air velocity greater than 1.5 m/sec (300 ft/min)

6.3. The location of spot-type smoke detectors shall be based on an evaluation of potential ambient sources of smoke, moisture, dust, or fumes, and electrical or mechanical influences to minimize nuisance alarms.

Note: The common sources of aerosols, particles and moistures that may affect or influence the performance of smoke detectors can be referred from Table A.17.7.1.9(a) of NFPA 72:2010.

6.4. Detectors shall not be installed until after the cleanup of all construction works is completed and finalized. Any detectors installed during construction for the purposes of protection during construction, shall be checked to confirm that their sensitivity is within the listed and marked sensitivity range and shall be repaired or replaced as necessary.

6.5. Location and Spacing.

6.5.1. General

6.5.1.1. The location and spacing of smoke detectors shall be based upon the anticipated smoke flows due to the plume and ceiling jet produced by the anticipated fire as well as any pre-existing ambient air flows that could exist in the protected compartment. The design shall account for the contribution of the following factors in predicting detector response to the anticipated fires to which the system is intended to respond:

- i. Ceiling shape and surface.
- ii. Ceiling height.
- iii. Configuration of contents in the protected area.
- iv. Combustion characteristics and probable equivalence ratio of the anticipated fires involving the fuel loads within the protected area.
- v. Compartment ventilation.
- vi. Ambient temperature, pressure, altitude, humidity, and atmosphere.

6.5.2. If the intent is to protect against a specific hazard, the detector(s) shall be permitted to be installed closer to the hazard in a position where the detector can intercept the smoke.

6.5.3. Spot-type smoke detectors shall be located on the ceiling not less than 100 mm from a sidewall to the near edge or, if on a sidewall, between 100mm and 300 mm down from the ceiling to the top of the detector.



- 6.5.4.** To minimize dust contamination, smoke detectors, where installed under raised floors, shall be mounted only in an orientation for which they have been listed. See [Figure 8.7](#).

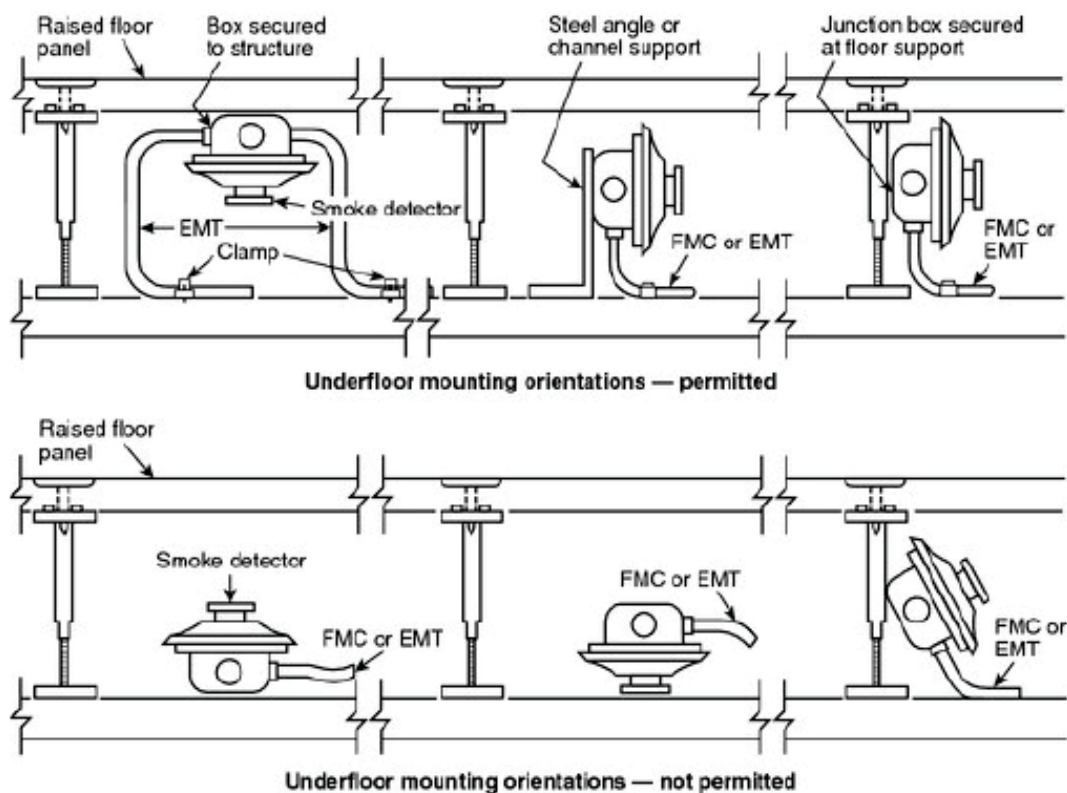


Figure 8.7: Mounting of smoke detectors in raised floor.

- 6.5.5.** On smooth ceilings, spacing for spot-type smoke detectors, in the absence of performance based design criteria, shall be permitted to be located using not more than 9.1 m spacing.
- 6.5.6.** In all cases, the manufacturer's published instructions shall be followed.
- 6.5.7.** Other spacing shall be permitted to be used depending on ceiling height, different conditions, or response requirements.
- 6.5.8.** For smooth ceilings, all points on the ceiling shall have a detector within a distance equal to 0.7 times the selected spacing.
- 6.6.** For solid joist and beam construction, spacing for spot-type smoke detectors shall be as follows:



- 6.6.1.** Solid joists shall be considered equivalent to beams for smoke detector spacing guidelines. For level ceilings the following shall apply:
- i. For ceilings with beam depths of less than 10 percent of the ceiling height ($0.1 H$), smooth ceiling spacing shall be permitted.
 - ii. For ceilings with beam depths equal to or greater than 10 percent of the ceiling height ($0.1 H$) and beam spacing equal to or greater than 40 percent of the ceiling height ($0.4 H$), spot-type detectors shall be located on the ceiling in each beam pocket.
 - iii. For waffle or pan-type ceilings with beams or solid joists no greater than 600 mm deep and no greater than 3.66 m center-to-center spacing, the following shall be permitted:
 - a. Smooth ceiling spacing including those provisions permitted for irregular areas.
 - b. Location of spot-type smoke detectors on ceilings or on the bottom of beams.
 - iv. For corridors 4.5 m in width or less having ceiling beams or solid joists perpendicular to the corridor length, the following shall be permitted:
 - a. Smooth ceiling spacing including those provisions permitted for irregular areas.
 - b. Location of spot-type smoke detectors on ceilings, sidewalls, or the bottom of beams or solid joists
 - v. For rooms of 84 m² area or less, only one smoke detector shall be required.
- 6.7.** For sloped ceilings with beams running parallel to (up) the slope, spacing shall comply with the following:
- i. The spacing for level beamed ceilings shall be used.
 - ii. The ceiling height shall be taken as the average height over slope.
 - iii. For slopes greater than 10 degrees, the detectors located at one-half the spacing from the low end shall not be required.
 - iv. Spacing shall be measured along a horizontal projection of the ceilings.
- 6.8.** For sloped ceilings with beams running perpendicular to (across) the slope, spacing shall comply with the following:



- i. The spacing for level beamed ceilings shall be used.
- ii. The ceiling height shall be taken as the average height over slope.

6.9. For sloped ceilings with solid joists, the detectors shall be located on the bottom of the joist.

7. Air-Sampling Type Smoke Detector.

7.1. General

- 7.1.1.** Air-sampling type smoke detectors shall conform to either of; EN 54-20, ISO 7240-20 or UL268.
- 7.1.2.** Air-sampling type smoke detectors are particularly applicable in the following situations:
 - 7.1.2.1.** Where very early detection is required
 - 7.1.2.2.** Where access for maintenance is limited
 - 7.1.2.3.** Where the protected area is particularly challenging in terms of environment (hot, cold & humidity) and/or contamination (dust, & dirt)
 - 7.1.2.4.** Where smoke is difficult to detect due to high airflows or large volume/high ceiling spaces
- 7.1.3.** Air-sampling type smoke detectors are available with different classes of sensitivities which shall be considered for optimum design and application.
- 7.1.4.** A single ASD detector may be able to provide several alarms signals corresponding to different Classes.
- 7.1.5.** Some Air-sampling type smoke detectors are approved as “normal sensitivity detectors, however, they may be configured to be high or enhanced sensitivity if required for the application.
- 7.1.6.** For the purposes of this code, the following applications are recommended:
 - 7.1.6.1.** Very high sensitivity:
Used for surveillance and very early warning in high value or high risk areas, particularly for rooms with electronic data processing equipment, for rooms containing artifacts or objects of particularly high value, and for rooms or cabinets containing equipment or machinery supporting a critical process or service.



- 7.1.6.2.** Enhanced sensitivity:
Applied as space surveillance in areas where the detection of smoke using normal spot-type smoke detection is challenging, particularly; for areas with ceiling height over 25m, areas with high air flows (more than 10 air changes per hour) and where early staff alarm is required
- 7.1.6.3.** Normal sensitivity:
Typically applied in place of standard spot-type smoke detections where harsh environment, aesthetics, concealment and/or easy maintenance access are factors, particularly in heritage buildings, prison cells, ceiling void, floor voids, cold storage and restricted access areas.

7.2. Location and Spacing

- 7.2.1.** For ceiling mount ASD each sampling hole shall be treated as a spot-type smoke detector for the purpose of location and spacing. (See clause 6.5).
- 7.2.2.** For applications with high airflows, sampling at air return grilles shall be provided.
- 7.2.3.** For smoke detection within an air-conditioning duct the probes shall be sampling from the top third of the duct and be installed in accordance with the manufacturer recommendation.
- 7.2.4.** For areas with ceiling heights over 10m and where stratification is likely to occur vertical sampling shall be provided, vertical sampling holes shall be spaced no more than 3 meters apart in the top third and no more than 8 meters apart in the middle third, sampling is not required in the bottom third.
- 7.3.** Maximum air sample transport time from the farthest sampling point to the detector shall be in accordance with the detector listing/instructions and shall not exceed 120 seconds.
- 7.4.** Sampling pipe networks shall be designed in accordance with the design rules, tables and/or software supplied by the manufacturer to ensure that the performance of the system is in accordance with the detector listing and/or the design objectives.
- 7.5.** Sampling pipe network design details shall include calculations showing the flow characteristics of the pipe network and each sample hole.
- 7.6.** Air-sampling type smoke detectors shall give a trouble signal if the airflow is outside the manufacturer's specified range.



- 7.7. In-line filter used on the pipe network shall be included in the listing for the air-sampling type smoke detector.
- 7.8. The sampling holes and in-line filter (if used) shall be maintained in accordance with the manufacturer's published instructions.
- 7.9. Air-sampling network piping and fittings shall be airtight and permanently fixed.

7.10. Labeling requirements

- 7.10.1. Sampling system piping shall be conspicuously identified as "SMOKE DETECTOR SAMPLING TUBE — DO NOT DISTURB," or equivalent as follows:
 - i. At changes in direction or branches of piping.
 - ii. At each side of penetrations of walls, floors, or other barriers.
 - iii. At intervals on piping that provide visibility within the space, but no greater than 6 m.
- 7.10.2. Sampling holes shall be clearly labeled unless specifically intended to be concealed in which case a clear plan of their location shall be provided.

8. Optical /Projected Beam-Type Smoke Detectors.

8.1. General

- 8.1.1. Optical beam-type smoke detectors shall conform to latest publishing of either EN, ISO or UL.
- 8.1.2. Optical beam-type smoke detectors are particularly applicable in the following situations:
 - 8.1.2.1. Where a large open area requires detection
 - 8.1.2.2. Where ceiling heights are very high and there is a high risk of stratification
- 8.2. The maximum distance between multiple optical beam-type smoke detectors protecting a single space shall be in accordance with the manufacturer's published instructions and shall not exceed 15m See **Figure 8.8**.
- 8.3. Where the likelihood of stratification is high detectors shall be provided at intermediate heights in addition to the detectors mounted on the ceiling.
 - 8.3.1. Where the likely stratification height is known the intermediate detectors shall be mounted at this height and be spaced in accordance with the requirements of 8.2.



8.3.2. Where the likely stratification height is unknown the intermediate beams shall be positioned to ensure that they will be obscured by a rising plume of smoke sufficient to cause an alarm.

8.3.2.1. The requirement of 8.3.2 shall either be demonstrated by a full scale smoke test on the installed system.

8.3.2.2. The maximum distance between beams shall be less than the height above the floor divided by 4.

8.4. The beam length shall not exceed the maximum permitted by the equipment listing.

8.5. If reflectors are used with optical beam-type smoke detectors, the reflectors shall be installed in accordance with the manufacturer's published instructions.

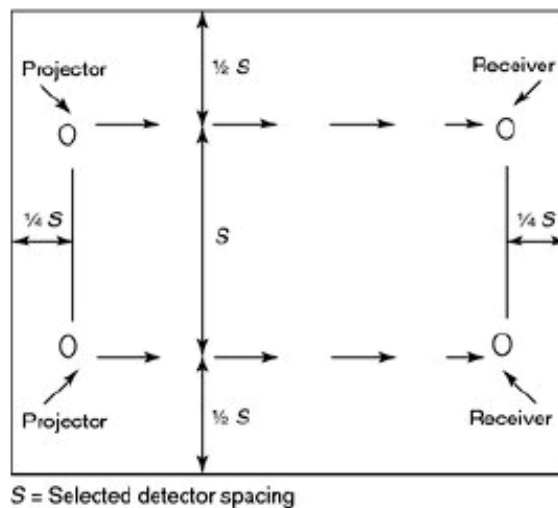


Figure 8.8: Spacing of Optical Beam-Type Smoke Detector

8.6. An optical beam-type smoke detector shall be considered equivalent to a row of spot-type smoke detectors for level and sloping ceiling applications.

8.7. Optical beam-type smoke detectors and reflectors shall be mounted on stable surfaces to prevent false or erratic operation due to movement.

8.8. The beam shall be designed so that small angular movements of the light source or receiver do not prevent operation due to smoke and do not cause nuisance alarms.

8.9. The light path of optical beam-type smoke detectors shall be kept clear of opaque obstacles at all times.



- 8.10.** On sloping ceilings (peaked or shed), optical beam-type detectors shall first be located within 900 mm (3 ft) of the highest point in the ceiling, measured horizontally. The number and spacing of additional detectors, if any, shall be based on the horizontal projection of the ceiling Peaked.

9. Raised Floors and Suspended Ceilings.

- 9.1.** Spaces beneath raised floors and above suspended ceilings shall be treated as separate rooms for smoke detector spacing purposes. Detectors installed beneath raised floors or above suspended ceilings, or both, including raised floors and suspended ceilings used for environmental air, shall not be used in lieu of providing detection within the room.

- 9.2.** For raised floors 400mm and above the floor level or containing combustible materials, the following shall apply:

- i. Detectors installed beneath raised floors shall be spaced in accordance with spot type requirements and **Figure 8.7**.
- ii. Where the area beneath the raised floor is also used for environmental air, detector spacing shall also conform to conditions for Heating, Ventilation and Air-Condition (HVAC), stated in this chapter.

- 9.3.** For suspended ceilings which are 800mm and more from the ceiling level and/or containing combustible materials, the following shall apply:

- i. Detector spacing above suspended ceilings shall conform to the requirements of spot type detectors for the ceiling configuration.
- ii. Where detectors are installed in ceilings used for environmental air, detector spacing shall also conform to requirements under Heating, Ventilation and Air-Conditioning (HVAC) in this chapter.

10. Partitions.

- 10.1.** Where partitions extend to within 15 percent of the ceiling height, the spaces separated by the partitions shall be considered as separate rooms.

11. Heating, Ventilating, and Air Conditioning (HVAC).

- 11.1.** In spaces served by air-handling systems, detectors shall not be located lesser than 1m where airflow prevents operation of the detectors.

- 11.2.** Detectors installed in plenums shall comply with the following:



- i. In under-floor spaces and above-ceiling spaces that are used as HVAC plenums, detectors shall be listed for the anticipated environment as required by ambient conditions like temperature, humidity and airflow.
- ii. Detector spacing and locations shall be selected on the basis of anticipated airflow patterns and fire type.
- iii. Detectors placed in environmental air ducts or plenums shall not be used as a substitute for open area detectors. Where detectors are used for the control of smoke spread, the requirements shall follow the section under Smoke Detectors for Control of Smoke Spread.

12. Spot-Type Detectors

- 12.1. Combination and multi-sensor smoke detectors that have a fixed-temperature element as part of the unit shall be selected in accordance with [Table 8.1](#) for the maximum ceiling temperature expected in service.
- 12.2. Holes in the back of a detector shall be covered by a gasket, sealant, or equivalent means, and the detector shall be mounted so that airflow from inside or around the housing does not prevent the entry of smoke during a fire or test condition.

13. High-Rack Storage.

- 13.1. The location and spacing of smoke detectors for high-rack storage shall address the commodity, quantity, and configuration of the rack storage. See [Figure 8.9](#) and [Figure 8.10](#).

14. High Air Movement Areas.

14.1. General.

- 14.1.1. The purpose and scope of this section shall be to provide location and spacing guidance for smoke detectors intended for early warning of fire in high air movement areas. Such detectors shall not be used in raised floor or suspended ceiling areas (concealed spaces).

14.2. Location.

- 14.2.1. Smoke detectors shall not be located directly in the airstream of supply registers.



14.3. Spacing.

14.3.1. Smoke detector spacing shall be in accordance with [Table 8.3](#) and [Figure 8.11](#).

14.4. HVAC Mechanical Rooms.

14.4.1. Where HVAC mechanical rooms are used as an air plenum for return air, the spacings of smoke detectors shall not be required to be reduced based on the number of air changes.

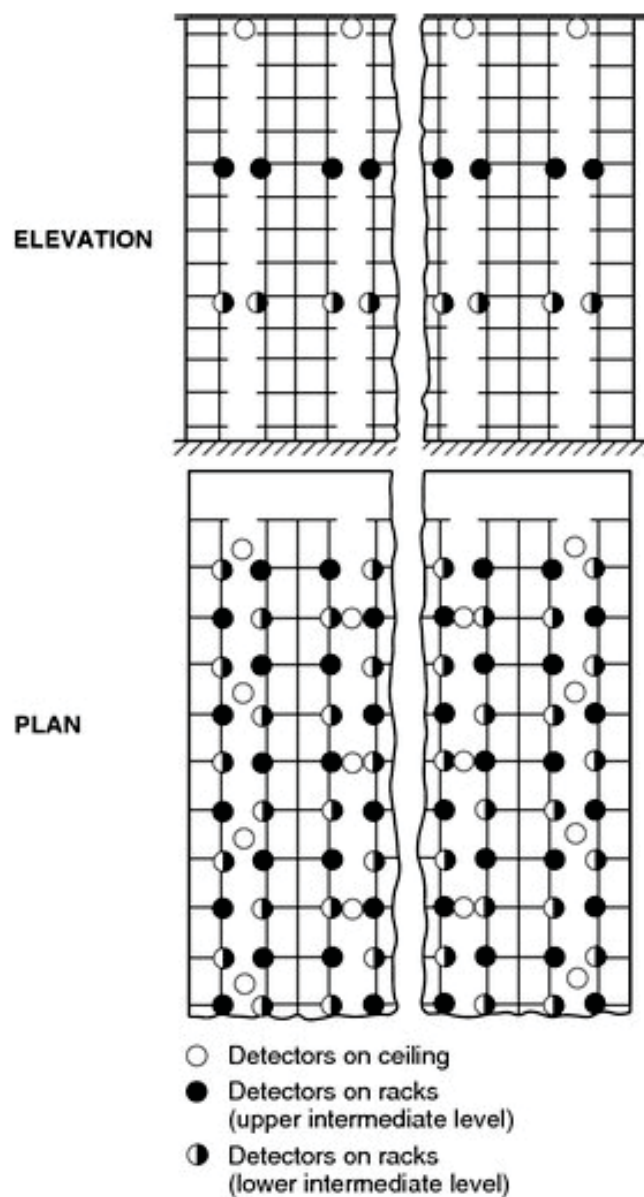


Figure 8.9: Detector Location for Solid Storage (Closed Rack) in Which Transverse and Longitudinal Flue Spaces Are Irregular or Nonexistent, as for Slatted or Solid Shelled Storage.



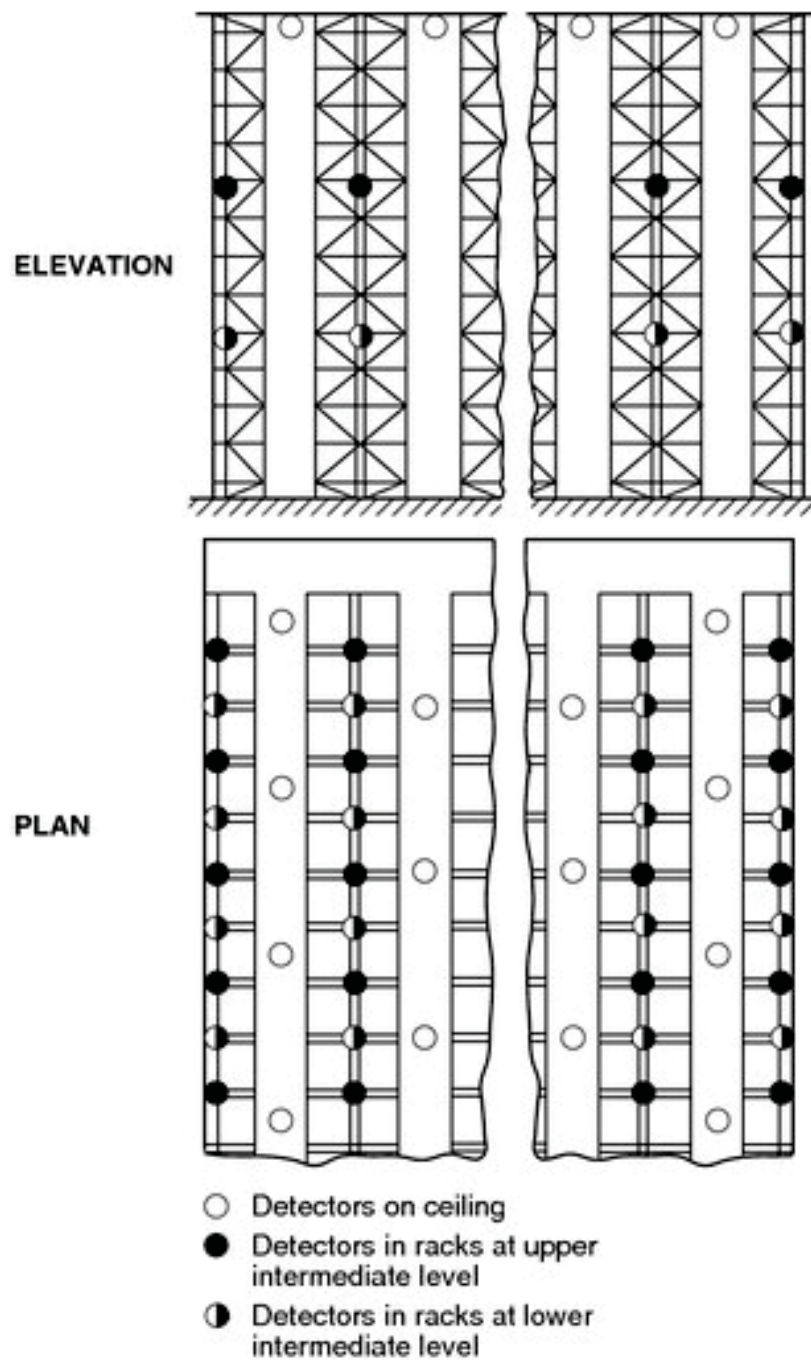


Figure 8.10: Detector Location for Palletized Storage (Open Rack) or No Shelved Storage in Which Regular Transverse and Longitudinal Flue Spaces Are Maintained.

15. Video Image Smoke Detection.

- 15.1.** Video image smoke detection systems and all of the components thereof, including hardware and software, shall be listed for the purpose of smoke detection.
- 15.2.** Systems shall be designed in accordance with a performance-based design approach.

16. Other Detectors

- 16.1.** There are other types detectors used such as Radiant Energy–Sensing Fire Detectors, Flame Detectors, Spark/Ember Detectors, Video Image Flame Detection, Video Smoke detectors, Combination technologies, Multi-Criteria, and Multi-Sensor Detectors. The selection, spacing, location and installation of these detectors shall be based on the associated criteria such as follows

- i. Size of the fire that is to be detected
- ii. Fuel involved
- iii. Sensitivity of the detector
- iv. Field of view of the detector
- v. Distance between the fire and the detector
- vi. Radiant energy absorption of the atmosphere
- vii. Presence of extraneous sources of radiant emissions
- viii. Purpose of the detection system
- ix. Response time required
- x. Structural features, size, and shape of the rooms and bays
- xi. Occupancy and uses of the area
- xii. Ceiling height
- xiii. Ceiling shape, surface, and obstructions
- xiv. Ventilation
- xv. Ambient environment
- xvi. Burning characteristics of the combustible materials present
- xvii. Configuration of the contents in the area to be protected

- 16.2.** In addition, Manufacturer's specifications shall be followed based on the different application and design characteristics.

Table 8.3: Smoke Detector Spacing Based on Air Movement

MINUTES PER AIR CHANGE	AIR CHANGES PER HOUR	SPACING PER DETECTOR (M ²)
1	60	11.61
2	30	23.23
3	20	34.84
4	15	46.45
5	12	58.06
6	10	69.68
7	8.6	81.29
8	7.5	83.61
9	6.7	83.61
10	6	83.61



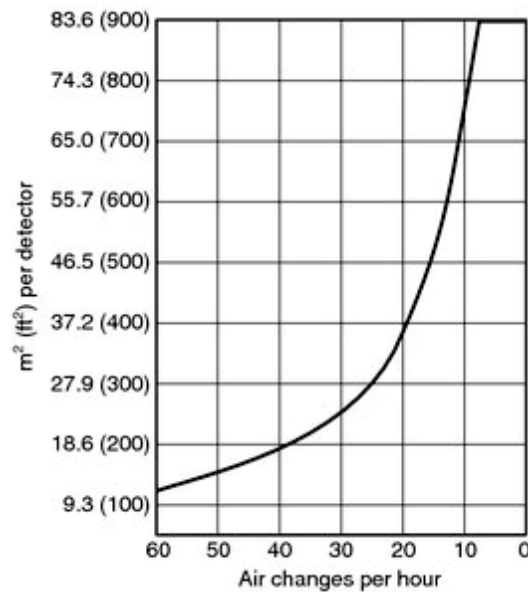


Figure 8.11: Area of coverage for high air movement areas

17. Sprinkler Waterflow Alarm-Initiating Devices.

- 17.1. Activation of the initiating device shall occur within 90 seconds of waterflow at the alarm-initiating device when flow occurs that is equal to or greater than that from a single sprinkler of the smallest orifice size installed in the system.
- 17.2. Movement of water due to waste, surges, or variable pressure shall not initiate an alarm signal.

18. Detection of the Operation of Other Automatic Extinguishing Systems.

- 18.1. The operation of fire extinguishing systems or suppression systems shall initiate an alarm signal by alarm-initiating devices installed in accordance with their individual listings.

19. Supervisory Signal-Initiating Devices.

19.1. Control Valve Supervisory Signal-Initiating Device.

- 19.1.1. Two separate and distinct signals shall be initiated: one indicating movement of the valve from its normal position (off-normal) and the other indicating restoration of the valve to its normal position.



- 19.1.2.** The off-normal signal shall be initiated during the first two revolutions of the hand wheel or during one-fifth of the travel distance of the valve control apparatus from its normal position.
- 19.1.3.** The off-normal signal shall not be restored at any valve position except normal.
- 19.1.4.** An initiating device for supervising the position of a control valve shall not interfere with the operation of the valve, obstruct the view of its indicator, or prevent access for valve maintenance.

20. Pressure Supervisory Signal-Initiating Device.

- 20.1.** Two separate and distinct signals shall be initiated: one indicating that the required pressure has increased or decreased (off-normal) and the other indicating restoration of the pressure to its normal value.
- 20.2.** The following requirements shall apply to pressure supervisory signal-initiating devices:
 - i. A pressure tank supervisory signal-initiating device for a pressurized limited water supply, such as a pressure tank, shall indicate both high- and low-pressure conditions.
 - ii. The off-normal signal shall be initiated when the required pressure increases or decreases by 70 kPa (10 psi).
 - iii. A pressure supervisory signal-initiating device for a dry-pipe sprinkler system shall indicate both high- and low-pressure conditions. The off-normal signal shall be initiated when the pressure increases or decreases by 70 kPa (10 psi).
 - iv. A steam pressure supervisory signal-initiating device shall indicate a low-pressure condition. The off-normal signal shall be initiated prior to the pressure falling below 110 percent of the minimum operating pressure of the steam-operated equipment supplied.

21. Water Level Supervisory Signal-Initiating Device.

- 21.1.** Two separate and distinct signals shall be initiated: one indicating that the required water level has been lowered or raised (off-normal) and the other indicating restoration.
- 21.2.** A pressure tank signal-initiating device shall indicate both high- and low-water level conditions. The off-normal signal shall be initiated when the water level falls 76 mm (3 in.) or rises 76 mm (3 in.).



- 21.3.** A supervisory signal-initiating device for other than pressure tanks shall initiate a low-water level signal when the water level falls 300 mm (12 in.).

22. Smoke Detectors for Control of Smoke Spread.

22.1. Classifications.

- 22.1.1.** Smoke detectors installed and used to prevent smoke spread by initiating control of fans, dampers, doors, and other equipment shall be classified in the following manner:
- Area detectors that are installed in the related smoke compartments
 - Detectors that are installed in the air duct systems
 - Video image smoke detection that is installed in related smoke compartments

22.2. Purposes.

- 22.2.1.** To prevent the recirculation of dangerous quantities of smoke, a detector approved for air duct use shall be installed on the supply side of air-handling systems as required by NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.

22.3. Application.

22.3.1. Area Smoke Detectors within Smoke Compartments

- 22.3.1.1.** Area smoke detectors within smoke compartments shall be permitted to be used to control the spread of smoke by initiating operation of doors, dampers, and other equipment.

23. Smoke Detection for the Air Duct System.

23.1. Supply Air System.

- 23.1.1.** Where the detection of smoke in the supply air system is required by other NFPA standards, a detector(s) listed for the air velocity present and that is located in the supply air duct downstream of both the fan and the filters shall be installed. Additional smoke detectors shall not be required to be installed in ducts where the air duct system passes through other smoke compartments not served by the duct.



23.2. Return Air Systems

- 23.2.1.** A detector(s) listed for the air velocity present shall be located where the air leaves each smoke compartment, or in the duct system before the air enters the return air system common to more than one smoke compartment.
- 23.2.2.** Additional smoke detectors shall not be required to be installed in ducts where the air duct system passes through other smoke compartments not served by the duct.
- 23.2.3.** Where total coverage smoke detection is installed in all areas of the smoke compartment served by the return air system, installation of air duct detectors in the return air system shall not be required, provided their function is accomplished by the design of the area detection system. See [Figure 8.12](#) and [8.13](#).

24.² Location and Installation of Detectors in Air Duct Systems.

- 24.1.** Detectors shall be listed for the purpose for which they are being used.
- 24.2.** Air duct detectors shall be installed in such a way as to obtain a representative sample of the airstream. This installation shall be permitted to be achieved by any of the following methods:
 - i. Rigid mounting within the duct
 - ii. Rigid mounting to the wall of the duct with the sensing element protruding into the duct
 - iii. Installation outside the duct with rigidly mounted sampling tubes protruding into the duct
 - iv. Installation through the duct with projected light beam
- 24.3.** Detectors shall be mounted in accordance with the manufacturer's published instructions and shall be accessible for cleaning by providing access doors or control units in accordance with NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
- 24.4.** The location of all detectors in air duct systems shall be permanently and clearly identified and recorded.
- 24.5.** Detectors mounted outside of a duct that employs sampling tubes for transporting smoke from inside the duct to the detector shall be designed and installed to allow verification of airflow from the duct to the detector.



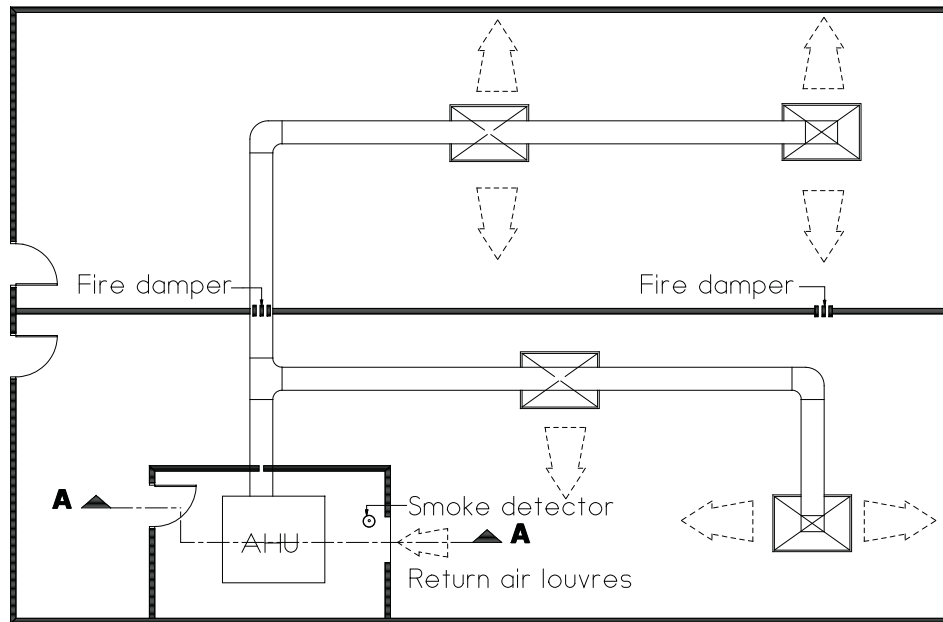
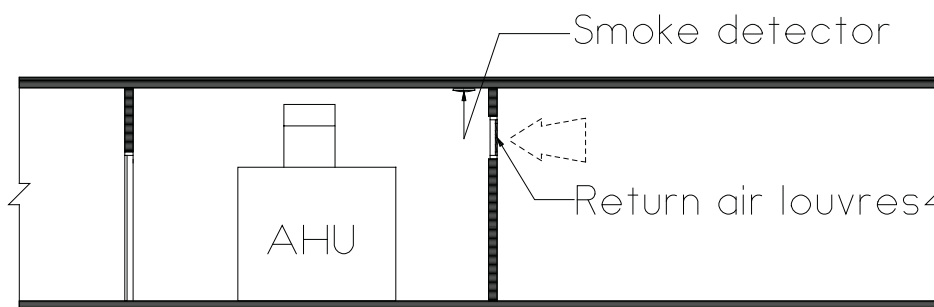


Figure 8.12: Smoke detector located at return air louvers.



SECTION A-A

.Figure 8.13: Location of smoke detector along return air stream

- 24.6.** Detectors shall be listed for operation over the complete range of air velocities, temperature, and humidity expected at the detector when the air-handling system is operating.
- 24.7.** All penetrations of a return air duct in the vicinity of detectors installed on or in an air duct shall be sealed to prevent entrance of outside air and possible dilution or redirection of smoke within the duct.
- 24.8.** Where in-duct smoke detectors are installed in concealed locations more than 3 m above the finished floor or in arrangements where the detector's alarm or supervisory indicator is not visible to responding personnel, the detectors shall be provided with remote alarm or supervisory indication in a location within the room.
- 24.9.** Remote alarm or supervisory indicators shall be installed in an accessible location and shall be clearly labelled to indicate both their function and the air-handling unit(s) associated with each detector.

25. Smoke Detectors for Door Release Service.

- 25.1.** Smoke detectors that are part of an open area protection system covering the room, corridor, or enclosed space on each side of the smoke door and that are located and spaced as required by spot-type detectors requirement shall be permitted to accomplish smoke door release service.
- 25.2.** Where smoke door release is accomplished directly from the smoke detector(s), the detector(s) shall be listed for releasing service.
- 25.3.** Smoke detectors shall be of the photoelectric, ionization, or other approved type.
- 25.4.** If the depth of wall section above the door is 610 mm (24 in.) or less, one ceiling-mounted smoke detector shall be required on one side of the doorway only, or two wall-mounted detectors shall be required, one on each side of the doorway. **Figure 8.14, part A or B**, shall apply.



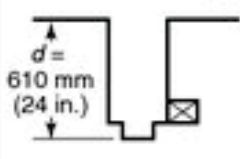
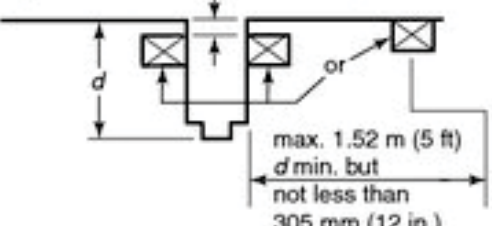
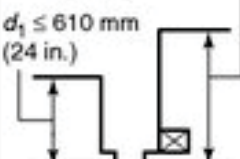
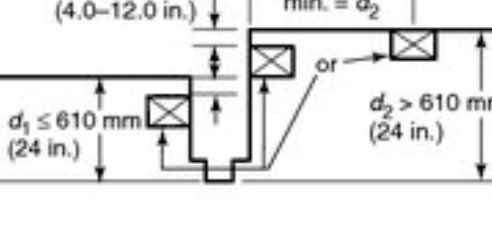
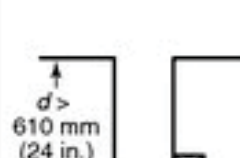
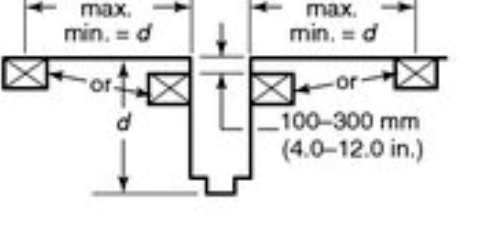
Depth of wall section above door	Door frame mounted	Ceiling or wall mounted
d	Smoke detector listed for frame mounting or as part of closer assembly	Smoke detector ceiling or wall mounted
0–610 mm (0–24 in.) on both sides of doorway	A  Detector or detector closer mounted on either side	B  One ceiling-mounted detector on either side or one wall-mounted detector on each side
Over 610 mm (24 in.) on one side only	C  Detector or detector closer mounted on higher side	D  One ceiling-mounted detector on higher side or one wall-mounted detector on each side
Over 610 mm (24 in.) on both sides	E  Detector or detector closer mounted on either side	F  Two detectors required
Over 1524 mm (60 in.)	G Might require additional detectors	

Figure 8.14 - Detector Location Requirements for Wall Sections.



- 25.5.** If the depth of wall section above the door is greater than 610 mm (24 in.) on one side only, one ceiling-mounted smoke detector shall be required on the higher side of the doorway only, or one wall-mounted detector shall be required on both sides of the doorway. **Figure 8.14, part D**, shall apply.
- 25.6.** If the depth of wall section above the door is greater than 610 mm (24 in.) on both sides, two ceiling-mounted or wall-mounted detectors shall be required, one on each side of the doorway. **Figure 8.14, part F**, shall apply.
- 25.7.** If a detector is specifically listed for door frame mounting or if a listed combination or integral detector-door closer assembly is used, only one detector shall be required if installed in the manner recommended by the manufacturer's published instructions. **Figure 8.14, parts A, C, and E**, shall apply.
- 25.8.** If the separation between doorways exceeds 610 mm (24 in.), each doorway shall be treated separately. **Figure 8.15, part E**, shall apply.

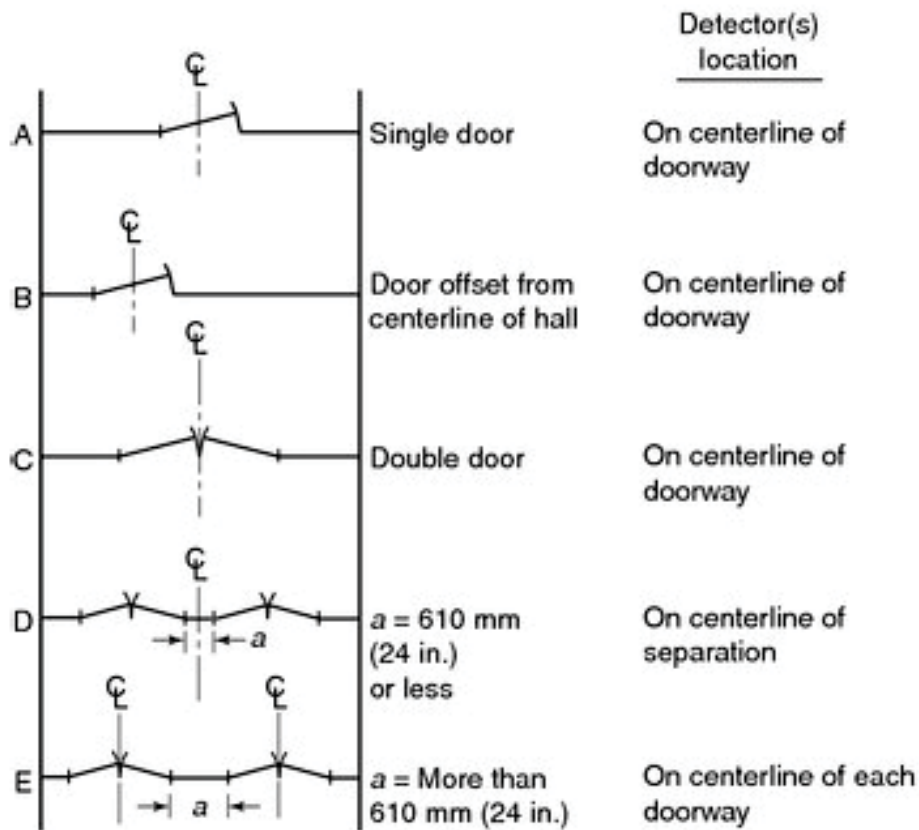


Figure 8.15 - Detector Location Requirements for Single and Double Doors.



- 25.9.** Each group of three or more doorway openings shall be treated separately. **Figure 16** shall apply.

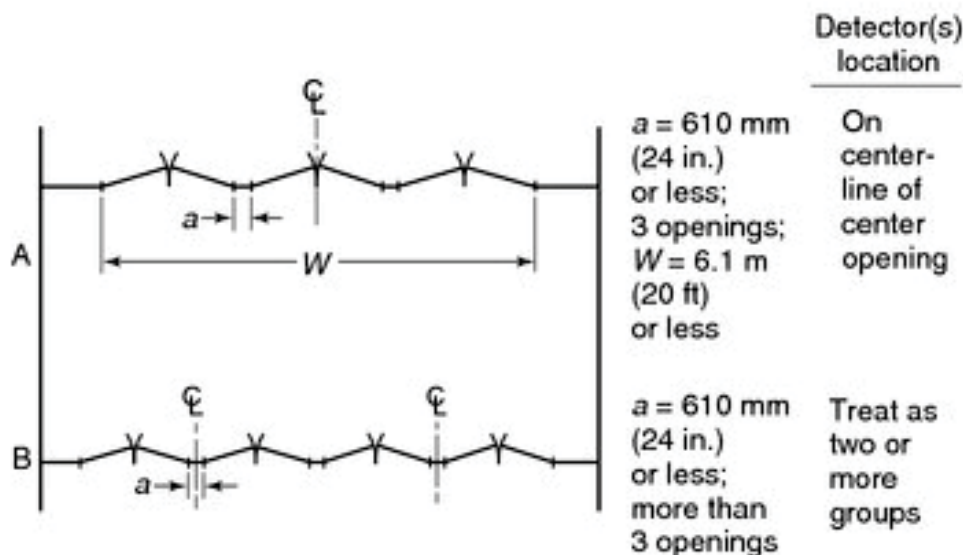


Figure 8.16 - Detector Location Requirements for Group Doorways.

- 25.10.** Each group of doorway openings that exceeds 6.1 m (20 ft) in width measured at its overall extremes shall be treated separately. **Figure 8.17** shall apply.

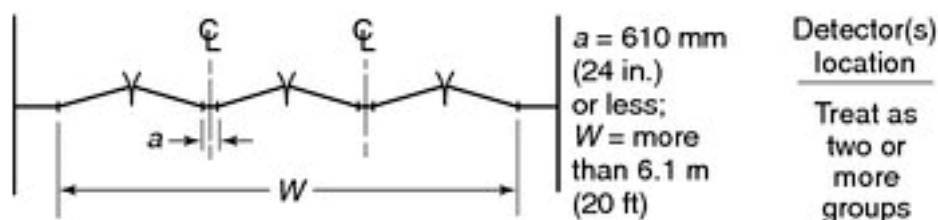


Figure 8.17 - Detector Location Requirements for Group Doorways over 6.1 m (20 ft) in Width.

- 25.11.** If there are multiple doorways and listed door frame-mounted detectors or if listed combination or integral detector-door closer assemblies are used, there shall be one detector for each single or double doorway.

- 25.12.** If ceiling-mounted smoke detectors are to be installed on a smooth ceiling for a single or double doorway, they shall be located as follows (**Figure 8.15 shall apply**):

- On the centreline of the doorway
- No more than 1.5 m (5 ft) measured along the ceiling and perpendicular to the doorway (**Figure 8.14 shall apply**.)
- No closer than shown in **Figure 8.14, parts B, D, and F**



26. Building Fire Alarm Systems.

26.1. Protected premises fire alarm systems that serve the general fire alarm needs of a building or buildings shall include the following systems or functions where applicable:

- i. Manual alarm signal initiation
- ii. Automatic alarm signal initiation
- iii. Monitoring of abnormal conditions in fire suppression systems
- iv. Activation of fire suppression systems
- v. Activation of fire safety functions
- vi. Activation of alarm notification appliances
- vii. Emergency voice/alarm communications
- viii. Guard's tour supervisory service
- ix. Process monitoring supervisory systems
- x. Activation of off-premises signals
- xi. Combination systems
- xii. Integrated systems

26.2. System Requirements.

26.2.1. Actuation Time.

Actuation of alarm notification appliances or emergency voice communications, fire safety functions, and annunciation at the protected premises shall occur within 10 seconds after the activation of an initiating device.

26.2.2. An open or ground condition of any fire alarm circuits shall result in the annunciation of a trouble signal at the protected premise within 200 seconds.

26.2.3. The signal from an automatic fire detection device selected for positive alarm sequence operation shall be acknowledged at the fire alarm control unit by trained personnel within 15 seconds of annunciation in order to initiate the alarm investigation phase.

26.2.4. If the signal is not acknowledged within 15 seconds, notification signals in accordance with the building evacuation or relocation plan and remote signals shall be automatically and immediately activated.

26.2.5. Trained personnel shall have up to 180 seconds during the alarm investigation phase to evaluate the fire condition and reset the system. If the system is not reset during the investigation phase, notification signals in accordance with the building evacuation plan and remote signals shall be automatically and immediately activated.



- 26.2.6.** If a second automatic fire detector selected for positive alarm sequence is actuated during the alarm investigation phase, notification signals in accordance with the building evacuation or relocation plan and remote signals shall be automatically and immediately activated.
- 26.2.7.** If any other initiating device is actuated, notification signals in accordance with the building evacuation or relocation plan and remote signals shall be automatically and immediately activated.
- 26.2.8.** The system shall provide means for bypassing the positive alarm sequence.
- 26.2.9.** System bandwidth is monitored to confirm that all communications between equipment that is critical to the operation of the fire alarm system or fire safety functions take place within 10 seconds; failure shall be indicated within 200 seconds.
- 26.2.10.** Failure of any equipment that is critical to the operation of the fire alarm system or fire safety functions is indicated at the master fire alarm control unit within 200 seconds.
- 26.2.11.** A listed barrier gateway, integral with or attached to each control unit or group of control units, as appropriate, shall be provided to prevent the other systems from interfering with or controlling the fire alarm system.
- 26.2.12.** Each interconnected fire alarm control unit shall be separately monitored for alarm, supervisory, and trouble conditions.
- 26.2.13.** Interconnected fire alarm control unit alarm signals shall be permitted to be monitored by zone or by combined common signals.
- 26.2.14.** Protected premises fire alarm control units shall be capable of being reset or silenced only from the fire alarm control unit at the protected premises.
- 26.2.15.** All non-fire alarm components shall be listed for fire alarm use or for fire conditions.

26.3. Combination Systems

- 26.3.1.** Speakers used as alarm notification appliances on fire alarm systems shall also be permitted to be used for non-emergency purposes, provided that condition i or ii is met:
- The emergency command centre is constantly attended by trained personnel.



- ii. The speakers and associated audio equipment are installed or located with safeguards to resist tampering or maladjustments of those components essential for intended emergency notification.

26.3.2. Speakers used as alarm notification appliances on fire alarm systems shall also be permitted to be used for mass notification systems.

26.3.3. Fire alarm signals from combination system shall be distinctive, clearly recognizable, and, with the exception of mass notification inputs, take precedence over any other signal even when a non-fire alarm signal is initiated first and shall be indicated as follows in descending order of priority unless otherwise permitted by this Code:

- i. Signals associated with life safety
- ii. Signals associated with property protection
- iii. Trouble signals associated with life and/or property protection
- iv. All other signals

26.3.4. Live voice instructions originating from the protected premises fire or mass notification systems shall override all previously initiated signals and shall have priority over both of the following:

- i. Any subsequent automatically initiated signals on that channel
- ii. Remotely generated mass notification messages

26.3.5. Signals from carbon monoxide detectors and carbon monoxide detection systems transmitted to a fire alarm system shall be permitted to be supervisory signals.

26.4. Alarm Signal Initiation — Detection Devices

26.4.1. A smoke detector that is continuously subjected to a smoke concentration above alarm threshold does not delay the system functions by more than 1 minute.

26.5. Alarm Signal Initiation — Sprinkler Systems.

26.5.1. Where required to be electronically monitored, waterflow alarm-initiating devices shall be connected to a dedicated function fire alarm control unit designated as “sprinkler waterflow and supervisory system,” and permanently identified on the control unit and record drawings.



26.5.2. Where waterflow alarm-initiating devices are connected to a building fire alarm system, a dedicated function fire alarm control unit shall not be required.

26.5.3. The number of waterflow alarm-initiating devices permitted to be connected to a single initiating device circuit shall not exceed five.

26.6. Supervisory Signal Initiation — Sprinkler Systems.

26.6.1. Where required to be electronically monitored, supervisory signal-initiating devices shall be connected to a dedicated function fire alarm control unit designated as “sprinkler waterflow and supervisory system,” and permanently identified on the control unit and record drawings.

26.6.2. Where supervisory signal-initiating devices are connected to a building fire alarm system, a dedicated function fire alarm control unit shall not be required.

26.6.3. The number of supervisory signal-initiating devices permitted to be connected to a single initiating device circuit shall not exceed 20.

26.7. Alarm Signal Initiation — Fire Suppression Systems Other Than Sprinklers.

26.7.1. Where required to be monitored and a building fire alarm system is installed, the actuation of a fire suppression system shall annunciate an alarm or supervisory condition at the building fire alarm control unit.

26.8. Supervisory Signal Initiation — Fire Suppression Systems Other Than Sprinklers.

26.8.1. Where required to be monitored and a building fire alarm system is installed, an off-normal condition of a fire suppression system shall annunciate a supervisory condition at the building fire alarm control unit.

26.8.2. Supervisory signals that latch in the off-normal state and require manual reset of the system to restore them to normal shall be permitted.

26.9. Signal Initiation — Fire Pump.

26.9.1. Where fire pumps are required to be monitored and a building fire alarm system is installed, a pump running signal shall be permitted to be a supervisory or alarm signal.

26.10. Fire Alarm and Supervisory Signal Initiation — Releasing Service Control Units.

26.10.1. Releasing service control units shall be connected to the protected premises fire alarm system.



- 26.10.2.** Fire alarm and supervisory signals generated at the releasing control unit shall be annunciated at a protected premises fire alarm unit.
- 26.10.3.** Where required, actuation of any suppression system connected to a releasing service control unit shall be annunciated at the protected premises fire alarm control unit even where the system actuation is by manual means or otherwise accomplished without actuation of the releasing service control unit.
- 26.10.4.** If a valve is installed in the connection between a suppression system and an initiating device, the valve shall be supervised.

26.11. Trouble Signal Initiation.

- 26.11.1.** Automatic fire suppression system alarm-initiating devices and supervisory signal-initiating devices and their circuits shall be designed and installed so that they cannot be subject to tampering, opening, or removal without initiating a signal. This provision shall include junction boxes installed outside of buildings to facilitate access to the initiating device circuit.

26.12. Fire Alarm and Mass Notification System Notification Outputs.

26.12.1. Occupant Notification.

- 26.12.1.1.** Fire alarm and mass notification systems provided for evacuation or relocation of occupants shall have one or more notification on each floor of the building.

26.13. Notification Appliances in Exit Stair Enclosures, Exit Passageways, and Elevator Cars.

- 26.13.1.** Visible notification signal appliances shall not be required in exit stair enclosures, exit passageways, and elevator cars.

26.14. Notification Zones.

- 26.14.1.** Notification zones shall be consistent with the emergency response or evacuation plan for the protected premises.
- 26.14.2.** The boundaries of notification zones shall be coincident with building outer walls, building fire or smoke compartment boundaries, floor separations, or other fire safety subdivisions.

26.15. Circuits for Addressable Notification Appliances.

- 26.15.1.** In protected premises with more than one notification zone, a single open, short-circuit, or ground on the system installation conductors shall not affect operation of more than one notification zone.



27. Suppression System Actuation.

- 27.1.** Fire alarm control units used for automatic or manual activation of a fire suppression system shall be listed for releasing service.
- 27.2.** Releasing devices for suppression systems shall be listed for use with releasing service control units.
- 27.3.** Fire alarm systems used for fire suppression–releasing service shall be provided with a disconnect switch to allow the system to be tested without actuating the fire suppression systems.
- 27.4.** Operation of a disconnect switch or a disable function shall cause a supervisory signal at the fire alarm control unit.
- 27.5.** The disconnect shall be a physical switch and not be accomplished by using software.
- 27.6.** Suppression systems or groups of systems shall be controlled by a single control unit that monitors the associated initiating device(s), actuates the associated releasing device(s), and controls the associated agent release notification appliances. If the releasing control unit is located in a protected premises having a separate fire alarm system, it shall be monitored for alarm, supervisory, and trouble signals, but shall not be dependent on or affected by the operation or failure of the protected premises fire alarm system.
- 27.7.** Fire alarm systems performing suppression system releasing functions shall be installed in such a manner that they are effectively protected from damage caused by activation of the suppression system(s) they control.

28. Elevator Recall for Fire Fighters' Service.

- 28.1.** System-type smoke detectors, or other automatic fire detection located in elevator lobbies, elevator hoist ways, and elevator machine rooms including machine space, control room, and control space used to initiate fire fighters' service recall, shall be connected to the building fire alarm system.
- 28.2.** Each elevator lobby, elevator hoist way, and elevator machine room smoke detector, or other automatic fire detection, shall be capable of initiating elevator recall when all other devices on the same initiating device circuit have been manually or automatically placed in the alarm condition.
- 28.3.** A lobby smoke detector shall be located on the ceiling within 6.4 m of the centerline of each elevator door within the elevator bank under control of the detector.
- 28.4.** Smoke detectors shall not be installed in unsprinklered elevator hoistways unless they are installed to activate the elevator hoistway smoke relief equipment.



- 28.5. If ambient conditions prohibit installation of automatic smoke detection, other automatic fire detection shall be permitted.
- 28.6. When actuated, any detector that has initiated firefighters' recall shall also be annunciated at the building fire alarm control unit and required remote annunciators.

29. Visual Warning – for elevators.

- 29.1. Actuation from elevator hoist way and elevator machine room smoke detectors or other automatic fire detection shall cause separate and distinct visible annunciation at the building fire alarm control unit or the fire alarm control unit and required annunciators to alert fire fighters and other emergency personnel that the elevators are no longer safe to use.
- 29.2. Where lobby detectors are used for other than initiating elevator recall, the signal initiated by the detector shall also initiate an alarm signal.
- 29.3. For each elevator or group of elevators, an output(s) shall be provided for the elevator visual warning signal in response to the following:
 - i. Activation of the elevator machine room initiating devices
 - ii. Activation of the elevator hoist way initiating devices

30. Elevator Shutdown.

- 30.1. Where heat detectors are used to shut down elevator power prior to sprinkler operation, the detector shall have both a lower temperature rating and a higher sensitivity as compared to the sprinkler.
- 30.2. If heat detectors are used to shut down elevator power prior to sprinkler operation, they shall be placed within 610 mm of each sprinkler head.
- 30.3. If pressure or water flow switches are used to shut down elevator power immediately upon or prior to the discharge of water from sprinklers, the use of devices with time-delay switches or time-delay capability shall not be permitted.
- 30.4. Control circuits to shut down elevator power shall be monitored for presence of operating voltage. Loss of voltage to the control circuit for the disconnecting means shall cause a supervisory signal to be indicated at the control unit and required remote annunciators.
- 30.5. The initiating devices shall be monitored for integrity by the fire alarm control unit



31. HVAC Systems.

- 31.1.** If connected to the fire alarm system serving the protected premises, all detection devices used to cause the operation of HVAC systems smoke dampers, fire dampers, fan control, smoke doors, and fire doors shall be monitored for integrity.
- 31.2.** Smoke detectors mounted in the air ducts of HVAC systems shall initiate either an alarm signal at the protected premises or a supervisory signal at a constantly attended location or supervising station.
- 31.3.** If the fire alarm control unit actuates the HVAC system for the purpose of smoke control, the automatic alarm-initiating zones shall be coordinated with the smoke-control zones they actuate.
- 31.4.** Where interconnected as a combination system, a Firefighter's Smoke Control Station (FSCS) shall be provided to perform manual control over the automatic operation of the system's smoke control strategy.
- 31.5.** Where interconnected as a combination system, the smoke control system programming shall be designed such that normal HVAC operation or changes do not prevent the intended performance of the smoke control strategy.

32. Door Release Service.

- 32.1.** All detection devices used for door hold-open release service shall be monitored for integrity.
- 32.2.** All door hold-open release and integral door release and closure devices used for release service shall be monitored for integrity.
- 32.3.** Magnetic door holders that allow doors to close upon loss of operating power shall not be required to have a secondary power source.

33. Door Unlocking Devices.

- 33.1.** Any device or system intended to actuate the locking or unlocking of exits shall be connected to the fire alarm system serving the protected premises.
- 33.2.** All exits shall unlock upon receipt of any fire alarm signal by means of the fire alarm system serving the protected premises.
- 33.3.** If exit doors are unlocked by the fire alarm system, the unlocking function shall occur prior to or concurrent with activation of any public-mode notification appliances in the area(s) served by the normally locked exits.



- 33.4.** All doors that are required to be unlocked by the fire alarm system shall remain unlocked until the fire alarm condition is manually reset.

34. Public Mode Audible Requirements.

- 34.1.** To ensure that audible public mode signals are clearly heard, they shall have a sound level at least 15 dB above the average ambient sound level or 5 dB above the maximum sound level having a duration of at least 60 seconds, whichever is greater, measured 1.5 m above the floor in the area required to be served. Refer to [Table 8.4](#) for the sound level based on location.
- 34.2.** A fire alarm system arranged to stop or reduce ambient noise shall produce a sound level at least 15 dB above the reduced average ambient sound level or 5 dB above the maximum sound level having a duration of at least 60 seconds after reduction of the ambient noise level, whichever is greater, measured 1.5 m above the floor in the area required to be served.

35. Private Mode Audible Requirements.

- 35.1.** To ensure that audible private mode signals are clearly heard, they shall have a sound level at least 10 dB above the average ambient sound level or 5 dB above the maximum sound level having a duration of at least 60 seconds, whichever is greater, measured 1.5 m above the floor in the area required to be served.
- 35.2.** A system arranged to stop or reduce ambient noise shall be permitted to produce a sound level at least 10 dB above the reduced average ambient sound level or 5 dB above the maximum sound level having a duration of at least 60 seconds after reduction of the ambient noise level, whichever is greater, measured 1.5 m above the floor.

36. Sleeping Area Requirements.

- 36.1.** Audible appliances shall be installed to provide signals for sleeping areas. They shall have a sound level of at least 15 dB above the average ambient sound level or 5 dB above the maximum sound level having a duration of at least 60 seconds or a sound level of at least 75 dBA, whichever is greater, measured at the pillow level in the area required to be served.
- 36.2.** If any barrier, such as a door, curtain, or retractable partition, is located between the notification appliance and the pillow, the sound pressure level shall be measured with the barrier placed between the appliance and the pillow.



37. Location of Audible Notification Appliances for a Building or Structure.

- 37.1.** If ceiling heights allow, wall-mounted appliances shall have their tops above the finished floors at heights of not less than 2290 mm and below the finished ceilings at distances of not less than 150 mm.
- 37.2.** Ceiling-mounted or recessed appliances shall be permitted.

38. Location of Audible Notification Appliances for Wide Area Signalling.

- 38.1.** Audible notification appliances for wide area signaling shall be installed in accordance with the approved design documents, and the manufacturer's installation instruction to achieve the required performance.



Table 8.4 - Average Ambient Sound Level According to Location

Location	Average Ambient Sound Level (dBA)
Business occupancies	55
Educational occupancies	45
Industrial occupancies	80
Institutional occupancies	50
Mercantile occupancies	40
Mechanical rooms	85
Piers and water-surrounded structures	40
Places of assembly	55
Residential occupancies	35
Storage occupancies	30
Thoroughfares, high-density urban	70
Thoroughfares, medium-density urban	55
Thoroughfares, rural and suburban	40
Tower occupancies	35
Underground structures and windowless buildings	40
Vehicles and vessels	50

39. Visible Characteristics — Public Mode.

39.1. Light, Color, and Pulse Characteristics.

- 39.1.1.** The flash rate shall not exceed two flashes per second (2 Hz) nor be less than one flash every second (1 Hz) throughout the listed voltage range of the appliance.
- 39.1.2.** A maximum pulse duration shall be 0.2 second with a maximum duty cycle of 40 percent.
- 39.1.3.** The pulse duration shall be defined as the time interval between initial and final points of 10 percent of maximum signal.
- 39.1.4.** Lights used for fire alarm signalling only or to signal the intent for complete evacuation shall be clear or nominal white and shall not exceed 1000 cd (effective intensity).
- 39.1.5.** Lights used to signal occupants to seek information or instructions shall be clear, nominal white or other colour as required by the emergency plan.

39.2. Appliance Location.

- 39.2.1.** Visual alarm signals (flashers) shall be used in areas where audio alarm signal is not effective, not feasible to type of occupancy (i.e. operating theatres in hospitals, extremely noisy environment like engine room, intensive care units in health care occupancies) or in areas where audio alarm requires the aid of visual alarm.
- 39.2.2.** Wall-mounted appliances shall be mounted such that the entire lens is not less than 2030 mm and not greater than 2440 mm above the finished floor.

39.3. Spacing in Rooms.

- 39.3.1.** Spacing of wall and ceiling mounted visible appliances shall be in accordance with [Table 8.5](#) and [Figure 8.18 or Table 8.6](#) accordingly.



Table 8.5 - Room Spacing for Wall-Mounted Visible Appliances

Maximum Room Size		Minimum Required Light Output (Effective Intensity, cd)			
m	ft	One Light per Room	Two Lights per Room (Located on Opposite Walls)	Four Lights per Room (One Light per Wall)	
6.10 × 6.10	20 × 20	15	NA	NA	NA
8.53 × 8.53	28 × 28	30	Unknown	NA	NA
9.14 × 9.14	30 × 30	34	15	NA	NA
12.2 × 12.2	40 × 40	60	30	15	15
13.7 × 13.7	45 × 45	75	Unknown	19	19
15.2 × 15.2	50 × 50	94	60	30	30
16.5 × 16.5	54 × 54	110	Unknown	30	30
16.8 × 16.8	55 × 55	115	Unknown	28	28
18.3 × 18.3	60 × 60	135	95	30	30
19.2 × 19.2	63 × 63	150	Unknown	37	37

Maximum Room Size		Minimum Required Light Output (Effective Intensity, cd)			
m	ft	One Light per Room	Two Lights per Room (Located on Opposite Walls)	Four Lights per Room (One Light per Wall)	
20.7 × 20.7	68 × 68	177	Unknown	43	43
21.3 × 21.3	70 × 70	184	95	60	60
24.4 × 24.4	80 × 80	240	135	60	60
27.4 × 27.4	90 × 90	304	185	95	95
30.5 × 30.5	100 × 100	375	240	95	95
33.5 × 33.5	110 × 110	455	240	135	135
36.6 × 36.6	120 × 120	540	305	135	135
39.6 × 39.6	130 × 130	635	375	185	185

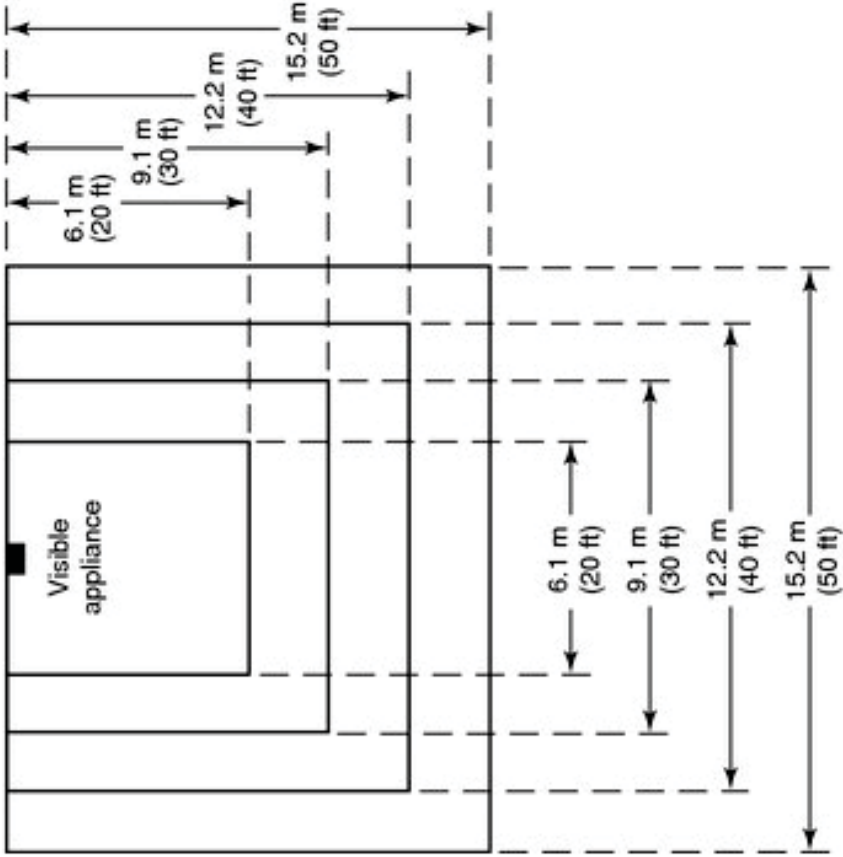


Figure 8.18 - Room Spacing for Wall-Mounted Visible Appliances.

Table 8.6 - Room Spacing for Ceiling-Mounted Visible Appliances

Maximum Room Size		Maximum Ceiling Height		Minimum Required Light Output (Effective Intensity); One Light (cd)
m	ft	m	ft	
6.1 × 6.1	20 × 20	3.0	10	15
9.1 × 9.1	30 × 30	3.0	10	30
12.2 × 12.2	40 × 40	3.0	10	60
13.4 × 13.4	44 × 44	3.0	10	75
15.2 × 15.2	50 × 50	3.0	10	95
16.2 × 16.2	53 × 53	3.0	10	110
16.8 × 16.8	55 × 55	3.0	10	115
18.0 × 18.0	59 × 59	3.0	10	135
19.2 × 19.2	63 × 63	3.0	10	150
20.7 × 20.7	68 × 68	3.0	10	177
21.3 × 21.3	70 × 70	3.0	10	185
6.1 × 6.1	20 × 20	6.1	20	30
9.1 × 9.1	30 × 30	6.1	20	45
13.4 × 13.4	44 × 44	6.1	20	75
14.0 × 14.0	46 × 46	6.1	20	80
15.2 × 15.2	50 × 50	6.1	20	95
16.2 × 16.2	53 × 53	6.1	20	110
16.8 × 16.8	55 × 55	6.1	20	115
18.0 × 18.0	59 × 59	6.1	20	135
19.2 × 19.2	63 × 63	6.1	20	150
20.7 × 20.7	68 × 68	6.1	20	177
21.3 × 21.3	70 × 70	6.1	20	185
6.1 × 6.1	20 × 20	9.1	30	55
9.1 × 9.1	30 × 30	9.1	30	75
15.2 × 15.2	50 × 50	9.1	30	95
16.2 × 16.2	53 × 53	9.1	30	110
16.8 × 16.8	55 × 55	9.1	30	115
18.0 × 18.0	59 × 59	9.1	30	135
19.2 × 19.2	63 × 63	9.1	30	150
20.7 × 20.7	68 × 68	9.1	30	177
21.3 × 21.3	70 × 70	9.1	30	185

- 39.4.** Visible notification appliances shall be installed in accordance with [Table 8.5](#), using one of the following:
- i. A single visible notification appliance.
 - ii. Two visible notification appliances located on opposite walls.
 - iii. Two groups of visible notification appliances, where visual appliances of each group are synchronized, in the same room or adjacent space within the field of view. This shall include synchronization of strobes operated by separate systems.
 - iv. More than two visible notification appliances or groups of synchronized appliances in the same room or adjacent space within the field of view that flash in synchronization.
- 39.5.** Room spacing in accordance with [Table 8.5](#) and [Figure 8.18](#) for wall-mounted appliances shall be based on locating the visible notification appliance at the halfway distance of the wall.
- 39.6.** In square rooms with appliances not centered or in nonsquare rooms, the effective intensity (cd) from one visible wall-mounted notification appliance shall be determined by maximum room size dimensions obtained either by measuring the distance to the farthest wall or by doubling the distance to the farthest adjacent wall, whichever is greater, as required by [Table 8.3](#) and [Figure 8.16](#).
- 39.7.** If a room configuration is not square, the square room size that allows the entire room to be encompassed or allows the room to be subdivided into multiple squares shall be used.
- 39.8.** If ceiling heights exceed 9.14 m (30 ft), ceiling-mounted visible notification appliances shall be suspended at or below 9.14 m (30 ft) or wall-mounted visible notification appliance shall be installed in accordance with [Table 8.3](#).
- 39.9.** [Table 8.4](#) shall be used if the ceiling-mounted visible notification appliance is at the center of the room. If the ceiling-mounted visible notification appliance is not located at the center of the room, the effective intensity (cd) shall be determined by doubling the distance from the appliance to the farthest wall to obtain the maximum room size.
- 39.10. Spacing in Corridors.**
- 39.10.1.** The installation of visible notification appliances in corridors 6.1 m or less in width shall be in accordance with the requirements of [Table 8.5](#) or [8.6](#) accordingly.
- 39.10.2.** In a corridor application, visible appliances shall be rated not less than 15 cd.



39.10.3. Corridors greater than 6.1 m wide shall also comply with the spacing requirements for rooms in accordance with [Table 8.3](#) or [8.4](#) accordingly.

39.11. Visible notification appliances shall be located not more than 4.57 m from the end of the corridor with a separation not greater than 30.4 m between appliances.

39.12. If there is an interruption of the concentrated viewing path, such as a fire door, an elevation change, or any other obstruction, the area shall be treated as a separate corridor.

39.13. In corridors where more than two visible notification appliances are in any field of view, they shall flash in synchronization.

39.14. Wall-mounted visible notification appliances in corridors shall be permitted to be mounted on either the end wall or the side wall of the corridor not more than 4.57 m from the end of the corridor with a separation not greater than 30.4 m between appliances.

40. Material Approval

40.1. All the Materials, Systems, Assemblies, equipment, Products and Accessories, referred to in this chapter with respect to Life Safety, Fire Safety and Emergency Services shall be Listed, Approved and Registered by the Civil Defence Material Approval Department.

40.2. The above requirement applies to all the products with or without international listing, registration or approval.

41. Further References

41.1. The following International Codes and Standards were referred, studied and consulted for this chapter. Further details where applicable can be referred to in these Codes and Standards. Also see [XV. ACKNOWLEDGEMENT OF INTERNATIONAL CODES AND STANDARDS](#).

- NFPA 72: National Fire Alarm and Signaling Code.
- NFPA 70: National Electrical Code®
- NFPA 75: Standard for the protection of computer EDP/ Clean Agents.
- NFPA 76: Standard for the fire protection of telecommunication facility.
- NFPA 110: Standard for Emergency and Standby Power Systems.
- NFPA 111: Standard on Stored Electrical Energy Emergency and Standby Power Systems.
- NFPA 170: Standard for Fire Safety and Emergency Symbols.
- BA 6266: Fire Protection for electronic equipment installation – code of practice.
- FIA COP: Code of Practice for Design, Installation Commissioning & Maintenance of Aspirating Smoke Detector (ASD) Systems



CHAPTER 9

FIRE PROTECTION SYSTEMS

1. General

- 1.1.** The provision of Fire Protection systems is to provide automatic as well as manual approach to extinguish fires. Along with their Fire fighting equipment, Civil Defence Fire-fighters also utilize Fire Protection Systems installed in occupancies, to manually fight fires thereby protecting the property and lives of people. Thus a well designed and well functioning Fire Protection System in any occupancy is very important. Fire Protection or Fire Extinguishment can be achieved with various techniques and mechanisms. However, basically the concepts behind all the extinguishing measures are one or more of the following.

- i. Physically separate the combustible material from the flame
- ii. Removing or Reducing the Oxygen supply
- iii. Reducing temperature of the combustible or the flame
- iv. Introducing the chemicals that modify the combustion chemistry

- 1.2.** This section of the code deals with the requirements for application, design, installation and maintenance of following types of internationally accepted and approved Fire Protection Systems.

- i. Water Based Fire Protection Systems
- ii. Gas and Chemical Based Fire Protection Systems
- iii. Other types of Fire Extinguishers, Extinguishing Agents, Extinguishing methods and mechanisms which are not part of this code shall obtain approval from Civil Defence.

2. Definitions

2.1. Water Based Fire Protection Systems

- 2.1.1.** Water is the most widely used and available fire-extinguishing agent. Water is inexpensive, abundant (See 2.1.2), and effective in fire suppression. The techniques and mechanisms using water and its heat absorbing, cooling and fire extinguishing properties to fight and extinguish fires are Water Based Fire Protection Systems such as Standpipe System, Automatic Sprinkler Systems, Water Spray Systems, Water Mist Systems, Fire Hydrant Systems, and Foam Systems etc.

- 2.1.2.** See Chapter V. COMMITMENT TO BEST PRACTICE, section 2. ENVIRONMENTAL MANAGEMENT and SUSTAINABILITY on '*Save Water*'

2.2. Gas and Chemical Based Fire Protection Systems

- 2.2.1.** Gas extinguishing technology is based mainly on the principle of removing oxygen. By introducing a gaseous extinguishing agent into the room's atmosphere the oxygen content is reduced to the point where the combustion process is halted. The gas



extinguishing process uses either inert or chemical gases. This technique and mechanism using various gases and chemicals such as Clean Agents, CO2, Dry Chemical and Wet Chemical agents and their fire extinguishing properties to fight and extinguish fires are called Gas and Chemical based Fire Protection Systems.

2.3. Standpipe Systems

2.3.1. The vertical portion of the Water Based Fire Protection system piping that delivers the water supply for Hose connections (and sprinklers in combined systems) vertically from floor to floor. The term standpipe can also refer to the horizontal portion of the system piping that delivers the water supply for two or more hose connections (and sprinklers on combined systems), on a single level.

2.3.2. Two types of Standpipe Systems are approved by the Civil Defence based on the building specifications and floor areas. One is Dry Type Standpipe Systems and second is Wet Type Standpipe Systems. These standpipe systems are further categorized into Class I, Class II and Class III Standpipe Systems.

2.3.3. Combined Standpipe Systems with a common riser providing water supply to both hose connections as well as Sprinkler systems are not allowed by Civil Defence.

2.4. Dry Standpipe Systems or Dry Riser System

2.4.1. Dry riser systems are normally dry without permanent water connection to it and depend on the Civil Defence fire truck to pump water into the system. Dry riser system comprises of one or multiple vertical riser pipes or horizontal runs of piping that are terminated to the two way breeching inlets located at ground level and connected to the 65mm dia landing (Fire Department) valve outlets coupled or uncoupled with 65mm diameter, 30 m long re-inforced rubber lined (RRL) hose with multipurpose hose nozzle that are placed inside a cabinet for the use of Civil Defence Department personnel or other trained fire fighting personnel.

2.5. Wet Standpipe Systems or Wet Riser System

2.5.1. Wet riser systems are normally pressurized with water having permanent water supply from fire water pumps and fire water storage tanks. Wet riser system comprises of one or multiple vertical riser pipes or horizontal runs of piping that feed the Sprinkler System, Water Spray System as well as Hose and Landing Valve connections. These risers are connected to fire pumps and fire water storage tanks located within the buildings. 25mm for Hose Reel System, 40 mm for Hose Rack system, 65 mm diameter for Landing Valve tapplings will be made from the wet riser in each floor level and fitted with multipurpose hoses and nozzles that are placed inside a cabinet for the use of Civil Defence department personnel or other trained fire fighting personnel. In addition four way breeching inlets located at ground level are connected to bottom of the wet riser to pump water from the Civil Defence fire truck as supplementary water supply.



2.6. Fire Hose Reel System

- 2.6.1.** Fire hose reel systems are also normally pressurized with water having permanent water supply from fire water pumps and fire water storage tanks. Fire hose reel system comprises of one or multiple vertical riser pipes or horizontal runs of piping that are connected to the 25 mm dia bore, 30 m long fire hose reels located at all the floors. System includes permanent fire pumps and fire water tanks.

2.7. Fire Hose Rack System

- 2.7.1.** Fire hose rack systems are also normally pressurized with water having permanent water supply from fire water pumps and fire water storage tanks. Fire hose rack system comprises of one or multiple vertical riser pipes or horizontal runs of piping that are connected to the 40 mm dia bore, 30 m long fire hose, folded vertically and attached over the pins in an approved manner and located at all the floors. System includes permanent fire pumps and fire water tanks.

2.8. Class I System

- 2.8.1.** Class I systems comprises of 65 mm diameter Landing Valve outlets coupled or uncoupled with 65mm diameter, 30 m long re-inforced rubber lined (RRL) hose with multipurpose hose nozzle for the use of Civil Defence department personnel or other trained fire fighting personnel.

2.9. Class II System

- 2.9.1.** Class II systems comprises of 25 mm diameter bore for Hose Reel System or 40 mm diameter bore for Hose Rack System, 30 m long dual reinforced rubber hose coupled with 6 or 8 mm bore multipurpose nozzle, for the use of occupants to extinguish small fires or when the fire is at its incipient stages until the arrival of Civil Defence fire fighters.

2.10. Class III System

- 2.10.1.** Class III system is a combination of both Class I & Class II systems for the use of occupants and as well as Civil Defence use. In general the class I system equipments are installed in lower level or compartment and class II system equipments in upper level or compartment of a cabinet.
- 2.10.2.** Alternatively, because of the multiple use, class III stand pipe system comprising 65 mm diameter landing valve with 65 mm x 40 mm easily removable adapter and coupled with 40 mm diameter, 30 m long fire hose and nozzle may be permitted as a special cases.

2.11. Automatic Sprinkler System

- 2.11.1.** The sprinklers are the devices which consist of an orifice to discharge water is normally closed by a disc or cap held in place by temperature sensitive element such as fusible link or quartzoid bulbs. Convicted heat from a fire causes operation of one or more thermally sensitive sprinklers, thereby permitting water to be



discharged directly over the fire affected area. A typical sprinkler system consists essentially of a piping network, connected to a permanent water supply and control valves feeding automatic water sprinklers spaced regularly throughout the protected premises, incorporating local and fire department service alarms.

2.12. Water Spray System

- 2.12.1.** Similar to automatic Sprinkler system, it is an automatic or manually actuated fixed piping network system connected to a fixed water supply and equipped with water spray nozzles designed to provide a specific water discharge and distribution over the protected surfaces or area.

2.13. Water Mist System

- 2.13.1.** Similar to Automatic Sprinkler System, water mist system is an automatic or manual fire protection system connected to a fixed water supply network and using special spray nozzles discharging very fine water sprays (i.e., water mist). The water discharged to produce small particles of water (mist effect) which absorbs heat, displaces oxygen, or blocks radiant heat in order to control or suppress fire in an environment where water damage and water quantity is a concern. Watermist systems are available in both High Pressure & Low Pressure versions. Watermist systems can also be used as alternatives to sprinkler systems in certain applications.

2.14. Fire Hydrant System

- 2.14.1.** Fire Hydrant is an exterior valved connection to water supply that provides one or more hose connections. As a system it is a water supply piping network system having one or more outlets and that is used to supply hose and fire department pumpers with water on private property. Where connected to a public water system, the private hydrants are supplied by a private service main that begins at the point of service, usually at a manually operated valve near the property line.
- 2.14.2.** Fire Hydrant system can also be a Fire Hydrants distributed through piping network with permanent Water Tank and Pumps for the pressurized water supply which is normally a requirement for private property protection without public water system. (See chapter 2, section 6)

2.15. Foam System

- 2.15.1.** Foam is a stable aggregation of small gas filled bubbles of lower density than oil or water, formed from aqueous solutions of specially formulated concentrated liquid foaming agents that exhibits a tenacity for covering horizontal surfaces, producing an air excluding, cooling continuous layer of vapour-sealing, water-bearing material that prevents combustion. A fixed Foam system is a complete installation in which foam concentrate and water are mixed in foam station thus creating required foam which then is piped from foam station, discharging through fixed delivery outlets to the hazard to be protected with permanently installed pumps where required.



- 2.15.2.** Foam system can also be mobile with any type of foam-producing unit that is mounted on wheels and that is self-propelled or towed by a vehicle and can be connected to a water supply or can utilize a premixed foam solution.

2.16. Clean Agent System

- 2.16.1.** Clean Agents are essentially the fire extinguishing agents which are electrically non-conducting, vaporize readily and leave no residue upon evaporation. Clean agents are Halon replacements which are broadly classified into two categories. Halocarbon compounds such as Hydrobromofluorocarbons (HBFC), Hydrofluorocarbons (HFC), Hydrochlorofluorocarbons (HCFC), perfluorocarbons (FC or PFC) and Fluoriodocarbons (FIC). Fluoroketone (FK), Inert Gases such as Nitrogen and Argon or blends of these gases.
- 2.16.2.** See V. COMMITMENT TO BEST PRACTICE, section 2. ENVIRONMENTAL MANAGEMENT and SUSTAINABILITY on '**Acceptable and Approved Clean Agent Systems**'
- 2.16.3.** All clean agent systems should be listed in NFPA 2001, latest version and designed in accordance with this standard.
- 2.16.4.** These Clean agents can be either discharged as 'Total Flooding' which is the act and mechanism of discharging agent through distribution piping network and through nozzles for the purpose of achieving a specified minimum agent concentration throughout a hazard to extinguish fire OR can be discharged as 'Local Application' where a system consisting of a supply of Clean agent arranged to discharge directly on the burning material.

2.17. Carbon Dioxide (CO2) System

- 2.17.1.** Carbon Dioxide is a non conductive gas which extinguishes fire by Oxygen Reduction principle. This can be achieved through various mechanisms such as Automatic Total flooding, Local application and Manual Hose lines. Total flooding is supply of carbon dioxide arranged with storage tank, piping distribution and nozzles to discharge into, and fill to the proper concentration, an enclosed space or enclosure around the hazard. Similarly Local application is discharging CO2 directly on the burning surface. Manual hose lines consist of a hose and nozzle assembly connected by fixed piping network and CO2 storage tank or connected directly to a supply of CO2. CO2 system should be applied for the protection of unmanned areas.

2.18. Dry Chemical System

- 2.18.1.** Dry Chemical is a powder composed of very small particles, usually sodium bicarbonate-, potassium bicarbonate-, or ammonium phosphate-based with added particulate material supplemented by special treatment to provide resistance to packing, resistance to moisture absorption (caking), and the proper flow capabilities. Dry chemical has Oxygen reduction, Cooling and Radiation Shielding properties which is used to extinguish fires by various automatically and



manually operating mechanisms such as Total flooding, Local application, Hand Hose line.

2.19. Wet Chemical System

- 2.19.1.** Wet Chemical normally is an aqueous solution of organic or inorganic salts or a combination thereof that forms an extinguishing agent with Oxygen reducing and cooling properties. This agent is then discharged through piping or tubing network triggered by expellant gas pressure.

3. Application

3.1. Building Classification and Application of Fire Protection Systems

- 3.1.1.** Abbreviations below are used to guide through the selection and application of Fire Protection Systems in the following sections of this code.

DRS	Dry Riser System
WRS	Wet Riser System
FHR	Fire Hose Reel System
AS	Automatic Sprinkler System
PAS	Pre-action Sprinkler System
WSS	Water Spray System
WMS	Water Mist System
YFH	Yard Fire Hydrant System
FSS	Foam Sprinkler System
FIS	Foam Injection System
DCS	Dry Chemical System
WCS	Wet Chemical System
CAS	Clean Agent System
CDS	Carbon Dioxide System
FM	Foam Monitors
FE	Portable Fire Extinguisher

3.2. Non-industrial and Non-storage occupancies

- 3.2.1.** All occupancies with more than 20,000 m² plot area, usually with cluster of all types of buildings shall be provided with Yard Fire Hydrant Systems with dedicated Fire Pump set and water tank.
- 3.2.2.** The selection of Fire Protection Systems for Non-Industrial and Non Storage occupancies shall be as per [Table 9.1](#).
- 3.2.3.** Auxiliary occupancies such as Electrical rooms, Telephone Rooms, Generator Rooms, Anesthetizing Rooms, Laboratories etc., connected with and part of the primary or predominant occupancies shall comply with the requirements of [Table 9.2](#).

3.3. Industrial occupancies

- 3.3.1.** All Industrial premises more than 3600 m² plot area shall be provided with Yard Fire Hydrant Systems.



- 3.3.2.** All Industrial occupancies having more than 3 floors above Fire Access Level shall be fully protected with Automatic Sprinkler System. In such occupancies, where application of water as extinguishing medium is not appropriate due to the water reactive material presence, a suitable other extinguishing system and method shall be proposed.
- 3.3.3.** All High Hazard Industrial occupancies where gasoline and other flammable liquids are handled, used, or stored under such conditions that involve possible release of flammable vapors; where grain dust, wood flour or plastic dust, aluminum or magnesium dust, or other explosive dusts are produced; where hazardous chemicals or explosives are manufactured, stored, or handled; where materials are processed or handled under conditions that might produce flammable flyings; and where other situations of similar hazard exist in manufacturing, processing, extracting, coating and treating activities are held and the industries identified in [Table 9.3](#), a Fire risk analysis report of the facility, prepared by Civil Defence approved Fire Consultant shall be furnished for Civil Defence authority's jurisdiction.
- 3.3.4.** Also See [CHAPTER 13. FIRE SAFETY REQUIREMENT FOR MULTITENANT WAREHOUSE AND FACTORIES](#) for specific requirements for group of warehouses and/or factories arranged for multiple usages by multiple owners.
- 3.3.5.** See [CHAPTER 14. FIRE SAFETY REQUIREMENTS FOR SUBSTATIONS](#)
- 3.3.6.** Fire Protection System for Industrial Occupancies shall be as per [Table 9.3](#).

3.4. Storage occupancies

- 3.4.1.** All Storage occupancies with premises more than 3600 m² plot area shall be provided with Yard Fire Hydrant Systems.
- 3.4.2.** Storage occupancies having more than 3 floors above Fire Access Level shall be fully protected with Automatic Sprinkler System. In such occupancies, where application of water as extinguishing medium is not appropriate due to the water reactive material presence, a suitable other extinguishing system and method shall be proposed.
- 3.4.3.** All Storage occupancies where Explosives and Flammable solids, liquids and gases are stored, a Fire risk analysis report prepared by Civil Defence approved Fire Consultant, complete with material data sheet and specifications, method of storage details shall be furnished for Civil Defence authority's jurisdiction.
- 3.4.4.** Also See [CHAPTER 13. FIRE SAFETY REQUIREMENT FOR MULTITENANT WAREHOUSE AND FACTORIES](#) for specific requirements for group of warehouses and/or factories arranged for multiple usages by multiple owners.
- 3.4.5.** Selection of Fire Protection System for Storage Occupancies shall be as per [Table 9.4](#).



Table 9.1: Building Classification and Application of Fire Protection Systems

Table 9.1: Building Classification and Application of Fire Protection Systems								
LOCATION	LARGEST FLOOR / SINGLE LARGEST COMPARTMENT AREA LESS THAN OR EQUAL TO 900 M ²	LARGEST FLOOR / SINGLE LARGEST COMPARTMENT AREA MORE THAN 900 M ²	LOW DEPTH UNDERGROUND BUILDING WITH LESS THAN OR EQUAL TO 2 BASEMENTS AND BASEMENT AREA LESS THAN OR EQUAL TO 900 M ²	HIGH DEPTH UNDERGROUND BUILDING WITH MORE THAN 2 BASEMENTS OR BASEMENT AREA MORE THAN 900 M ²	LOWRISE BUILDING WITH HEIGHT LESS THAN OR EQUAL TO 15 M	MIDRISE BUILDING WITH HEIGHT 15 M TO 23 M	HIGHRISE BUILDING WITH HEIGHT MORE THAN 23 M	SPRINKLER SYSTEM IS REQUIRED IF FOLLOWING CONDITION EXISTS (See Chapter 1, Table 1.7 for reference)
ANIMAL HOUSING	• DRS	• WRS	• DRS • AS	• WRS • AS	• DRS	• WRS • AS	• WRS • AS	• Total Area is more than 2230 m ²
ASSEMBLY	• WRS • AS	• WRS • AS	• WRS • AS	• WRS • AS	• WRS • AS	• WRS • AS	• WRS • AS	Unconditional
BUSINESS	• DRS	• WRS • AS	• DRS • AS	• WRS • AS	• DRS	• WRS	• WRS • AS	Unconditional
DAYCARE AND RESIDENTIAL BOARD /CARE	• DRS • AS	• WRS • AS	• DRS • AS	• WRS • AS	• DRS • AS	• WRS • AS	• WRS • AS	Unconditional
DETENTION AND CORRECTIONAL	• WRS • PAS	• WRS • PAS	• WRS • PAS	• WRS • PAS	• WRS • PAS	• WRS • PAS	• WRS • PAS	Unconditional
EDUCATIONAL	• DRS	• WRS • AS (If not with open corridor)	• DRS • AS	• WRS • AS	• DRS • AS (If not with open corridor)	• WRS • AS	• WRS • AS	• Total Area is more than 1860 m ² • No of Basement More than 1
HEALTHCARE AND AMBULATORY	• WRS • AS	• WRS • AS	• WRS • AS	• WRS • AS	• WRS • AS	• WRS • AS	• WRS • AS	Unconditional
HOTEL	• WRS • AS	• WRS • AS	• WRS • AS	• WRS • AS	• WRS • AS	• WRS • AS	• WRS • AS	Unconditional
LABOR ACCOMMODATION	• DRS	• WRS	• DRS • AS	• WRS • AS	• DRS	• WRS • AS	• WRS • AS	• Total Area of largest compartment is more than 1860 m ²

Table 9.1: Building Classification and Application of Fire Protection Systems

LOCATION	LARGEST FLOOR / SINGLE LARGEST COMPARTMENT AREA LESS THAN OR EQUAL TO 900 M ²	LARGEST FLOOR / SINGLE LARGEST COMPARTMENT AREA MORE THAN 900 M ²	LOW DEPTH UNDERGROUND BUILDING WITH LESS THAN OR EQUAL TO 2 BASEMENTS AND BASEMENT AREA LESS THAN OR EQUAL TO 900 M ²	HIGH DEPTH UNDERGROUND BUILDING WITH MORE THAN 2 BASEMENTS OR BASEMENT AREA MORE THAN 900 M ²	LOWRISE BUILDING WITH HEIGHT LESS THAN OR EQUAL TO 15 M	MIDRISE BUILDING WITH HEIGHT 15 M TO 23 M	HIGHRISE BUILDING WITH HEIGHT MORE THAN 23 M	SPRINKLER SYSTEM IS REQUIRED IF FOLLOWING CONDITION EXISTS (See Chapter 1 Table 1.7 for reference)
MERCANTILE	• DRS	• WRS	• DRS • AS	• WRS • AS	• DRS	• WRS • AS	• WRS • AS	• Total Area of largest compartment is more than 1115 M ²
MULTIPLE AND MIXED OCCUPANCIES	• DRS	• WRS • AS	• DRS • AS	• WRS • AS	• DRS • AS	• WRS • AS	• WRS • AS	
RESIDENTIAL APARTMENT	• DRS	• WRS	• DRS • AS	• WRS • AS	• DRS	• WRS	• WRS • AS	
STAFF ACCOMMODATION AND LODGING/ROOMING HOUSE	• DRS	• WRS	• DRS • AS	• WRS • AS	• DRS	• WRS • AS	• WRS • AS	
VILLAS - PRIVATE	• IT IS RECOMMENDED TO THE OWNER TO PROVIDE DOMESTIC SPRINKLER SYSTEM • FE				• IT IS RECOMMENDED TO THE OWNER TO PROVIDE DOMESTIC SPRINKLER SYSTEM • FE	• AS	• AS	• Area is more than 1115 M ²
VILLAS – COMMERCIAL GROUP	• YFH	• YFH	• YFH • AS	• WRS • AS • YFH	• YFH	• YFH	• WRS • AS • YFH	

Table 9.1: Building Classification and Application of Fire Protection Systems

LOCATION	LARGEST FLOOR / SINGLE LARGEST COMPARTMENT AREA LESS THAN OR EQUAL TO 900 M ²	LARGEST FLOOR / SINGLE LARGEST COMPARTMENT AREA MORE THAN 900 M ²	LOW DEPTH UNDERGROUND BUILDING WITH LESS THAN OR EQUAL TO 2 BASEMENTS AND BASEMENT AREA LESS THAN OR EQUAL TO 900 M ²	HIGH DEPTH UNDERGROUND BUILDING WITH MORE THAN 2 BASEMENTS OR BASEMENT AREA MORE THAN 900 M ²	LOWRISE BUILDING WITH HEIGHT LESS THAN OR EQUAL TO 15 M	MIDRISE BUILDING WITH HEIGHT 15 M TO 23 M	HIGHRISE BUILDING WITH HEIGHT MORE THAN 23 M	SPRINKLER SYSTEM/YFH IS REQUIRED IF FOLLOWING CONDITION EXISTS (See Chapter 1, Table 1.7 for reference)
WAREHOUSES AND FACTORIES WITH SINGLE-TENANT AND WITH LOW HAZARD COMMODITIES, ACTIVITY AS PER CHAPTER 13, LIST A.	• DRS	• WRS • AS	• DRS • AS	• WRS • AS	• DRS	• WRS • AS	• WRS • AS	• Total area is more than 2230 m² • YFH if Total Plot area of distributed group of warehouses & Factories with class I commodities or Activities as per List A, is more than 3600 m²
SINGLE STORIED, MULTI-TENANT, GROUP OF WAREHOUSES & FACTORIES HAVING LOW HAZARD COMMODITIES/ ACTIVITIES (See Chapter 13, List A)	• See Chapter 13, Figure 13 A.1/ 13A.2/ 13A. 3	• WRS • AS	• WRS • AS	• WRS • AS	• WRS • AS	• WRS • AS	• WRS • AS	• See Chapter 13, Figure 13 A.1/ 13A.2/ 13A. 3
MULTI STORIED, MULTI-TENANT, GROUP OF WAREHOUSES & FACTORIES HAVING LOW HAZARD COMMODITIES/ ACTIVITIES (See Chapter 13, List A)	• See Chapter 13, Figure 13 A.1/ 13A.2/ 13A. 3	• WRS • AS	• WRS • AS	• WRS • AS	• WRS • AS	• WRS • AS	• WRS • AS	• See Chapter 13, Figure 13 A.1/ 13A.2/ 13A. 3

Table 9.2: Auxiliary Rooms and Acceptable Fire Protection Systems

Table 9.2: Auxiliary Rooms and Selection of Fire Protection Systems									
LOCATION	ACCEPTABLE AND APPLICABLE FIRE SUPPRESSION SYSTEMS								
Anesthetizing Rooms	• AS			• PAS					
Battery Charger Rooms		• CAS		• PAS					
BMS Rooms		• CAS		• PAS					
Battery Rooms		• CAS		• PAS					
Closets having heaters, dryers, furnaces	• AS					• WMS			
Cold Rooms				• PAS					
Computer Rooms		• CAS							
Control Rooms		• CAS		• PAS					
Diesel Generators					• FSS	• WMS	• WSS		
Diesel Storage Tanks						• WMS	• WSS		
Electrical Rooms		• CAS		• PAS					
Equipment/ AHU Rooms	• AS								
Garbage Rooms	• AS								
Generator Rooms					• FSS	• WMS	• WSS		
Gymnasium	• AS								
HV/LV Rooms		• CAS							
Laboratories with Flammable Liquids					• FSS	• WMS			
Laundries	• AS								
Lift Machine Rooms				• PAS					
LPG Tanks					• FSS	• WMS	• WSS		
Main Telephone Rooms		• CAS		PAS					
Medical Gas Storage	• AS								
Pump Rooms	• AS								
School Laboratories	• AS								
Server Rooms		• CAS		• PAS					
Soiled Linen Rooms	• AS								
Store Rooms	• AS								
Swimming Pools									• FHS
Transformer Rooms									• WSS

Table 9.3: Location and Selection of Fire Protection Systems for Industrial Occupancies

LOCATION	TOTAL FLOOR AREA LESS THAN OR EQUAL TO 900 M ²	TOTAL FLOOR AREA MORE THAN 900 M ²	ANY BUILDING WITH BASEMENT/S	SUPPRESSION SYSTEM IS REQUIRED IF FOLLOWING CONDITION EXISTS (See Chapter 1, Table 1.7 for reference)	BUILDINGS WITH MORE THAN 3 FLOORS OR HEIGHT MORE THAN 15 M	PROTECTION REQUIRED WITHOUT ANY CRITERIA	SYSTEMS SHALL BE BASED ON RISK ANALYSIS REPORT
Air Compressor/Rooms	• DRS	• WRS • AS	• WRS • AS		• WRS • AS		
Arms and Ammunition Factories							• Suppression systems shall be based on risk analysis
Bakeries	• DRS	• WRS	• WRS • AS	• Area of Largest Compartment is more than 900 m ² • Total Floor area is more than 2230 m ²	• WRS • AS		
Battery rooms,				If area is more than 16 Sq m.		• CAS	
Beverage, tobacco, essential oil industry.	• DRS	• WRS	• WRS • AS	• Area of Largest Compartment is more than 900 m ² • Total Floor area is more than 2230 m ²	• WRS • AS		
Boiler and Combustion						• WRS • AS	
Cable Spread/ Cable tunnel	• DRS • WMS	• WRS • WMS	• WRS • AS		• WRS • AS	• WRS • AS	
Canneries	• DRS	WRS	• WRS • AS	• Area of Largest Compartment is more than 900 m ² • Total Floor area is more than 2230 m ²	• WRS • AS		
Chemical, plastic, petroleum industry.							• Suppression systems shall be based on risk analysis
Cooling Towers – Counter Flow							• Suppression



Table 9.3: Location and Selection of Fire Protection Systems for Industrial Occupancies

LOCATION	TOTAL FLOOR AREA LESS THAN OR EQUAL TO 900 M ²	TOTAL FLOOR AREA MORE THAN 900 M ²	ANY BUILDING WITH BASEMENT/S	SUPPRESSION SYSTEM IS REQUIRED IF FOLLOWING CONDITION EXISTS (See Chapter 1, Table 1.7 for reference)	BUILDINGS WITH MORE THAN 3 FLOORS OR HEIGHT MORE THAN 15 M	PROTECTION REQUIRED WITHOUT ANY CRITERIA	SYSTEMS SHALL BE BASED ON RISK ANALYSIS REPORT
							systems shall be based on risk analysis
Cooling Towers – Cross Flow							• Suppression systems shall be based on risk analysis
Dairy products manufacturing	• DRS	WRS	• WRS • AS	- Area of Largest Compartment is more than 900 m² - Total Floor area is more than 2230 m²	- WRS - AS		
Diesel Generators						- FSS - WMS	
Dry Cleaning Plants	• DRS	WRS	• WRS • AS	- Area of Largest Compartment is more than 900 m² - Total Floor area is more than 2230 m² - Also depends on the Class of the solvents.			
Electric Equipment						- WRS - CAS - WMS	
Electrical Rooms, Telephone Rooms				If area is more than 16 Sq m		- WRS - CAS - WMS	
Electronic Plants				- Area of Largest Compartment is more than 900 m² - Total Floor area is more than 2230 m²			• Suppression systems shall be based on risk analysis
Equipment/ AHU Rooms	DRS	WRS	WRS, AS				

Table 9.3: Location and Selection of Fire Protection Systems for Industrial Occupancies

LOCATION	TOTAL FLOOR AREA LESS THAN OR EQUAL TO 900 M ²	TOTAL FLOOR AREA MORE THAN 900 M ²	ANY BUILDING WITH BASEMENT/S	SUPPRESSION SYSTEM IS REQUIRED IF FOLLOWING CONDITION EXISTS (See Chapter 1, Table 1.7 for reference)	BUILDINGS WITH MORE THAN 3 FLOORS OR HEIGHT MORE THAN 15 M	PROTECTION REQUIRED WITHOUT ANY CRITERIA	SYSTEMS SHALL BE BASED ON RISK ANALYSIS REPORT
Factories of all kinds with use of Flammable Liquids, Gases and Metals				²			Suppression systems shall be based on risk analysis
Factories of all kinds without material or Activities as mentioned in List A, Chapter 13.	• DRS	WRS	- WRS - AS	- Area of Largest Compartment is more than 232 m² - Total Floor area is more than 900 m²	- WRS - AS		
Food industry.	• DRS	WRS	- WRS - AS	- Area of Largest Compartment is more than 900 m² - Total Floor area is more than 2230 m²	- WRS - AS		
Footwear, wearing apparel, leather, rubber industry	• DRS	WRS	- WRS - AS	- Area of Largest Compartment is more than 232 m² - Total Floor area is more than 900 m²	- WRS - AS		
Fuel Handling-Coal	• DRS	WRS	- WRS - AS		- WRS - AS		
Fuel Handling-Gas-Indoor							Suppression systems shall be based on risk analysis
Fuel Handling-Gas-Outdoor							Suppression systems shall be based on risk analysis
Fuel Handling-Oil							Suppression systems shall be based on risk analysis
Furnaces	• DRS	WRS	- WRS - AS		- WRS - AS		
Garages	• DRS	WRS	• WRS	Area of Largest Compartment is more than 900 m ²	• WRS		

Table 9.3: Location and Selection of Fire Protection Systems for Industrial Occupancies

LOCATION	TOTAL FLOOR AREA LESS THAN OR EQUAL TO 900 M ²	TOTAL FLOOR AREA MORE THAN 900 M ²	ANY BUILDING WITH BASEMENT/S	SUPPRESSION SYSTEM IS REQUIRED IF FOLLOWING CONDITION EXISTS (See Chapter 1, Table 1.7 for reference)	BUILDINGS WITH MORE THAN 3 FLOORS OR HEIGHT MORE THAN 15 M	PROTECTION REQUIRED WITHOUT ANY CRITERIA	SYSTEMS SHALL BE BASED ON RISK ANALYSIS REPORT
			• AS		• AS	• WRS • FSS • WMS	
Generator Rooms	• DRS	WRS	• WRS • FSS • WMS				
Glass Manufacturing	• DRS	WRS	• WRS • AS	- Area of Largest Compartment is more than 900 m² - Total Floor area is more than 2230 m²			
Hangers (Servicing & Maintenance	• DRS	WRS	• FSS • WMS	- Area of Largest Compartment is more than 900 m² - Total Floor area is more than 2230 m²			
HV/LV Rooms						CAS	
Incineries/ Waste Treatment	• DRS	WRS	• WRS • AS	- Area of Largest Compartment is more than 900 m² - Total Floor area is more than 2230 m²			
Laundries	• DRS	WRS	• WRS • AS				
LPG Tanks	• DRS	WRS	• WSS • WMS			• WSS • WMS	
Metal, metal products industry- (Alkali Metals) Water reactive				- Area of Largest Compartment is more than 900 m² - Total Floor area is more than 2230 m² - Water suppression system is not applicable			Suppression systems shall be based on risk analysis
Metal, metal products industry- Non water reactive	• DRS	WRS	• WRS • AS	- Area of Largest Compartment is more than 900 m² - Total Floor area is more than 2230 m²			
Oxidizing Material Handling							• Suppression systems shall

Table 9.3: Location and Selection of Fire Protection Systems for Industrial Occupancies

LOCATION	TOTAL FLOOR AREA LESS THAN OR EQUAL TO 900 M ²	TOTAL FLOOR AREA MORE THAN 900 M ²	ANY BUILDING WITH BASEMENT/S	SUPPRESSION SYSTEM IS REQUIRED IF FOLLOWING CONDITION EXISTS (See Chapter 1, Table 1.7 for reference)	BUILDINGS WITH MORE THAN 3 FLOORS OR HEIGHT MORE THAN 15 M	PROTECTION REQUIRED WITHOUT ANY CRITERIA	SYSTEMS SHALL BE BASED ON RISK ANALYSIS REPORT
							be based on risk analysis
Paint and Varnish Factories				2			Suppression systems shall be based on risk analysis
Plastic Processing	• DRS	WRS	FSS	- Area of Largest Compartment is more than 900 m² - Total Floor area is more than 2230 m²			
Pumping Stations	• DRS	WRS	- WRS - AS				
Radiant material handling							Suppression systems shall be based on risk analysis
Rubber Processing	• DRS	WRS	FSS	- Area of Largest Compartment is more than 900 m² - Total Floor area is more than 2230 m²			
Saw Mills	• DRS	WRS	- WRS - AS	- Area of Largest Compartment is more than 900 m² - Total Floor area is more than 2230 m²			
Spray Painting Processes	• DRS	WRS	FSS			FSS	
Steam Generators	• DRS	WRS	- WRS - AS			- CAS - WSS - WMS	

Table 9.3: Location and Selection of Fire Protection Systems for Industrial Occupancies

LOCATION	TOTAL FLOOR AREA LESS THAN OR EQUAL TO 900 M ²	TOTAL FLOOR AREA MORE THAN 900 M ²	ANY BUILDING WITH BASEMENT/S	SUPPRESSION SYSTEM IS REQUIRED IF FOLLOWING CONDITION EXISTS (See Chapter 1, Table 1.7 for reference)	BUILDINGS WITH MORE THAN 3 FLOORS OR HEIGHT MORE THAN 15 M	PROTECTION REQUIRED WITHOUT ANY CRITERIA	SYSTEMS SHALL BE BASED ON RISK ANALYSIS REPORT
Switchgear and Relay Rooms				If area is more than 16 Sq m		CAS • WSS • WMS •	
Telephone Exchanges	• FE	• CAS	• CAS	- Area of Largest Compartment is more than 232 m² - Total Floor area is more than 900 m²			
Textile industry.	• DRS	• WRS	- WRS - AS	- Area of Largest Compartment is more than 900 m² - Total Floor area is more than 2230 m²			
Transformer Rooms						- CAS - WSS - WMS	
Turbines						Suppression systems shall be based on risk analysis	
Vehicle assembly, manufacture.	• DRS	• WRS	- WRS - AS	- Area of Largest Compartment is more than 900 m² - Total Floor area is more than 2230 m²			
Wood, furniture, paper, printing industry	• DRS	• WRS	- WRS - AS	- Area of Largest Compartment is more than 232 m² - Total Floor area is more than 900 m²			
Workshops	• DRS	• WRS	- WRS - AS				

Table 9.4: Location and Selection of Fire Protection Systems for Storage Occupancies

Table 9.4: Location and Selection of Fire Protection Systems for Storage Occupancies							
LOCATION	TOTAL FLOOR AREA LESS THAN OR EQUAL TO 900 M ²	TOTAL FLOOR AREA MORE THAN 900 M ²	ANY BUILDING WITH BASEMENT/S	SUPPRESSION SYSTEM IS REQUIRED IF FOLLOWING CONDITION EXISTS (See Chapter 1, Table 1.7 for reference)	BUILDINGS WITH MORE THAN 3 FLOORS OR HEIGHT MORE THAN 15 M	PROTECTION REQUIRED WITHOUT ANY CRITERIA	SYSTEMS SHALL BE BASED ON RISK ANALYSIS REPORT
Low Hazard Storage	• DRS	• WRS	• WRS • AS				
High Hazard Storage							• Suppression systems shall be based on risk analysis
Warehouses and Factories	REFER TO TABLE 9.1						
Barns	• DRS	• WRS		Area > 900 Sq m.			• Suppression systems shall be based on risk analysis
Bulk Oil Storage							• Suppression systems shall be based on risk analysis
Bulk Storage of Flammable Liquids							• Suppression systems shall be based on risk analysis
Bulk Storage of Flammable Gases							• Suppression systems shall be based on risk analysis
Bulk Storage of Explosive Material							• Suppression systems shall be based on risk analysis
Cold Storage	• DRS	• WRS		Area > 900 Sq m.		• WRS • PAS	
Hangers (Storage Only)						• WRS • AS, WMS	
Freight Terminals						• WRS • AS, WMS	
Grain elevators						• WRS • AS	

Table 9.4: Location and Selection of Fire Protection Systems for Storage Occupancies

LOCATION	TOTAL FLOOR AREA LESS THAN OR EQUAL TO 900 M ²	TOTAL FLOOR AREA MORE THAN 900 M ²	ANY BUILDING WITH BASEMENT/S	SUPPRESSION SYSTEM IS REQUIRED IF FOLLOWING CONDITION EXISTS (See Chapter 1, Table 1.7 for reference)	BUILDINGS WITH MORE THAN 3 FLOORS OR HEIGHT MORE THAN 15 M	PROTECTION REQUIRED WITHOUT ANY CRITERIA	SYSTEMS SHALL BE BASED ON RISK ANALYSIS REPORT
Parking Structures -enclosed		• WRS • AS			• WRS • AS		
Parking Structures -Open	• DRS	• WRS					
Parking Structures –Robotic/Automated		• WRS • FSS			• WRS • FSS		
Stables	• DRS	• WRS		• Total Floor area is more than 2230 m ²			
Truck Terminals	• DRS	• WRS				• WRS	• Suppression systems shall be based on risk analysis
Marine Terminals	• DRS	• WRS • AS				• WRS	• Suppression systems shall be based on risk analysis
Group of Warehouses and Factories with multi tenants	• REFER TO CHAPTER 13, FIRE SAFETY REQUIREMENT FOR MULTI TENANT WAREHOUSE AND FACTORIES REQUIREMENT						



4. DESIGN REQUIREMENTS

4.1. Dry Riser Systems

- 4.1.1.** Dry riser system shall be provided in occupancies and criteria as mentioned in [Table 9.1](#), [Table 9.3](#) and [Table 9.4](#)

4.2. Fire Hose Station locations

- 4.2.1.** Class III fire hose stations which are combination of class I & Class II hose connections, shall be located preferably inside the stair enclosure at typical floors and beside the exit ways at ground floor. (Also See Chapter 2., section 15.6)
- 4.2.2.** The Fire Hose Station should be clearly visible beside the exit way or stairway. Additional fire hose stations along the exit access corridor, horizontal exit or in the car park floors shall be installed such that all portions of each floor are within 30 m from the fire hose station while measured along the natural path of travel from the hose station.
- 4.2.3.** The landing valve shall be installed at a height of not less than 900 mm and not more than 1200 mm from the finished floor level while the fire hose reel or Fire hose rack shall be installed at a height of not less than 1200 mm and not more than 1500 mm from the finished floor level.

4.3. Flow & Pressure Requirements

- 4.3.1.** Maximum residual pressure at any point within the Class II system shall not exceed 12 bar. The minimum flow and residual pressure required at the hydraulically remotest and /or top most 25 mm fire hose reel outlet shall be not less than 6.5 GPM at 6 bar.
- 4.3.2.** Maximum residual pressure at any point within the Class II system shall not exceed 12 bar. The minimum flow and residual pressure required at the hydraulically remotest and /or top most 40 mm fire hose rack outlet shall be not less than 100 GPM at 6 bar.
- 4.3.3.** Maximum residual pressure at any point within the Class I system shall not exceed 12 bar. The minimum flow and residual pressure required at the hydraulically remotest and /or top most fire hose outlet shall be not less than 250 GPM at 6.9 bar. If the residual pressure exceeds 7 bar at the fire hose connection, an approved pressure reducing valve shall be introduced to restrict the pressure to 7 bar.

4.4. Fire water demand & Hydraulic Calculations

- 4.4.1.** The Fire water demand for the fire fighting system for occupancies having floor area less than 900 m² shall be calculated based on the flow rates of fire hose outlets installed in the system.
- 4.4.2.** The minimum flow rate at hydraulically most remote 25 mm dia hose reel shall be 6.5 GPM at the residual pressure of 6 bar and for the hydraulically remotest 40 mm



dia hose rack valve shall be 100 GPM at the residual pressure of 6 bar. Hydraulic calculations shall be performed to determine the fire water demand, pressure and pipe sizes required for hose reel system installed.

4.5. Pipe Sizes

- 4.5.1. The minimum pipe size for serving a single fire hose reel shall not be less than 25 mm dia and the pipe line serving two or more hose reels shall not be less than 50 mm dia.
- 4.5.2. The minimum pipe size of each dry riser shall be not less than 100 mm dia while the branches for a Landing valve shall be not less than 65 mm dia.
- 4.5.3. In case of horizontal dry riser pipelines, the minimum pipe sizes for serving a single 65 mm dia hose valve shall be not less than 65 mm dia and the pipe line serve two or more hose valve shall be not less than 100 mm diameter.

4.6. Fire Pump set

- 4.6.1. Fire Pump shall be located at the lowest level of the building, pumping water upwards. Fire pumps at levels higher than the lowest level of the building with water supply feeding downwards is not allowed.
- 4.6.2. Fire pump set for buildings required to have Dry Riser System shall consists of one Main Electric Pump and one standby Diesel driven pump having minimum flow of 100 GPM with pressure requirements according to the hydraulic calculations.

4.7. Fire Water tanks

- 4.7.1. Fire water shall be stored in a permanent water tank having two compartments or in two interconnected tanks with total effective fire water reserve to cater the pumping demand of not less than 60 minutes of fire pump set capacity.
- 4.7.2. The fire water tanks shall be provided with a filling connection directly from DEWA line with a float operated valve for automatic refilling. The tanks shall be provided with drain arrangement, overflow connection, level indicators, low level switch, and other necessary accessories.
- 4.7.3. Fire water tanks shall be located and constructed such that the fire pump set gets flooded water supply in case of fire pumps are horizontal centrifugal type.
- 4.7.4. Where the situation does not permits to provide flooded water supply, negative suction arrangement is permitted for fire hose reel pump set by providing an automatic priming arrangement complete priming tank & accessories as required.

4.8. Civil Defence Breeching Inlets

- 4.8.1. Dry riser stand pipe system shall be terminated to a 2-way breeching inlet connection having 100 mm dia flanged outlet with 2 nos of 65 mm dia instantaneous male coupling inlets, located at Fire Access level for Civil Defence. Civil defence breeching inlets shall be located in an easily accessible, visible location, especially at



front side of the buildings at ground level within 18 mtrs from the civil defence vehicle approach road. (See Chapter 2 for details)

4.9. Wet Riser Systems

- 4.9.1.** Wet Riser Systems shall be provided with Class III system. Class III system fire hose station shall consists of a 25 mm fire hose reel or 40 mm fire hose rack & 65 mm dia landing valve with hoses & nozzles. Hose stations shall be located preferably inside stair enclosure at typical floors and beside each exit way at the ground floor. (Also see Chapter 2. Section 15.6)
- 4.9.2.** Additional fire hose station along the exit access corridor or horizontal exit or in the car park floors shall be installed such that all portions of each floor are within 30 m from the fire hose station while measured along the natural path travel from the hose station.
- 4.9.3.** The landing valve shall be installed at a height of not less than 900 mm and not more than 1200 mm from the finished floor level while the fire hose reel shall be installed at a height of not less than 1200 mm and not more than 1500 mm from the finished floor level.
- 4.9.4.** Additionally a roof manifold consisting of 3 nos of 65 mm dia landing valve outlets shall be provided at the topmost point (at roof level) of hydraulically remotest standpipe riser for testing purposes.



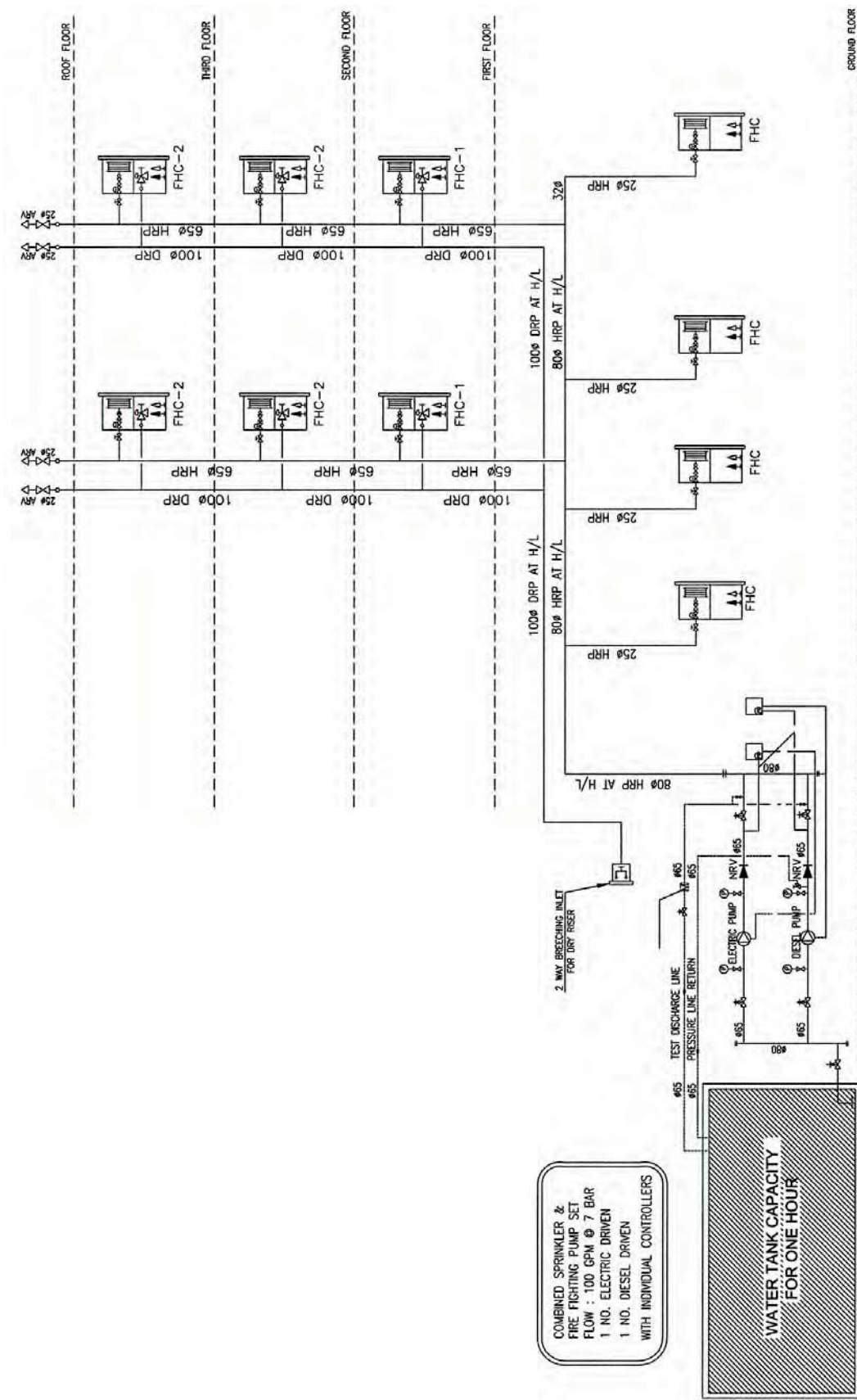


Figure 9.1:
Example 1: Typical Arrangement of Dry Riser with Fire Hose Reel System



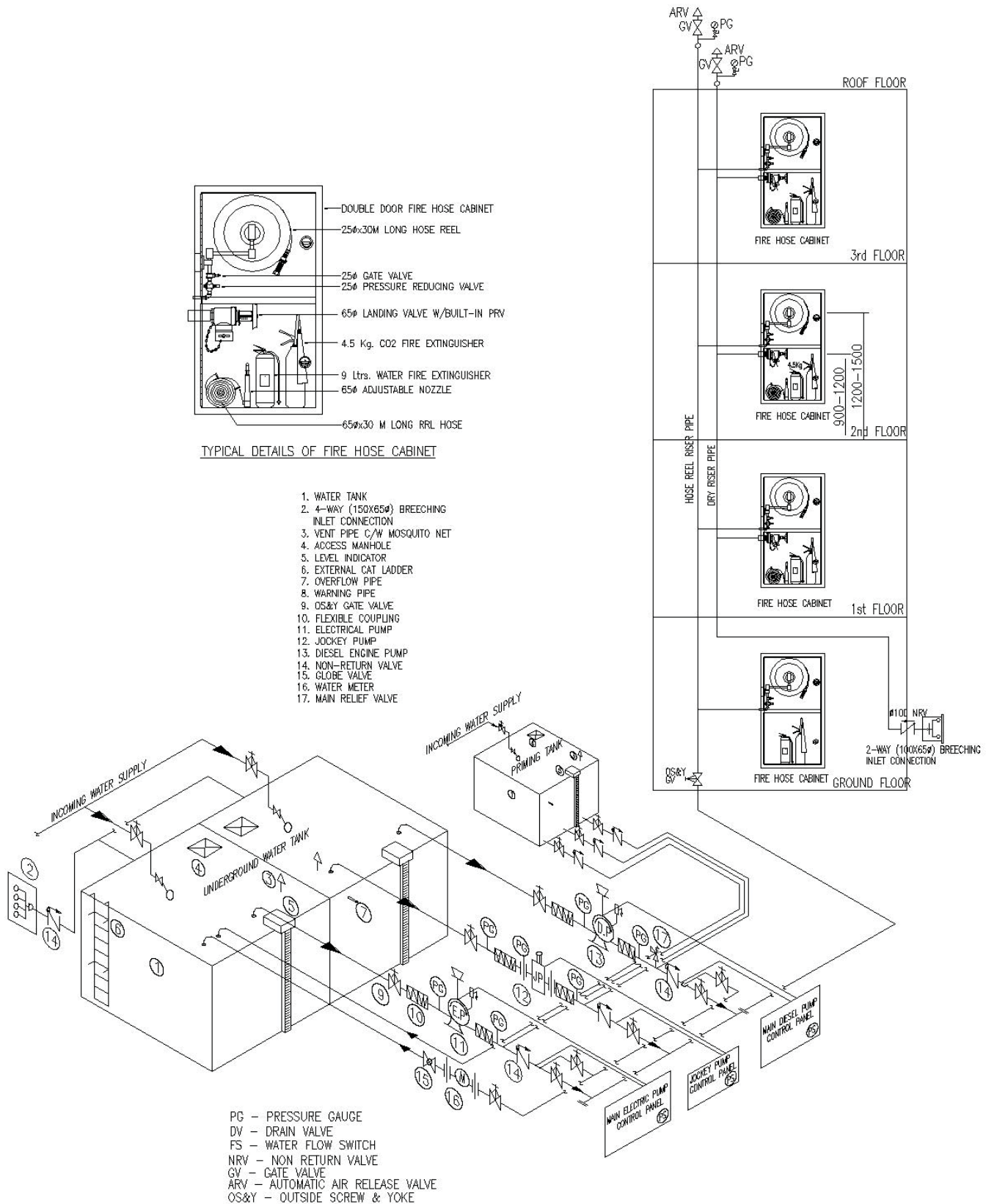


Figure 9.2:
Example2: Typical schematic of Fire Pump, Dry riser with Fire Hose Reel System with Priming Tank



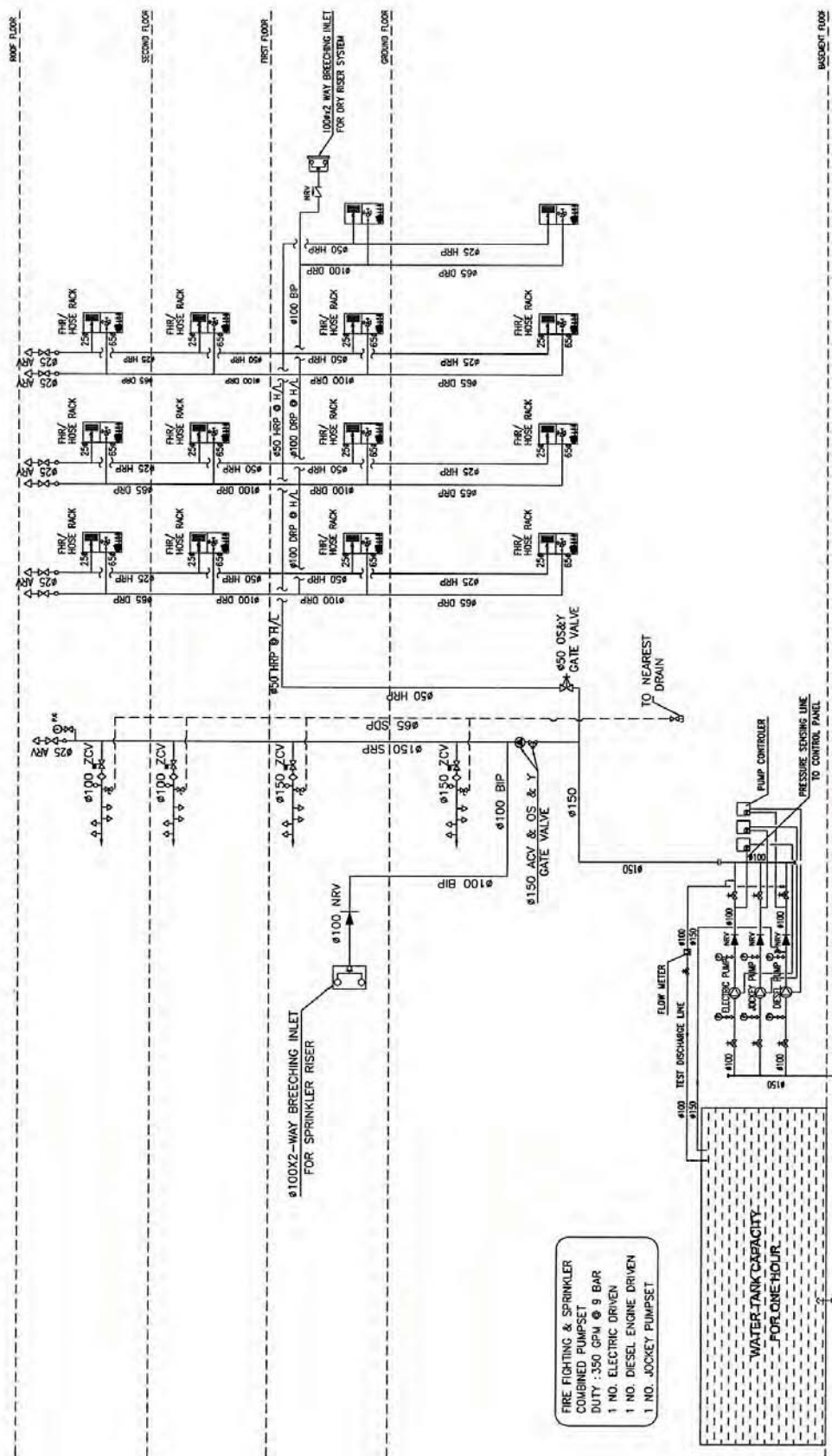


Figure 9.3:
Example 3: Typical schematic of Sprinkler provision along with Dry riser and
Fire Hose Reel System



4.10. Flow & Pressure Requirements

- 4.10.1.** Where two or more wet risers are installed in a system, all wet risers shall be interconnected at the bottom of the risers.
- 4.10.2.** Maximum pressure at any point within the fire hose reel system shall not exceed 12 bar. The minimum flow & residual pressure required at the hydraulically remotest and / or top most fire hose reel shall be not less than 6.5 GPM at 4.5 bar and If the residual pressure exceeds 7 bar at the fire hose reel connection, an approved pressure reducing valve (PRV) shall be introduced to restrict the pressure to 7 bar.
- 4.10.3.** The minimum flow & residual pressure required at the hydraulically remotest and /or top most 65 mm dia Landing valve shall be not less than 250 GPM at 6.9 bar. Maximum residual pressure at any 65mm dia Landing valve outlet shall not exceed 12 bar. If the residual pressure exceeds 7 bar at the landing valve outlet, the Landing valve shall be of built in pressure regulating type to restrict the pressure to 7 bar.
- 4.10.4.** If static pressure at any Landing valve exceeds 12 bar, an approved pressure reducing valve (PRV) station shall be introduced to restrict the static & residual pressure within 12 bar.
- 4.10.5.** Pressure reducing valve station shall consist of by-pass arrangement having all equipments & accessories same as in the main connection as shown in **Figure 9.4** below. The rated working pressure of all devices including pressure reducing valve installed on upstream side of PRV shall be higher than the inlet pressure of PRV station.

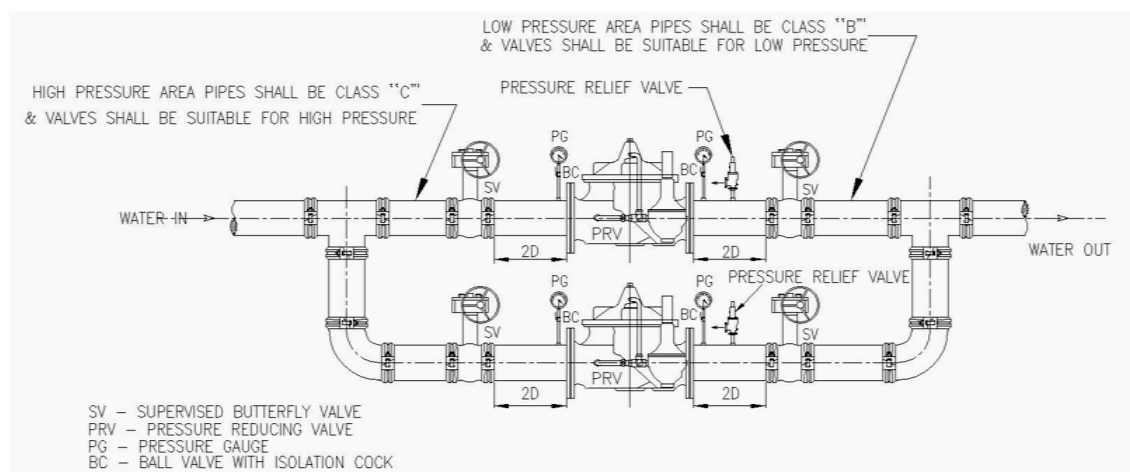


Figure 9.4: Typical Arrangement of Pressure Reducing Valve (PRV) Stations in Fire Fighting System.





4.11. Zoning of Wet riser system:

- 4.11.1.** Multiple wet risers' zoning system shall be established in high rise buildings where pressure reducing valve station is utilized with single fire pump set instead of multiple pumping station, to restrict pressure limit with in 12 bar at any Landing valve outlet. Refer the **Figure 9.6** which shows typical arrangement of multiple wet riser zones with single fire pump set.
- 4.11.2.** However, the pressure at any point of wet riser system shall not exceed 24 bar at any point of time with Fire Pump set to cut-off at 140% of rated operational pressure.
- 4.11.3.** If pressure exceeds this limit, multiple fire pumping stations complete with dedicated fire water tanks for each pumping station shall be provided. Refer to **Figure 9.7**.

4.12. Fire Water Demand

- 4.12.1.** The Fire water demand shall be calculated based on the flow rates of landing valves and fire hose reels or racks installed in the wet riser system. The minimum flow rate at the hydraulically remotest 65 mm dia landing valve in a wet riser shall be not less than 250 GPM at the residual pressure of 7 bar.
- 4.12.2.** The minimum flow rate at hydraulically remotest 25 mm dia hose reel in a fire fighting system shall be 6.5 GPM at the residual pressure of 4.5 bar and for the hydraulically remotest 40 mm dia hose valve in a fire fighting system shall be 100 GPM at the residual pressure of 4.5 bar.
- 4.12.3.** The minimum flow rate of class I & class III hydraulically remotest vertical wet riser system shall be not less than 500 GPM while the horizontal wet riser system where there are 3 or more landing valves, the minimum flow rate shall be not less than 750 GPM.
- 4.12.4.** The minimum flow rate for each additional standpipe shall be 250 GPM with total demand need not exceed more than 1250GPM or 1000 GPM if the building is fully protected by an automatic sprinkler system.



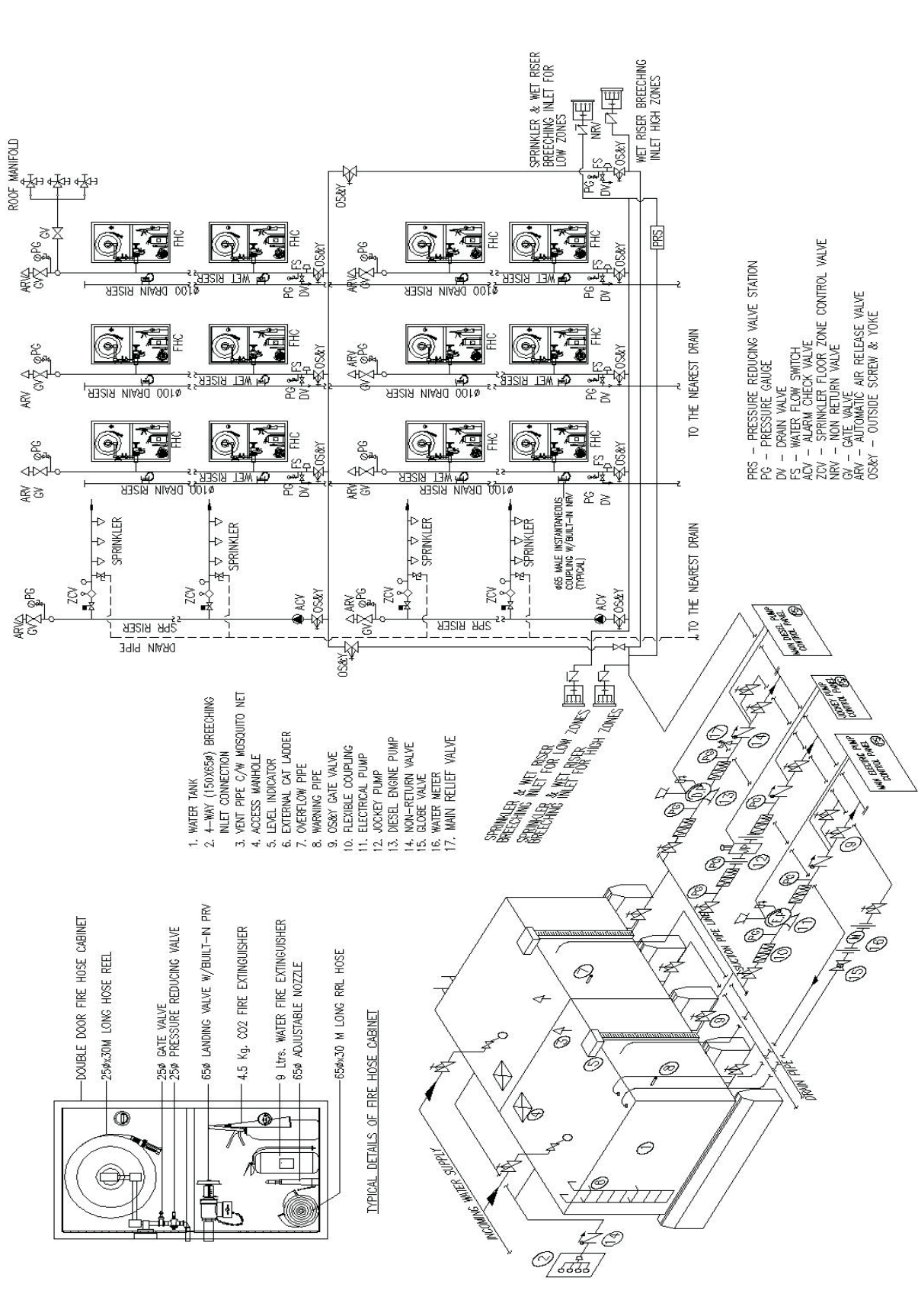


Figure 9.6:
Typical Arrangement of Two Zone Wet Riser System for High Rise Buildings.



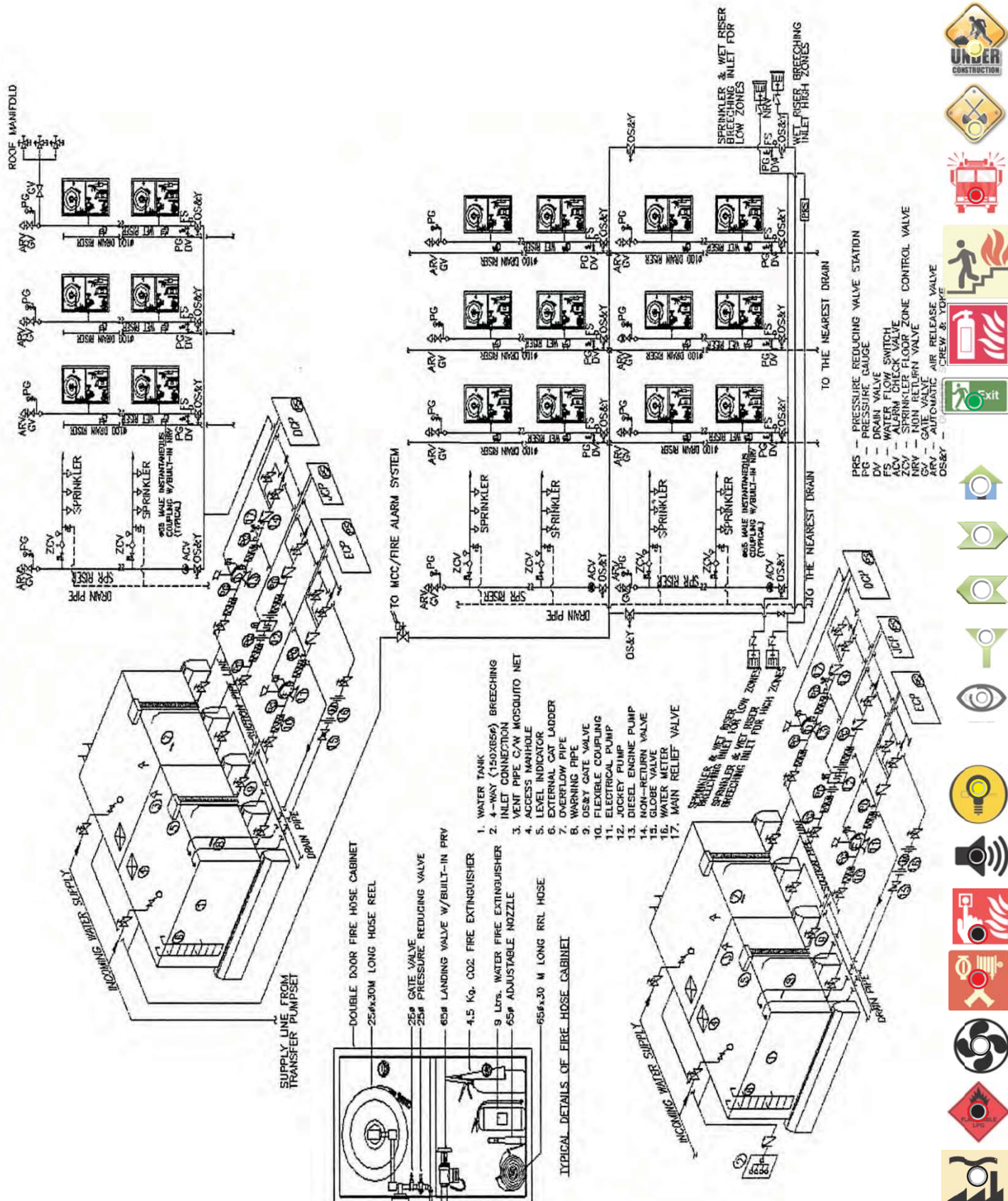


Figure 9.7: Typical Arrangement of Multiple Zones Wet Riser System for High Rise Buildings. Example 1.

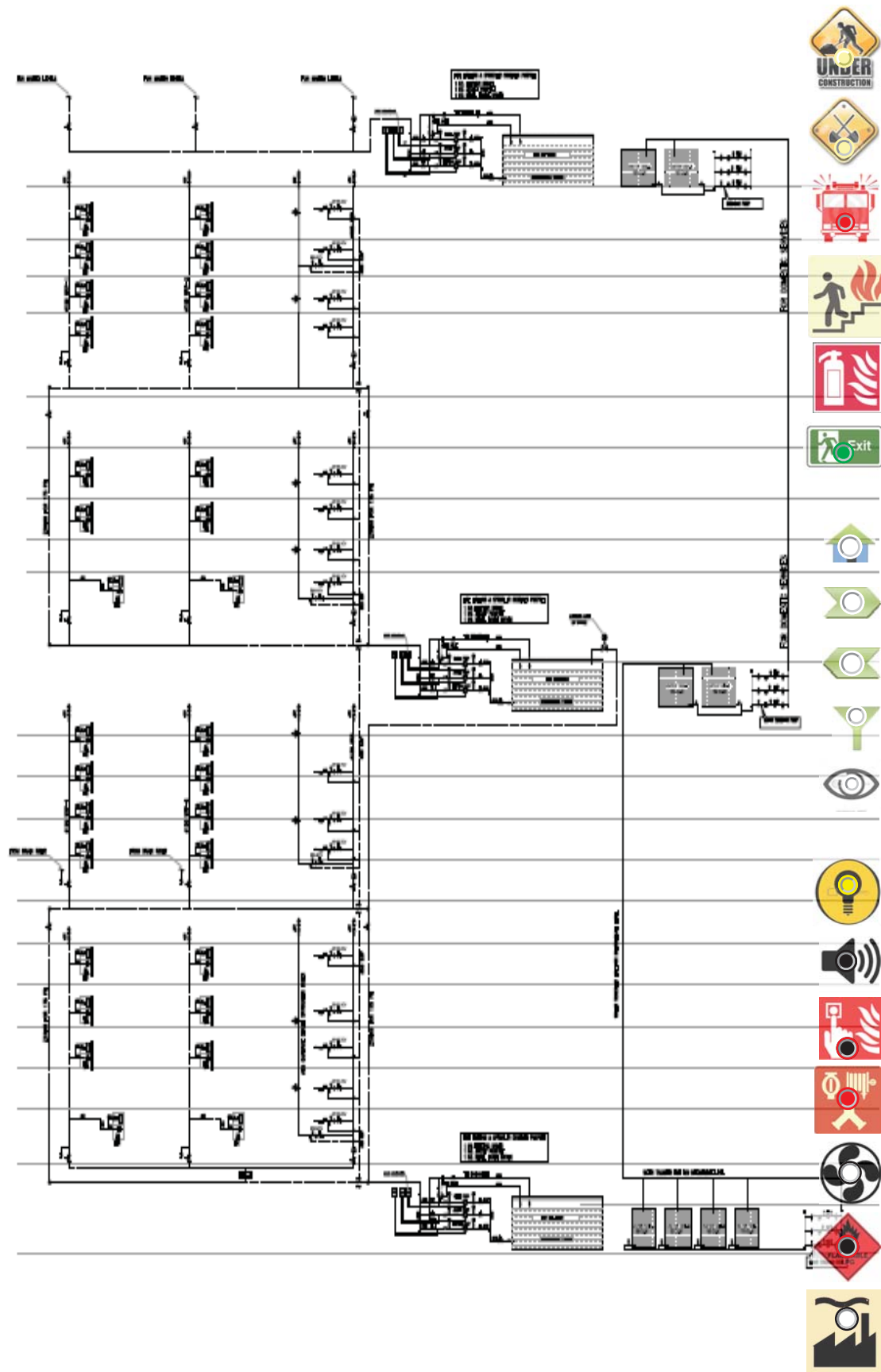


Figure 9.7A: Typical Arrangement of Multiple Zones Wet Riser System for High Rise Buildings.
Exale 2.

4.13. Combined System Water Demand

- 4.13.1.** If the fire water supply is combined for both sprinkler and wet riser stand pipe system, the fire water demand shall be established as follows.
- 4.13.2.** In the buildings fully protected by an automatic sprinkler system, the fire water demand as established in [section 4.12](#) for the wet riser system is permitted to serve sprinkler system without adding additional water demand to it.
- 4.13.3.** In the buildings partially or not protected by sprinkler system, the fire water demand as established in [section 4.12](#) for the wet riser system shall be increased by adding the hydraulically calculated sprinkler fire water demand to it.
- 4.13.4.** If the Hydraulically Calculated sprinkler system water demand including the hose stream allowance exceeds the wet riser water demand as established in [section 4.12](#), the larger of the two demand values shall be proposed.

4.14. Hydraulic Calculations

- 4.14.1.** Hydraulic calculations shall be performed to determine the fire water demand, pressure and pipe sizes required for a stand pipe system.
- 4.14.2.** The hydraulic calculation shall be performed using the Civil Defence listed and approved software based on following criteria:
 - i. Two numbers of Landing valves on top most point of the hydraulically most unfavorable wet riser providing 250 GPM flow at 7 bar per outlet and One Landing valve outlet on the topmost point of adjacent wet risers 250 GPM flow at 7 bar per outlet.
 - ii. If horizontal wet riser system provides supply for 3 or more landing valve outlets in a floor, the hydraulic calculation shall be based on 3 numbers of landing valve at remotest point of the hydraulically most unfavourable wet riser pipe providing 250 GPM flow at 7 bar per outlet and one fire department valve outlet at the topmost point of each adjacent wet riser pipes providing 250 GPM flow at 7 bar per outlet
- 4.14.3.** The total fire water demand need not exceed 1250 GPM in any case, to determine the common supply pipe which is feeding all the wet riser pipes.

4.15. Pipe Sizes

- 4.15.1.** The minimum pipe sizes shall be determined according to the hydraulic calculations. However, the minimum pipe size of each wet riser shall be not less than 150 mm dia while the branches for each Landing valve shall be not less than 65 mm dia.
- 4.15.2.** In case of horizontal wet riser pipe, the minimum pipe sizes for serving a single 65 mm dia Landing valve shall be not less than 65 mm dia and the pipe line which



serve two Landing valve shall be not less than 100 mm diameter and more than two shall be served by not less than 150 mm diameter.

- 4.15.3.** Water supply connection for fire hose reels can be tapped either directly from the 150 mm dia main wet riser or from the 65 mm dia branch line for landing valve.
- 4.15.4.** Feeder main pipes and riser pipes for wet riser system shall be independent from the sprinkler system piping. Common feeder main and riser piping shall not be permitted for wet riser and sprinkler system.

4.16. Fire Pump Sets

- 4.16.1.** Fire Pump shall be located at the lowest level of the building, pumping water upwards. Fire pumps at levels higher than the lowest level of the building with water supply feeding downwards is not allowed.
- 4.16.2.** In a typical wet riser system, the fire pump set shall consists of one Main Electric driven Pump, one standby Diesel driven pump and one Electric Jockey pump having minimum flow and pressure according to the hydraulic calculation to supply fire water demand of the system.
- 4.16.3.** Wherever pressure limitations and Hydraulic calculations demand for multiple pump sets, each pump set shall be separate, consisting of above mentioned group of pumps with separate Water tanks.

4.17. Fire Water tanks

- 4.17.1.** Fire water shall be stored in a water tank having two compartments or in two tanks with total effective fire water reserve to cater the pumping demand of not less than 60 minutes of fire pump set capacity. Fire water tank capacity shall be increased based on type of Hazard and Occupancies based on NFPA 13.
- 4.17.2.** The fire water tanks shall be provided with a filling connection directly from DEWA line with a float operated valve for automatic refilling.
- 4.17.3.** The fire water tanks shall be provided with drain arrangement, overflow connection, access manhole, ladders, level indicators, low level switch and other necessary accessories as required by the Civil Defence.
- 4.17.4.** Fire water tanks shall be constructed / located such that the fire pump sets gets flooded water supply in case of fire pumps are horizontal centrifugal type.
- 4.17.5.** Where the situation does not permits to provide flooded water supply arrangement, the tanks below the pumps may be acceptable by providing vertical turbine type fire pumps as shown in [Figure 9.8](#).



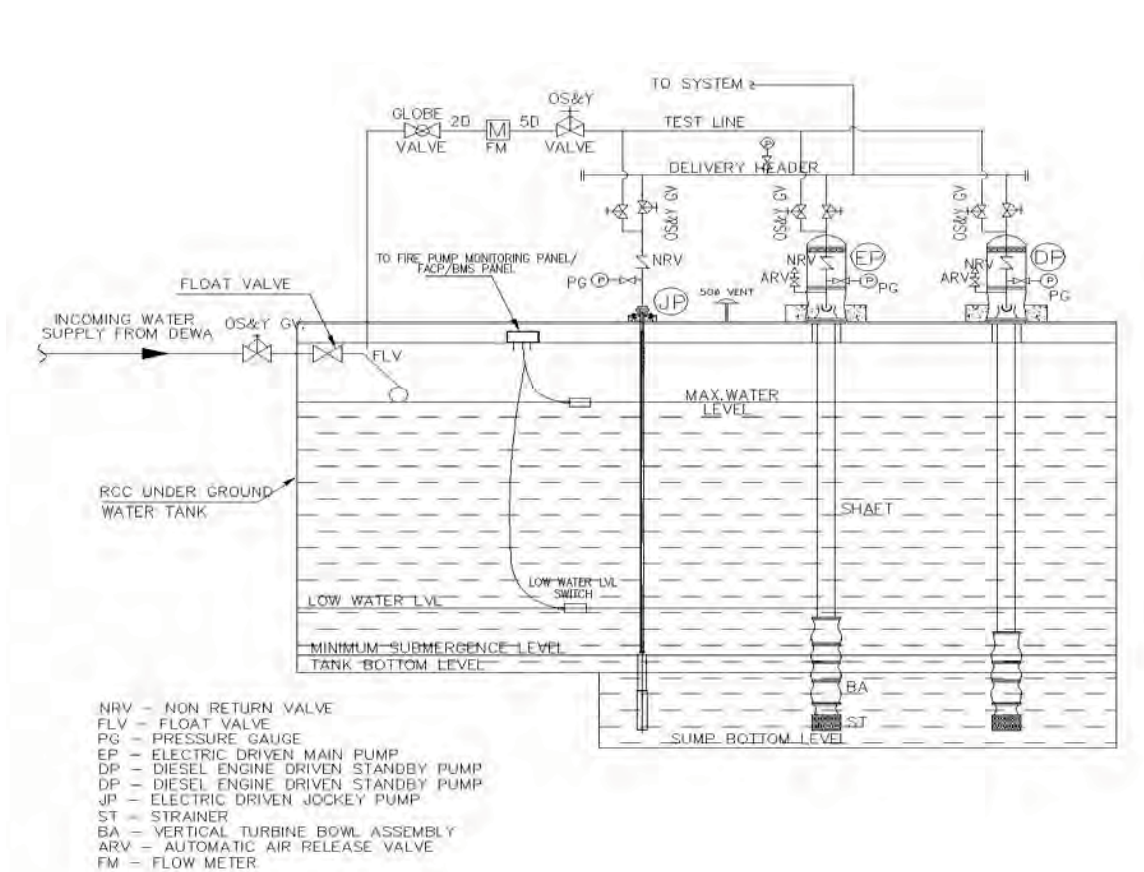


Figure 9.8: Typical Arrangement of Fire Pumping system with Vertical Turbine Pumps.

4.18. Test Risers and Drains

- 4.18.1. There shall be a drain riser with not less than 100 mm dia installed beside the wet riser pipe.
- 4.18.2. Drain risers shall be fitted with 65 mm dia instantaneous male coupling with built-in spring loaded non return valve with blank cap beside each landing valve outlet to facilitate the landing valve test during routine testing.
- 4.18.3. The drain riser shall be terminated back to fire water tank or to open drain.
- 4.18.4. Additionally a roof manifold consisting of 3 nos of 65 mm dia landing valve outlets shall be provided at the topmost point (at roof level) of hydraulically remotest standpipe riser for testing purposes.
- 4.18.5. Each wet riser shall be provided with drain arrangements having not less than 50 mm dia on down stream side of riser isolation valve and where ever the riser pipe changes its direction which leaves water trapped in that sections.



4.19. Civil Defence Breeching Inlets

- 4.19.1.** Buildings provided with wet riser system shall be terminated to 4 way breeching inlet connection having 150 mm dia flanged outlet with 4 nos of 65 mm dia instantaneous male coupling inlets, located at ground level in an easily accessible, visible locations within 18m from the civil defence vehicle access road. All high rise buildings and large complex buildings shall be provided with minimum of two breeching inlets per wet riser at remote locations.
- 4.19.2.** Where wet riser is subdivided in to multiple zones, each wet riser zone shall be provided with one or more breeching inlet connections.
- 4.19.3.** In high rise buildings, the high level zone can not be supplied water from the civil defence vehicle due to requirements of high pressure. Breeching connection for high zone wet riser system shall be replaced by connecting roof mounted water storage tanks through an additional pumping units as shown on **Figure 9.7**. A 4 way breeching shall be provided connected to each fire water tanks / compartments to refill the fire water tanks from the civil defence vehicle in case of an emergency requirements.
- 4.19.4.** A 2 way breeching inlet can be provided depending on the highest hydraulic demand for lowrise building.

4.20. Location & Protection of Wet riser Pipe

- 4.20.1.** All the fire fighting system including hose reel, dry & wet riser piping in any building, shall be installed within a protected enclosure having fire resistance rating of not less than 2 hours.
- 4.20.2.** If the building is fully protected by an automatic sprinkler system, the protection of fire fighting riser pipe shall be with 1 hour fire resistant enclosure.
- 4.21.** All steel pipes & fittings used for fire fighting service shall be painted in Red. Where the situation does not permit due to the interior architecture finish, the pipe may be painted in other colours by marking the fire fighting pipe with RED coloured band at every 3 meters with directional arrow marks indicating water flow direction.



5. Sprinkler System

5.1. General

- 5.1.1.** This section depicts the design requirements of Automatic Sprinkler systems in all types of occupancies. The purpose of sprinkler system is to detect, control and extinguish the fire by discharging water automatically to provide protection for the occupant's life and property.
- 5.1.2.** Automatic sprinkler heads are individually heat activated and fixed into a piping network with water under pressure. When the heat of a fire raises the sprinkler temperature to its operating point, (a variety of temperature ratings, from 57 to 260 degrees) a liquid- filled glass bulb will shatter or a solder link will melt to open that single sprinkler, allowing water to discharge. The water is directed onto a diffuser or deflector which is designed to not only break the water into droplets of a specific size, but also to direct the spray to cover a specific floor and wall area.
- 5.1.3.** The sprinkler system also consists of required control valves, installation Alarm Check Valve (ACV), Floor Zone Control Valves (ZCV), Civil Defence breeching connections etc.
- 5.1.4.** Alarm Check Valves (ACV) and Floor Zone Control Valves (ZCV) shall be located inside stair enclosure at a higher level than required 'Headroom' for the stairs.

5.2. Types of Sprinkler Systems

- 5.2.1.** There are three types of sprinkler systems generally used and approved by the Civil Defence.
 - i. Wet Sprinkler System
 - ii. Dry Pipe Sprinkler System
 - iii. Pre-action Sprinkler System

5.3. Wet Sprinkler System

- 5.3.1.** The Wet Pipe System is the simplest and most common type of fire sprinkler installation. This system employs automatic and closed-type sprinklers heads which are connected to a water-filled piping system. The sprinklers contain either a heat responsive glass bulb or fusible element that prohibits water from discharging from the sprinkler's orifice. The water is contained until such time as the heat from the fire activates the element, causing its release, allowing the water to discharge.



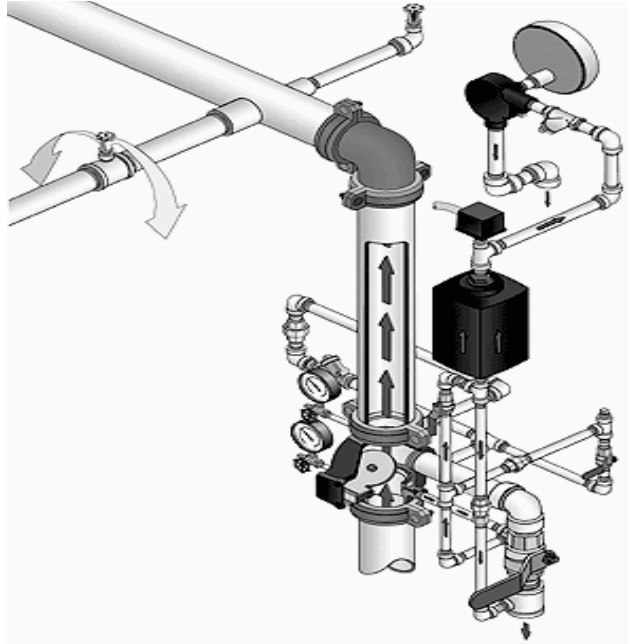


Figure 9.9: A Typical Arrangement of Wet Sprinkler System

5.4. Dry Pipe Sprinkler System

- 5.4.1.** A Dry Pipe Sprinkler System is a system which employs automatic and closed-type sprinkler heads which are connected to a piping system containing compressed air or nitrogen, rather than water. This type of system is used where the area being protected will be unable to maintain a constant year-round temperature of at least 40 degrees Fahrenheit (4°C), like cold or freezer rooms.
- 5.4.2.** Water would freeze in the piping, rendering the system inoperable, even causing severe damage should the system components crack or break. Dry Pipe Systems are frequently installed in areas subject to freezing temperatures, such as cold storage areas, coolers and freezers, special purpose laboratories and processing units.
- 5.4.3.** In case of cold or freezer rooms where the temperature is less than 4°C, ensure that the air inside the piping is free from moisture (by using dry air or nitrogen). Volume and compressor calculations shall be taken into consideration when designing the system.



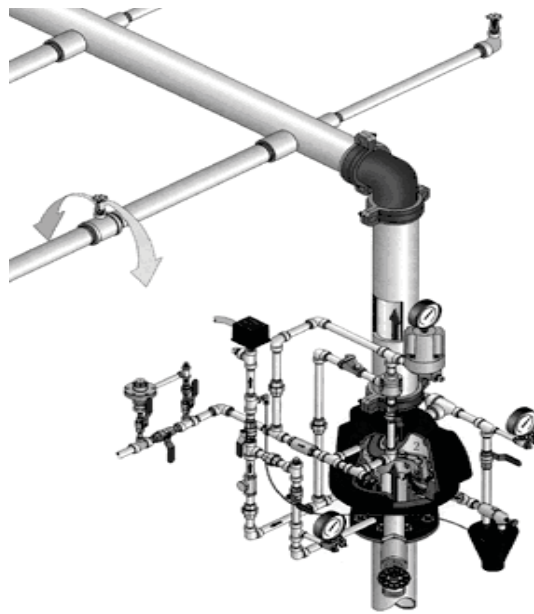


Figure 9.10: A Typical Arrangement of Dry Sprinkler System

5.5. Pre-Action Sprinkler system

- 5.5.1.** A Pre-action System is a system which employs automatic and closed-type sprinkler heads connected to a piping system that contains air (either pressurized or non-pressurized), with a supplemental system of detection serving the same area as the sprinklers.
- 5.5.2.** These systems are typically used in applications where the accidental discharge of water would be catastrophic to the usage occupancy (for example; computer servers, lift machine rooms, telecommunications equipment, and high voltage electrical components).

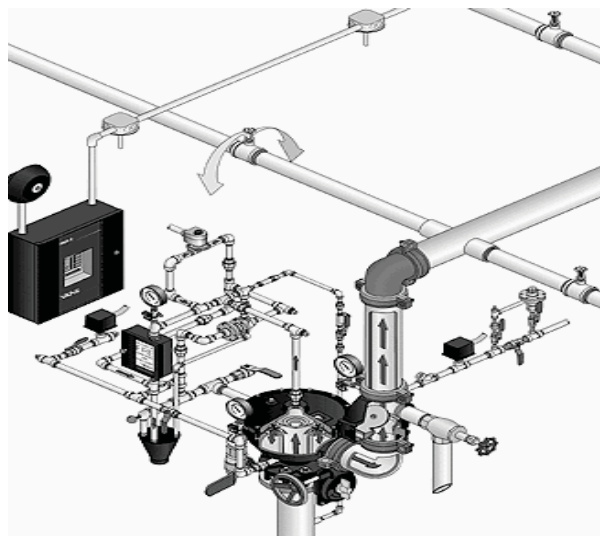


Figure 9.11: A Typical Arrangement of Pre-Action Sprinkler System



5.6. Types of Sprinkler Heads

5.6.1. There are two types of sprinkler heads based on the sensing element.

- i. **Quartzoid Bulb type:** A sprinkler that has sensing element consist of glass bulb filled with quartzoid liquid for sensing the surrounding temperature.
- ii. **Fusible Link type:** A sprinkler that has sensing element consist of solder type fusible link for sensing the surrounding temperature.

5.7. Types of Sprinkler Heads based on Discharge pattern

5.7.1. There are several types of sprinkler heads based on the discharge pattern.

- i. **Upright Sprinkler head:** A sprinkler designed to be installed in such a way that the water spray is directed upwards against the deflector.
- ii. **Pendent Sprinkler head:** A sprinkler designed to be installed in such a way that the water stream is directed downward against the deflector. In pendent there are two types based on its mounting application.
- iii. **Recessed pendent sprinkler:** A sprinkler in which all or part of the body, other than the shank thread, is mounted within a recessed housing.
- iv. **Concealed pendent sprinkler:** A recessed sprinkler with cover plates.
- v. **Conventional Sprinkler head:** A sprinkler that is designed to install both pendent or upright position.
- vi. **Side wall Sprinkler head:** A sprinkler having special deflectors that are designed to discharge most of the water away from the nearby wall in a pattern resembling one-quarter of a sphere, with a small portion of the discharge directed at the wall behind the sprinkler.

5.8. Types of Sprinkler Heads based on coverage

5.8.1. There are two types of sprinkler heads based on the coverage.

- i. **Standard Coverage:** A type of spray sprinkler with maximum coverage areas as specified in [Table 9.5](#).
- ii. **Extended Coverage:** A type of spray sprinkler with maximum coverage areas than a standard coverage.

5.9. Types of Sprinkler Heads based on Sensing Element

5.9.1. There are two types of sprinkler heads based on the response.



- i. **Standard Response type:** A type of spray sprinkler that meets the fast response criteria that have a thermal element with an RTI of 80 (meters-seconds) 1/2 or more.
- ii. **Fast (Quick) Response type:** A type of spray sprinkler that meets the fast response criteria that have a thermal element with an RTI of 50 (meters-seconds) 1/2 or less.

5.10. Sprinklers Operating Temperature

- 5.10.1.** Operating temperature of the sprinklers proposed shall be based on the maximum room temperature expected at the ceiling level at any time. Automatic sprinklers shall have their frame arms, deflector, coating material, or liquid bulb colored in accordance with the requirements of **Table 9.5** below.

Table 9.5: Sprinkler Temperature ratings and color coding				
MAXIMUM CEILING TEMPERATURE (IN °C)	REQUIRED OPERATING TEMPERATURE OF SPRINKLER (IN °C)	TEMPERATURE CLASSIFICATIONS	GLASS BULB COLOR	COLOR CODE OF SOLDER TYPE SPRINKLER
Up to 38°C	57°C, 68°C (Q.B. type) or 60 °C, 74°C (Solder type)	Ordinary	Orange or Red	Uncolored or Black
Above 38°C up to 66 °C	79°C, 93°C (Q.B. type) or 100°C (Solder type)	Intermediate	Yellow or Green	White
Above 66 °C up to 107 °C	141 °C (Q.B. Type) or 187 °C (Solder type)	High	Blue	Blue

5.11. Sprinkler Operating Response

- 5.11.1.** Thermal sensitivity is a measure of the rapidity with which the thermal element operates as installed in a specific sprinkler. The response time index (RTI) is a measure of the sensitivity of the sprinkler's thermal element as installed in a specific sprinkler. There are two types of sprinklers generally used, Standard Response and Quick or Fast Response.
- 5.11.2.** In light hazard occupancies, all the sprinklers used shall be of Quick or Fast response type sprinklers. In general view, the quick or fast response sprinklers consists of 3 mm thick Quartzoid glass bulb.
- 5.11.3.** In Ordinary hazard & storage hazard, either quick response or standard response sprinklers are permitted to use. In general view, the standard response sprinklers consists of 5 mm thick quartzoid glass bulb.



5.12. Sprinkler Thread, Orifice & K-Factor

- 5.12.1. Standard sprinklers shall have the thread size of not less than ½" (12.7mm) NPT having nominal orifice size of ½" (12.7mm) with K-factor 5.6 (Metric factor 80).
- 5.12.2. Extended coverage sprinklers shall have their thread size, orifice size and K-factor depending upon their approval listing and may vary upon the manufacturers.
- 5.12.3. Sprinklers having a K-factor exceeding K-5.6 (80) and having ½ in. (15 mm) NPT shall not be permitted to install in new sprinkler systems.
- 5.12.4. Where design density required is greater than 8.1 LPM/Sq.Mtrs (2.1 GPM/Sq.Mtrs) but lesser than 13.9 LPM/ Sq.mtrs (3.7 GPM/Sq.mtrs), the sprinklers having K-factor 8.0 (Metric factor K-116) shall be used.
- 5.12.5. If the design density required is greater than 13.9 LPM/ Sq.mtrs (3.7 GPM/Sq.mtrs), the sprinklers having K-factor 11.2 (Metric factor K-161) or higher shall be used as per the approval listing.

5.13. Sprinkler Zone Limitations

- 5.13.1. The maximum area of any single sprinkler zone in a floor shall be not more than the floor area specified in the [Table 9.6](#) given below. The water supply to the sprinklers supplied by any one sprinkler system riser or combined system riser shall be not more than the specified maximum floor area.
- 5.13.2. Where the floor area exceeds the limit as specified in the [Table 9.6](#), an additional water supply risers shall be proposed for every maximum sprinkler zone in each floor complete with sprinkler Alarm check Valve (ACV) assembly and riser isolation valve.
- 5.13.3. In addition, a floor zone control valve (ZCV) assembly shall be proposed at every floor where the tapping is taken from the sprinkler riser.
- 5.13.4. Alarm Check Valves (ACV) and Floor Zone Control Valves (ZCV) shall be located inside stair enclosure at a higher level than required 'Headroom' for the stairs.

5.14. Sprinkler Operating Pressure

- 5.14.1. The minimum operating pressure of any sprinkler for determining the water supply requirements shall be not less than 0.5 bar (7 PSI) in the light hazard occupancy and 1.0 bar (14.5 PSI) in the ordinary hazard occupancies.
- 5.14.2. The maximum operating pressure in a sprinkler system shall not be more than 12 bar.



- 5.14.3.** Where higher operating pressure is used for the sprinkler system, all the sprinklers, pipes and fittings shall be rated for the higher operating pressure, however the operating pressure shall not be more than 16 bar in any case.

5.15. Sprinkler Design Density & Water Supply Requirements

- 5.15.1.** The minimum required design density of water discharge over the protected surface area shall be determined based on the occupancy and hazard classification and shall be determined by the any one of the following methods:

- i. Density / AMAO (Assumed Maximum Area of Operation) method;
- ii. Room design method.

5.16. Density / AMAO Method

- 5.16.1.** In density / AMAO (Assumed Maximum Area of Operation) method, sprinkler fire water demand shall be calculated by hydraulic calculation method based on certain amount of water with in a specified period over the certain area (AMAO) of protected space and shall be not less than as specified in the **Table 9.7** below.

5.17. Room Design Method

- 5.17.1.** In room design, sprinkler fire water demand shall be calculated by hydraulic calculation method based on either a single largest room that requires higher water demand or multiple number of rooms that has communication openings between them those requires higher water demand. The design density shall be provided based on the hazard occupancy of each room. In this case the highest water demand shall be the fire water demand required for sprinkler system.
- 5.17.2.** Where room design method is used and the design AMAO is a corridor protected by a single row of sprinklers with protected openings, the maximum number of sprinklers that need to be calculated shall be not less than five in case of standard sprinklers or all sprinklers within 23 linear meters length of corridor in case of extended coverage sprinklers.
- 5.17.3.** Where room design method is used and the design AMAO is a service chute supplied by a separate sprinkler riser, the maximum number of sprinklers that needs to be calculated shall be not less than seven with minimum flow of 60 LPM (15.8 GPM).

5.18. Combined Sprinkler & Wet Riser system Water Demand

- 5.18.1.** The sprinkler water demand shall be calculated based on the hydraulic calculations according to the occupancy hazard classification, density of water discharge and design AMAO (Assumed Maximum Area of Operation) of sprinklers as stated in the **Table 9.7**.
- 5.18.2.** Hand line hose stream water demand shall be added to the sprinkler water demand according to the type fire fighting hose system proposed based on the occupancy classification as specified in the table **Table 9.7**.



- 5.18.3.** However, If the fire water supply is combined for both sprinkler and stand pipe wet riser system, the fire water demand shall be established as follows:
- 5.18.3.1.** In the buildings fully protected by an automatic sprinkler system, the fire water demand established for the wet riser system is permitted to serve sprinkler system without adding additional water demand in it.
 - 5.18.3.2.** In the buildings partially or not protected by sprinkler system, the fire water demand established for the wet riser system shall be increased by adding the hydraulically calculated sprinkler fire water demand in it.
 - 5.18.3.3.** If the wet riser system demand calculated exceeds the sprinkler system demand including the hose stream allowance, the larger of the two demand value shall be proposed depending on the hazard.

5.19. Hydraulic Calculations

- 5.19.1.** Computerized Hydraulic calculations shall be performed to determine the fire water demand, pressure and pipe sizes required for a sprinkler system installed in all types of occupancies.
- 5.19.2.** The hydraulic calculation shall be performed using the Civil Defence listed and approved software. Following criteria shall be used for Hydraulic calculations.
- 5.19.3.** Sprinkler system that is protecting an occupancy hazard that requires greatest water demand situated any where within the occupancy for the design AMAO & density of discharge according to the occupancy classification.
- 5.19.4.** Sprinkler system that is protecting an occupancy hazard that is located hydraulically farthest point from the source of fire water supply system within the occupancy for the design AMAO & density of discharge according to the occupancy classification.
- 5.19.5.** Sprinkler system that is protecting an occupancy hazard that is located hydraulically topmost point from the source of fire water supply system within the occupancy for the design AMAO & density of discharge according to the occupancy classification.
- 5.19.6.** The fire water source shall be selected based on the above criteria, whichever is the greater requirement.

5.20. Pipe Sizes

- 5.20.1.** The minimum pipe sizes shall be determined according to the hydraulic calculations. However, the minimum pipe sizes shall be not less than the diameters specified in the [Table 9.6](#) below.



Table 9.6: Number of sprinkler heads allowed per pipe size

NOMINAL STEEL PIPE Ø IN MM	IN LIGHT HAZARD OCCUPANCY	IN ORDINARY & STORAGE HAZARD OCCUPANCY	IN LIGHT, ORDINARY & STORAGE HAZARD (ABOVE FALSE CEILING AND BELOW RAISED FLOOR)
25 mm	2	2	2
32 mm	3	3	4
40 mm	5	5	7
50 mm	10	10	15
65 mm	30 or as per hydraulic calculations.	20 or as per hydraulic calculations.	30 or as per hydraulic calculations.
80 mm	60 or as per hydraulic calculations.	40 or as per hydraulic calculations.	60 or as per hydraulic calculations.
100 mm	100 or as per hydraulic calculations.	100 or as per hydraulic calculations.	100 or as per hydraulic calculations.
150 mm	230 or as per zone area limitation of 4831 m ² , which ever is greater subject to hydraulic calculation.	275 or as per zone area limitation of 3716 m ² , which ever is greater subject to hydraulic calculation	300 or as per hydraulic calculations.
150 mm	Maximum area limitation for High and Extra Hazard Sprinkler Zone is 3716 m ²		

- 5.21.** However the number of sprinklers fed by the pipes having 65 mm diameter and above in a sprinkler zone may be permitted to increase subject to the submission of acceptable computerized listed hydraulic calculations according to the area protection limitations as specified.

6. Certification of Fire Pumps

- 6.1.** The below mentioned criteria's shall be applicable to centrifugal single – stage and multistage pumps of horizontal or vertical shaft design and positive displacement pumps of the horizontal or vertical shaft design which are limited and intended for fire protection system only:
- 6.1.1.** Each pump, driver, controlling equipment, power supply and arrangement and liquid supply shall be tested and certified by a listed laboratory approved by the Civil Defence Authority.
- 6.1.2.** The fire pump unit, consisting of a pump, driver, controller and fittings shall perform in compliance with this standard as an entire unit when installed or when



components have been replaced. The selected fire pump is required to be verified with the listing before application.

- 6.1.3.** All the materials used in pump construction shall be tolerance dependent and selected based on the corrosion potential of the environment, fluids used and operational conditions. Engines shall have a nameplate indicating the listed horsepower rating available to drive the pump.
- 6.1.4.** All the equipment, materials or services shall be included in a listing published by the approved testing laboratory. The laboratories shall be concerned with evaluation of products or services that maintains periodic inspection of production of equipments or materials or periodic evaluation of services and meets the suitable standards for a specified purpose.
- 6.1.5.** A single entity should be designated as having unit responsibility for the pump driver, controller, transfer switch equipment and accessories. It shall hold the accountability to answer and resolve any and all problems regarding the proper installation, compatibility, performance and acceptance of the equipment. Unit responsibility shall lie with the installer until the equipment is accepted and officially handed over to the building owner. This shall not affect manufacturer/supplier warranties.
- 6.1.6.** Installation personnel shall be qualified or shall be supervised by persons who are qualified in the installation, inspection and testing of fire protection systems. Qualifications or certification of the personnel shall be provided at any time when requested by the Civil Defence Authorities. The installation team shall be registered, licensed or certified by the Civil Defence Authority.

7. Fire pump location and arrangement

- 7.1.** The proposed fire pump set for any water based suppression system including fire hydrants shall consists each of the following:

- i. Main Electric Pump
- ii. Standby Diesel driven Pump
- iii. Electric Jockey Pump

Two electrical pumps can be used, one as duty and another as standby. The power supply for the 2 electrical pumps shall reliable and be independent of each other.

- 7.2.** Fire Pumps shall be located at the lowest level of the building pumping upwards. Fire pumps at levels higher than the lowest level of the building with water supply feeding downwards is not allowed.
- 7.3.** Pumps shall have minimum flow and pressure according to the hydraulic calculation to supply fire water to sprinklers system, landing valves and hydrants.
- 7.4.** A common fire pump set is acceptable to feed both sprinkler and wet riser system. In such case, the fire pump set capacity shall be not less than the highest fire demand calculated.



- 7.5. Fire pumps and fire water tanks shall have protected and dedicated access from the fire engine access level.
- 7.6. Transfer fire pumps and transfer fire water tanks are to be located on mechanical floors and shall not be located on the roof top.
- 7.7. Any building higher than 90 m in habitable height from the lowest level of the building, shall require a transfer pump set and a transfer water tank located on the mechanical floor.

7.8. Fire Pump for Hydrants

- 7.8.1. Hydraulic calculation shall be provided to size up the fire pump required for the fire hydrant network. Separate pumps may be required to address pressure fluctuation within the hydrant network.
- 7.8.2. Each fire pump flowrate shall be a minimum of 1000 GPM for hydrant demand at minimum pump pressure of 10.3 bar.

8. Inspectors Test & Drains

8.1. Inspectors Test

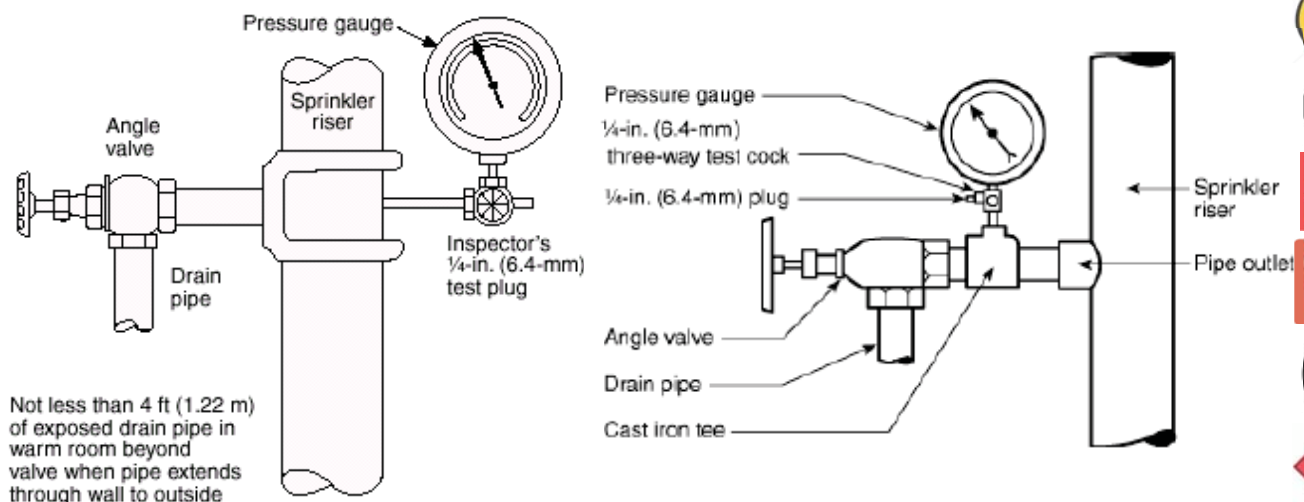
- 8.1.1. For all highrise buildings, an approved Auto Zone Check valve shall be considered for each floor Zone Control Valve, to enable the automatic checking of the Flow switch and simulation of sprinkler activation. (See **V. COMMITMENT TO BEST PRACTICE**, Water Conservation)
- 8.1.2. For non-highrise buildings, an approved alarm test valve shall be provided in each sectional or floor zone control valve assembly on downstream side of water flow switch. The test valve shall be not less than 25 mm diameter in size having an orifice diameter to give a flow equal to or less than one sprinkler of a type having the smallest orifice installed on the particular system to test each water flow alarm device for each system.
- 8.1.3. The inspectors test valve shall be located at an easily accessible & visible location with an identification sign board in a visible location in both Arabic & English languages.
- 8.1.4. Where test valve is located in a closed room or shaft access door or panel shall be provided with an identification sign board in visible location in both Arabic & English languages.

8.2. Drains

- 8.2.1. The complete sprinkler system piping shall be designed and installed in such a way that the entire water can be drained.



- 8.2.2.** A main drain valve shall be installed on each sprinkler system main riser on down stream side of an Alarm Check valve. The system main drain valve can be a part of an alarm check valve.
- 8.2.3.** The size of main drain valve (alarm check valve) shall not be less than 50mm dia. Auxiliary drains shall be provided where a change in piping direction prevents drainage of system piping through the main drain valve.
- 8.2.4.** In addition, where sectional zone or floor control valve is provided, it shall be provided with a drain connection having a minimum size not less than 25 mm diameter to drain that portion of the system controlled by the sectional valve. A listed and approved combined test & drain valve is permitted to use in sectional or floor zone control valve assembly.
- 8.2.5.** A drain riser shall be installed beside the sprinkler system riser pipe.
- 8.2.6.** The main sprinkler riser drain should discharge to an open drain outside the building at a point free from the possibility of causing water damage. Where it is not possible to discharge outside the building wall, the drain should be piped to a sump, which in turn should discharge by gravity or be pumped to a waste water drain or sewer. The main sprinkler riser drain connection should be of a size sufficient to carry off water from the fully open drain valve while it is discharging under normal water system pressures. Where this is not possible, a supplementary drain of equal size should be provided for test purposes with free discharge, located at or above grade.
- 8.2.7.** The drain riser may be permitted to terminate back to fire water tank if the tanks do not serves for domestic use. In such case, the drain discharge shall conform to any health or water department regulations. See **Figure 9.12** for illustrations.



Acceptable Pressure Gauge Location.

Unacceptable Pressure Gauge Location.

Figure 9.12: Drain and pressure gauge connection for System Riser



9. Classification of Fire Hazards for Sprinkler Design

- 9.1.** Occupancies shall be classified as four classes based on its use and content of materials stored or handled to determine the sprinkler design, installation, water discharge, fire pump and storage requirements.

9.2. Light Hazard

- 9.2.1.** The areas and occupancies which are used for non-industrial uses and contains low quantity and less combustible materials which are expected to release less heat release rates during fire condition shall be classified as light hazard occupancies.

9.3. Ordinary Hazard

- 9.3.1.** The areas and occupancies used for processing and handling of mainly ordinary combustible materials unlikely to develop intensely burning fires in the initial stages shall be classified as ordinary hazard occupancies. Ordinary Occupancies shall be further sub classified in to two groups:

9.3.1.1. Ordinary Hazard, Group-1

The areas and occupancies which are used for commercial & industrial uses and contains medium quantity and moderate combustible materials and the storages up to 2.4 meters which are expected to release moderate heat release rates during fire condition shall be classified as Ordinary Hazard group-1.

9.3.1.2. Ordinary Hazard, Group-2

The areas and occupancies which are used for commercial & industrial uses and contain medium quantity and moderate to high combustible materials and the storages up to 3.6 mtrs which are expected to release moderate heat release rates and the storages up to 2.4 mtrs which are high heat release rates during fire condition shall be classified as Ordinary Hazard group-2.

9.4. Extra High Hazard

- 9.4.1.** The areas and occupancies used for processing and handling abnormal fire loads, likely to produce exceptionally intense fires with high rates of heat release and with high storage heights. Extra high hazard occupancies shall be further classified in to two groups:



9.4.1.1. Extra High Hazard, Group-1

The areas and occupancies which are used for industrial uses and contains high quantity and very high combustible materials which will support fast development of fire and are expected to release very high heat release rates during fire condition and having less or no combustible or flammable liquids & gases shall be classified as Extra high hazard group-1.

9.4.1.2. Extra High Hazard, Group-2

The areas and occupancies which are used for industrial uses and contain moderate to high quantity of flammable & combustible liquids and gases which will support rapid growth of fire and expected to release very high heat release rates during fire condition shall be classified as Extra High hazard group-2.

9.5. Special / Storage Hazard

9.5.1. The areas and occupancies used for miscellaneous storage purposes having storage height greater than 3.6 mtrs shall be classified in to storage hazard occupancies. Storage hazard occupancies shall be further sub classified in to eight classes as described below:

9.5.1.1. Commodity Class -1

Class I commodity are the Non combustible materials that are stored directly on wooden pallets, single layer corrugated cartons with or with out pallets & shrink wrapped or paper wrapped as unit load with or without pallets.

9.5.1.2. Commodity Class-2

Class II commodity are the Non combustible materials that are stored in slatted wooden crates, solid wood boxes, multiple-layered corrugated cartons, or other similar combustible packaging material, with or without pallets.

9.5.1.3. Commodity Class-3

Class III commodity are the materials manufactured from wood, paper, natural fibers or Group C plastics with or without cartons, boxes or crates and with or without pallets. The materials that contain 5% by volume or by weight of group C plastics products may also be considered as class 3 commodities.

9.5.1.4. Commodity Class-4

Class IV commodity are the materials manufactured from group B plastics or from free flowing group A plastics or contain within itself or its packing 5 – 15 % by weight or by volume of group A plastics.



9.5.1.5. Group –A Plastics

Examples of Group A plastic materials are ABS (acrylonitrile-butadiene-styrene copolymer), Acetal (polyformaldehyde), Acrylic (polymethyl methacrylate), Butyl rubber, EPDM (ethylene-propylene rubber), FRP (fiberglass-reinforced polyester), Natural rubber (if expanded), Nitrile-rubber (acrylonitrile-butadiene-rubber), PET (thermoplastic polyester), Polybutadiene, Polycarbonate, Polyester elastomer, Polyethylene, Polypropylene, Polystyrene, Polyurethane, PVC (polyvinyl chloride — highly plasticized, with plasticizer content greater than 20 percent) (rarely found), SAN (styrene acrylonitrile) and SBR (styrene-butadiene rubber).

9.5.1.6. Group –B Plastics

Examples of Group B plastic materials are Cellulosics (cellulose acetate, cellulose acetate butyrate, ethyl cellulose), Chloroprene rubber, Fluoroplastics (ECTFE — ethylene-chlorotrifluoro-ethylene copolymer; ETFE — ethylene-tetrafluoroethylene-copolymer; FEP — fluorinated ethylene-propylene copolymer), Natural rubber (not expanded), Nylon (nylon 6, nylon 6/6) and Silicone rubber.

9.5.1.7. Group –C Plastics

Examples of Group C plastic materials are Fluoroplastics (PCTFE — polychlorotrifluoroethylene; PTFE — polytetrafluoroethylene), Melamine (melamine formaldehyde), Phenolic, PVC (polyvinyl chloride — flexible — PVCs with plasticizer content up to 20 percent), PVDC (polyvinylidene chloride), PVDF (polyvinylidene fluoride), PVF (polyvinyl fluoride) and Urea (urea formaldehyde).

9.5.1.8. Rolled paper Store

9.5.1.8.1. Rolled paper storage facility can be further subdivided in to four classes based on its weight to determine the sprinkler system design criteria.

- i. **Heavy weight Class:** Heavyweight class shall include paperboard and paper stock having a basis weight per 92.9 m² of 9.1 kg.
- ii. **Medium weight Class:** Medium weight class shall include all the broad range of papers having a basis weight per 92.9 m² of 4.5 kg to 9.1 kg.
- iii. **Lightweight class:** Light weight class shall include all papers having a basis weight per 92.9 m² of 4.5 kg.

9.5.1.8.2. Tissue shall include the broad range of papers of characteristic gauzy texture, which, in some cases, are fairly transparent such as crepe wadding and the sanitary class including facial tissue, paper napkins, bathroom tissue, and towelling.



10. Sprinkler System Design Requirements

- 10.1.** This section shall be the guideline for design of Sprinkler System for all occupancies other than storage occupancies.
- 10.2.** The sprinkler system shall include dedicated or combined fire water pump & water tanks, water supply riser, alarm check valve, breeching inlet, floor zone control valves, feeder main piping, cross main piping, branch piping and sprinklers.
- 10.3.** An automatic air release valve shall be installed at top most point of each riser with an isolation ball valve.
- 10.4.** A supervised control valve shall be installed at bottom of each sprinkler riser on upstream side of an Alarm check valve for isolation of the corresponding riser for repair & maintenance purposes.
- 10.5.** An approved pressure gauge shall be installed on bottom & top of each sprinkler riser and Alarm check valve with a control valve (gauge cock) having drain arrangement.
- 10.6.** Pressure relief valves shall be installed on a gridded wet sprinkler system to relieve the pressure when exceeds 12.1 bar.
- 10.7.** Each level or fire compartment zone shall be provided with a zone control valve assembly consists of a supervised isolation valve, a water flow switch, a pressure gauge with isolation valve, inspectors test valve and sectional drain valve.
- 10.8.** Maximum protection coverage & spacing of extended coverage Pendent / Upright / sidewall sprinklers shall be not less than that prescribed by the approval listing.
- 10.9.** For systems with multiple hazard classifications, the hose stream allowance and water supply shall be the requirements for the highest hazard classification within the system.
- 10.10. Hose Demand.**
- 10.10.1.** An allowance for inside and outside hose shall not be required where tanks supply sprinklers only.
- 10.10.2.** Where pumps taking suction from a private fire service main supply to sprinklers only, the pump need not be sized to accommodate inside and outside hose. Such hose allowance shall be considered in evaluating the available water supplies.
- 10.10.3.** Water allowance for outside hose shall be added to the sprinkler requirement at the connection to the city main or a yard hydrant, whichever is closer to the system riser.
- 10.11.** Where inside hose stations are planned or are required, the following shall apply:



- i. A total water allowance of 50 gpm (190 LPM) for a single hose station installation shall be added to the sprinkler requirements.
- ii. A total water allowance of 100 gpm (380 LPM) for a multiple hose station installation shall be added to the sprinkler requirements.
- iii. The water allowance shall be added in 50 gpm (190L/min) increments beginning at the most remote hose station, with each increment added at the pressure required by the sprinkler system design at that point.

10.12. Where the combined sprinkler system demand and hose stream allowance exceeds the requirements of Standpipe and Hose Systems' water demand, the higher demand shall be used.

10.13. For partially sprinklered buildings, the sprinkler water demand shall be added to the water requirements of Standpipe and Hose Systems.

11. Sprinkler System Design Requirements for all occupancies other than Storage Occupancies

11.1. Design criteria shall be as per [Table 9.7](#), which depicts Hazard Identification, Sprinkler spacing, Design density, Sprinkler Area of operation, Hose Stream allowance and duration of discharge requirements.



Table 9.7: Sprinkler Design Criteria for all occupancies Other Than Storage Occupancies

LOCATION	HAZARD CATEGORY	STANDARD SPRINKLERS		SIDEWALL SPRINKLERS		DESIGN DENSITY [L/min]/m ² (gpm)	AREA OF OPERATION Ft ² (m ²)	HOSE STREAM ALLOWANCE LPM (GPM)	WATER TANK DURATION (MINUTES)	SPRINKLER ZONE LIMITATION (m ²)
		MAXIMUM COVERAGE (m ²)	SPACING (m)	MAXIMUM COVERAGE (m ²)	SPACING (m)					
Above false ceiling concealed & below false floor spaces	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Acetylene Cylinder Charging Plants.	Extra (Group 1)	NFPA 51A, Standard for Acetylene Cylinder Charging Plants, open or closed head sprinkler system.					2500 (232)	1900 (500)	60	3716
Aircraft Engine Test Facilities, test cell	NFPA 423, Standard for Construction and Protection of Aircraft Engine Test Facilities						-	950 (250)	30	-
Aircraft Hangers	Extra (Group 1)	9.3	Max 3.7 Min 1.8	-	-	12.2 (0.30)	2500 (232)	1900 (500)	90	3716
Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways	Ordinary (Group1)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	6.1 (0.15)	1500 (140)	950 (250)	60	4831
Airport Terminal, Baggage, package, and mail handling areas	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Animal Housing Facilities.	Need quick response type	Refer to NFPA 13, Standard for the Installation of Sprinkler Systems					-	-	-	-
Archives	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Asphalt Saturating	Extra (Group 2)	9.3	Max 3.7 Min 1.8	-	-	16.3 (0.40)	2500 (232)	1900 (500)	120	3716
Attics Unused	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Auditoriums	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Automobile Parking	Ordinary (Group1)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	6.1 (0.15)	1500 (140)	950 (250)	60	4831
Bakeries	Ordinary (Group1)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	6.1 (0.15)	1500 (140)	950 (250)	60	4831
Beverage manufacturing	Ordinary	12	Max 4.6	9.3	Max 3	6.1	1500	950 (250)	60	4831



Table 9.7: Sprinkler Design Criteria for all occupancies Other Than Storage Occupancies

LOCATION	HAZARD CATEGORY	STANDARD SPRINKLERS		SIDEWALL SPRINKLERS		DESIGN DENSITY [L/min]/m ² (gpm)	AREA OF OPERATION Ft ² (m ²)	HOSE STREAM ALLOWANCE LPM (gpm)	WATER TANK DURATION (MINUTES)	SPRINKLER ZONE LIMITATION (m ²)
		MAXIMUM COVERAGE (m ²)	SPACING (m)	MAXIMUM COVERAGE (m ²)	SPACING (m)					
	(Group1)		Min 1.8		Min 1.8	(0.15)	(140)			
BMS, Fire control rooms	Ordinary (Group1)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	6.1 (0.15)	1500 (140)	950 (250)	60	4831
Cable Spreading Room.	NFPA 850, Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations					12.2 (0.30)	2500 (232)	-	-	-
Cable Tunnels.	NFPA 850, Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations					12.2 (0.30)	2500 (232)	-	-	-
Canneries	Ordinary (Group1)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	6.1 (0.15)	1500 (140)	950 (250)	60	4831
Car parking areas	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Cereal Mills	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Chemical Plants (Ordinary)	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Churches	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Class A Hyperbaric Chambers.	Refer to NFPA 13 ,Standard for the Installation of Sprinkler Systems					8.1 (0.20)	-	-	-	-
Cleanrooms.	-	-	6.1 (3.7 vertical)	-	-	8.1 (0.20)	(279)	-	-	-
Closets having heaters, dryers, furnaces	Refer to NFPA 13 ,Standard for the Installation of Sprinkler Systems					-	-	-	-	-
Clubs	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Combustible Hydraulic fluid use areas	Extra (Group 1)	9.3	Max 3.7 Min 1.8	-	-	12.2 (0.30)	2500 (232)	1900 (500)	90	3716
Compressed Gases and Cryogenic Fluids in Portable	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	(278)	950 (250)	60	4831

Table 9.7: Sprinkler Design Criteria for all occupancies Other Than Storage Occupancies

LOCATION	HAZARD CATEGORY	STANDARD SPRINKLERS		SIDEWALL SPRINKLERS		DESIGN DENSITY [L/min]/m ² (gpm)	AREA OF OPERATION Ft ² (m ²)	HOSE STREAM ALLOWANCE LPM (GPM)	WATER TANK DURATION (MINUTES)	SPRINKLER ZONE LIMITATION (m ²)
		MAXIMUM COVERAGE (m ²)	SPACING (m)	MAXIMUM COVERAGE (m ²)	SPACING (m)					
and Stationary Containers, Cylinders, and Tanks	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Confectionary products	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Conference Rooms	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Corridors	Ordinary (Group1)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	6.1	1500 (140)	950 (250)	60	4831
Dairy products manufacturing	Ordinary (Group1)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	6.1 (0.15)	1500 (140)	950 (250)	60	4831
Dairy products processing	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Data processing	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Detention and Correctional	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Die Casting	Extra (Group 1)	9.3	Max 3.7 Min 1.8	-	-	12.2 (0.30)	2500 (232)	1900 (500)	90	3716
Distilleries	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Dry Cleaners	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Duct systems	Refer to NFPA 13, Standard for the Installation of Sprinkler Systems					1.9	-	-	-	-
Educational	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Electronic plants	Ordinary (Group1)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	6.1 (0.15)	1500 (140)	950 (250)	60	4831
Emergency Diesel Generators and Combustion Turbines.	NFPA 850, Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations					10.2	-	-	-	-
Emergency generator set	Ordinary	12	Max 4.6	9.3	Max 3	8.1	1500 (140)	950 (250)	60	4831

Table 9.7: Sprinkler Design Criteria for all occupancies Other Than Storage Occupancies

LOCATION	HAZARD CATEGORY	STANDARD SPRINKLERS		SIDEWALL SPRINKLERS		DESIGN DENSITY [L/min]/m ² (gpm)	AREA OF OPERATION Ft ² (m ²)	HOSE STREAM ALLOWANCE LPM (GPM)	WATER TANK DURATION (MINUTES)	SPRINKLER ZONE LIMITATION (m ²)
		MAXIMUM COVERAGE (m ²)	SPACING (m)	MAXIMUM COVERAGE (m ²)	SPACING (m)					
rooms	(Group2)		Min 1.8		Min 1.8	(0.20)				
Feed Mills	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Fire Pump Room	Refer to NFPA 13, Standard for the Installation of Sprinkler Systems									
Flammable and Combustible Liquids	Extra (Group 2)	NFPA 30, Flammable and Combustible Liquids Code.								
Flammable Liquids Spraying	Extra Group 2	9.3	Max 3.7 Min 1.8	-	-	16.3 (0.40)	2500 (232)	1900 (500)	120	3716
Flow Coating	Extra (Group 2)	9.3	Max 3.7 Min 1.8	-	-	16.3 (0.40)	2500 (232)	1900 (500)	120	3716
Garages (Repair)	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Garbage collection rooms	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Glass manufacturing	Ordinary (Group1)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	6.1 (0.15)	1500 (140)	950 (250)	60	4831
Glass products manufacturing	Ordinary (Group1)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	6.1 (0.15)	1500 (140)	950 (250)	60	4831
Gymnasium, Health club,	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Horse Stables	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Hospitals	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Incinerators, and Waste and Linen Handling Systems and Equipment. ½ in. (13 mm) orifice and ordinary temperature-rated sprinklers	Refer to NFPA 82 Standard on Incinerators and Waste and Linen Handling Systems and Equipment									
Industrial Furnaces Using a	Refer to NFPA 86C Standard for Industrial Furnaces Using a Special Processing Atmosphere									

Table 9.7: Sprinkler Design Criteria for all occupancies Other Than Storage Occupancies

LOCATION	HAZARD CATEGORY	STANDARD SPRINKLERS		SIDEWALL SPRINKLERS		DESIGN DENSITY [L/min]/m ² (gpm)	AREA OF OPERATION Ft ² (m ²)	HOSE STREAM ALLOWANCE LPM (GPM)	WATER TANK DURATION (MINUTES)	SPRINKLER ZONE LIMITATION (m ²)
		MAXIMUM COVERAGE (m ²)	SPACING (m)	MAXIMUM COVERAGE (m ²)	SPACING (m)					
Special Process Atmosphere										
Information Technology Equipment.	NFPA 75,Standard for the Protection of Electronic Computer/Data Processing Equipment, they shall be valued separately from other sprinkler systems									
Institutional	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Laboratories Using Chemicals.	Class A and B – Ordinary Hazard Group 2 Class C and D – Ordinary Hazard Group 1						140	950 (250)	60	-
Laundries	Ordinary (Group1)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	6.1 (0.15)	1500 (140)	950 (250)	60	4831
Leather Goods Manufacturing	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Libraries less than 900 m ²	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Libraries more than 900 m2 area	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Lift machine rooms,	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Lobbies	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Machine Shops	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Maintenance workshops	Ordinary (Group1)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	6.1 (0.15)	1500 (140)	950 (250)	60	4831
Manufactured Homes building	Extra(Group 2)	9.3	Max 3.7 Min 1.8	-	-	16.3 (0.40)	2500 (232)	1900 (500)	120	3716
NFPA 307, Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves										
Mechanical plant Rooms	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Meeting Rooms	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1	1500	100	60	4831

Table 9.7: Sprinkler Design Criteria for all occupancies Other Than Storage Occupancies

LOCATION	HAZARD CATEGORY	STANDARD SPRINKLERS		SIDEWALL SPRINKLERS		DESIGN DENSITY [L/min]/m ² (gpm)	AREA OF OPERATION Ft ² (m ²)	HOSE STREAM ALLOWANCE LPM (GPM)	WATER TANK DURATION (MINUTES)	SPRINKLER ZONE LIMITATION (m ²)
		MAXIMUM COVERAGE (m ²)	SPACING (m)	MAXIMUM COVERAGE (m ²)	SPACING (m)					
			Min 1.8		Min 1.8	(0.10)	(140)			
Mercantile	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Metal Extruding	Extra (Group 1)	9.3	Max 3.7 Min 1.8	-	-	12.2 (0.30)	2500 (232)	1900 (500)	90	3716
Metal Works	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Miscellaneous stores	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Modular building assemblies	Extra (Group 2)	9.3	Max 3.7 Min 1.8	-	-	16.3 (0.40)	2500 (232)	1900 (500)	120	3716
Mosques	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Multipurpose halls	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Museums	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Nitrate Film	Extra Hazard (Group 2)	6	2.4max	-	-	16.3	NFPA 40, Standard for the Storage and Handling of Cellulose Nitrate Film, one sprinkler shall be provided for each shelf.			
Nursing Homes	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Offices	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Oil-Fired Boilers.	NFPA 850, Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations					10.2	-	-	-	-
Open Oil Quenching	Extra (Group 2)	9.3	Max 3.7 Min 1.8	-	-	16.3 (0.40)	2500 (232)	1900 (500)	120	3716
Ovens and Furnaces.	Refer to NFPA 86C Standard for Industrial Furnaces Using a Special Processing Atmosphere									
Pantry, Restaurants, Food courts service, Seating areas,	Ordinary (Group1)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	6.1	1500 (140)	950 (250)	60	4831

Table 9.7: Sprinkler Design Criteria for all occupancies Other Than Storage Occupancies

LOCATION	HAZARD CATEGORY	STANDARD SPRINKLERS		SIDEWALL SPRINKLERS		DESIGN DENSITY [L/min]/m ² (gpm)	AREA OF OPERATION Ft ² (m ²)	HOSE STREAM ALLOWANCE LPM (gpm)	WATER TANK DURATION (MINUTES)	SPRINKLER ZONE LIMITATION (m ²)
		MAXIMUM COVERAGE (m ²)	SPACING (m)	MAXIMUM COVERAGE (m ²)	SPACING (m)					
Paper & Pulp Mills	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Paper Process Plants	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Particle Board Manufacturing	Extra (Group 1)	9.3	Max 3.7 Min 1.8	-	-	12.2 (0.30)	2500 (232)	1900 (500)	90	3716
Passageways	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Patient Rooms	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Piers and Wharves	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Plastic Processing	Extra (Group 2)	9.3	Max 3.7 Min 1.8	-	-	16.3 (0.40)	2500 (232)	1900 (500)	120	3716
Plywood Manufacturing	Extra (Group 1)	9.3	Max 3.7 Min 1.8	-	-	12.2 (0.30)	2500 (232)	1900 (500)	90	3716
Post Offices	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Printing & Publishing Houses	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Printing (Inks with flash points below 38 °C	Extra (Group 1)	9.3	Max 3.7 Min 1.8	-	-	12.2 (0.30)	2500 (232)	1900 (500)	90	3716
Pyroxylin Plastic.	-	3				76		1900 (500)	20 (per sprinkler)	
Residential	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Resin Application areas	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Restaurant seating areas	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831

Table 9.7: Sprinkler Design Criteria for all occupancies Other Than Storage Occupancies

LOCATION	HAZARD CATEGORY	STANDARD SPRINKLERS		SIDEWALL SPRINKLERS		DESIGN DENSITY [L/min]/m ² (gpm)	AREA OF OPERATION Ft ² (m ²)	HOSE STREAM ALLOWANCE LPM (GPM)	WATER TANK DURATION (MINUTES)	SPRINKLER ZONE LIMITATION (m ²)
		MAXIMUM COVERAGE (m ²)	SPACING (m)	MAXIMUM COVERAGE (m ²)	SPACING (m)					
Restaurant service areas	Ordinary (Group1)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	6.1 (0.15)	1500 (140)	950 (250)	60	4831
Restaurants, Food courts kitchens	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Retail areas,	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Rubber Compounding	Extra (Group 1)	9.3	Max 3.7 Min 1.8	-	-	12.2 (0.30)	2500 (232)	1900 (500)	90	3716
Rubber Drying	Extra (Group 1)	9.3	Max 3.7 Min 1.8	-	-	12.2 (0.30)	2500 (232)	1900 (500)	90	3716
Rubber Milling	Extra (Group 1)	9.3	Max 3.7 Min 1.8	-	-	12.2 (0.30)	2500 (232)	1900 (500)	90	3716
Rubber reclaiming	Extra (Group 1)	9.3	Max 3.7 Min 1.8	-	-	12.2 (0.30)	2500 (232)	1900 (500)	90	3716
Rubber Vulcanizing	Extra (Group 1)	9.3	Max 3.7 Min 1.8	-	-	12.2 (0.30)	2500 (232)	1900 (500)	90	3716
Saw Mills	Extra (Group 1)	9.3	Max 3.7 Min 1.8	-	-	12.2 (0.30)	2500 (232)	1900 (500)	90	3716
Services rooms,	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Show rooms	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Solvent Cleaning	Extra (Group 2)	9.3	Max 3.7 Min 1.8	-	-	16.3 (0.40)	232	1900 (500)	120	3716
Solvent Extraction	Ordinary Hazard (Group 2)	10.2 l/min/m ² if using NFPA 15, Standard for Water Spray Fixed Systems for Fire Protection 6.5 l/min/m ² if using NFPA 16, Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems								
Stages	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Stationary stores	Ordinary	12	Max 4.6	9.3	Max 3	8.1	1500 (140)	950	60	4831

Table 9.7: Sprinkler Design Criteria for all occupancies Other Than Storage Occupancies

LOCATION	HAZARD CATEGORY	STANDARD SPRINKLERS		SIDEWALL SPRINKLERS		DESIGN DENSITY [L/min]/m ² (gpm)	AREA OF OPERATION Ft ² (m ²)	HOSE STREAM ALLOWANCE LPM (GPM)	WATER TANK DURATION (MINUTES)	SPRINKLER ZONE LIMITATION (m ²)
		MAXIMUM COVERAGE (m ²)	SPACING (m)	MAXIMUM COVERAGE (m ²)	SPACING (m)					
	(Group2)		Min 1.8		Min 1.8	(0.20)	(140)	(250)		
Store, Housekeeping material	Ordinary (Group1)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	6.1 (0.15)	1500 (140)	950 (250)	60	4831
Store, Non hazardous ordinary chemical	Ordinary (Group1)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	6.1 (0.15)	1500 (140)	950 (250)	60	4831
Textile Blending	Extra (Group 1)	9.3	Max 3.7 Min 1.8	-	-	12.2 (0.30)	2500 (232)	1900 (500)	90	3716
Textile Carding	Extra (Group 1)	9.3	Max 3.7 Min 1.8	-	-	12.2 (0.30)	2500 (232)	1900 (500)	90	3716
Textile Manufacturing	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Textile Opening	Extra (Group 1)	9.3	Max 3.7 Min 1.8	-	-	12.2 (0.30)	2500 (232)	1900 (500)	90	3716
Textile Picking	Extra (Group 1)	9.3	Max 3.7 Min 1.8	-	-	12.2 (0.30)	2500 (232)	1900 (500)	90	3716
Theaters	Light Hazard	21	Max 4.6 Min 1.8	18.2	Max 4.27 Min 1.8	4.1 (0.10)	1500 (140)	100	60	4831
Tire Manufacturing	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Tobacco Products Manufacturing	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Turbine Generator Bearings	NFPA 850, Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations					12.2 (0.30)	464	1900 (500)	120	-
Turbine Generator, under Operating Floor	Need foam-water sprinkler system	12.2 (0.30)				12.2	464	1900 (500)	120	-
Upholstering	Extra (Group 1)	9.3	Max 3.7 Min 1.8	-	-	12.2 (0.30)	2500 (232)	1900 (500)	90	3716
Utility LP-Gas Plants.	Refer to NFPA 59, Utility LP-Gas Plant Code					10.2		1000	120	

Table 9.7: Sprinkler Design Criteria for all occupancies Other Than Storage Occupancies

LOCATION	HAZARD CATEGORY	STANDARD SPRINKLERS		SIDEWALL SPRINKLERS		DESIGN DENSITY [L/min]/m ² (gpm)	AREA OF OPERATION Ft ² (m ²)	HOSE STREAM ALLOWANCE LPM (GPM)	WATER TANK DURATION (MINUTES)	SPRINKLER ZONE LIMITATION (m ²)
		MAXIMUM COVERAGE (m ²)	SPACING (m)	MAXIMUM COVERAGE (m ²)	SPACING (m)					
Varnish and Paint Dipping	Extra(Group 2)	9.3	Max 3.7 Min 1.8	-	-	16.3 (0.40)	2500 (232)	1900 (500)	120	3716
Water Cooling Towers., Extended Fan Decks	6.11 LPM/m ² (1.6 GPM/m ²) on the underside of the fan deck extension.	NFPA 214, Standard on Water-Cooling Towers.					-	1900 (500)	60	-
Water Cooling Towers., fan decks of counterflow towers	NFPA 214, Standard on Water-Cooling Towers.						-	1900 (500)	60	-
Water Cooling Towers., fan decks of crossflow towers	NFPA 214, Standard on Water-Cooling Towers.						-	1900 (500)	60	-
Water Cooling Towers., fill areas of crossflow towers	NFPA 214, Standard on Water-Cooling Towers.						-	1900 (500)	60	-
Wood Machining	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831
Wood Product Assembly	Ordinary (Group2)	12	Max 4.6 Min 1.8	9.3	Max 3 Min 1.8	8.1 (0.20)	1500 (140)	950 (250)	60	4831

Note: All special hazards such as diesel engines, boilers, turbines, ovens, cooling towers, aircraft hangers, chemical processes, laboratories, solvent extraction, flammable materials, marine terminals, cable tunnels and others, shall comply with the appropriate NFPA standard and Civil Defense requirements. Material Safety Data Sheet (where applicable) with risk assessment report shall be provided to verify the type of hazard and design of the applicable fire protection system.

Also see [Table 9.3](#) and [Table 9.4](#) for Facility/ Hazard Risk Analysis requirements.



12. Special Design Consideration for Atria

12.1. Atriums.

- 12.1.1.** Glass walls and inoperable windows shall be permitted if Automatic sprinklers are spaced along both sides of the glass wall and the inoperable window at intervals not to exceed 72 in. (1830 mm).
- 12.1.2.** The automatic sprinklers specified above are located at a distance from the glass wall not to exceed 305 mm and arranged so that the entire surface of the glass is wet upon operation of the sprinklers.
- 12.1.3.** The glass wall is of tempered, wired, or laminated glass held in place by a gasket system that allows the glass framing system to deflect without breaking (loading) the glass before the sprinklers operate.
- 12.1.4.** The automatic sprinklers are not required on the atrium side of the glass wall and the inoperable window where there is no walkway or other floor area on the atrium side above the main floor level.
- 12.1.5.** Listed quick-response or listed residential sprinklers shall be used throughout all dwelling units.
- 12.1.6.** The draft stop and closely spaced sprinkler requirements of NFPA 13 shall not be required for convenience openings complying with NFPA 101, 8.6.8.2, where the convenience opening is within the dwelling unit.

13. Sprinkler System Design Requirements for Storage Occupancies

13.1. General

- 13.1.1.** Sprinkler protection criteria are based on the assumption that roof vents and draft curtains are not being used.
- 13.1.2.** The sprinkler system criteria specified are intended to apply to buildings with ceiling slopes not exceeding 2 in 12 (16.7 %) unless modified by a specific sections.
- 13.1.3.** The maximum building height shall be measured to the underside of the roof deck or ceiling.
- 13.1.4.** Early suppression fast-response (ESFR) sprinklers shall be used only in buildings equal to, or less than, the height of the building for which they have been listed.
- 13.1.5.** The sprinkler system design shall be based on the storage height and clearance to ceiling that routinely or periodically exist in the building and create the greatest water demand. Where storage is placed above doors, the storage height shall be calculated from the base of storage above the door.
- 13.1.6.** For ceiling heights that exceed 9.14 m, and where the distance between the ceiling height and top of storage exceeds 6.1 m, protection shall be provided for the storage height that would result in a 6.1 m distance between the ceiling height and top of storage.
- 13.1.7.** For dry pipe systems and pre-action systems, the area of sprinkler operation shall be increased by 30 percent without revising the density.



13.1.8. Densities and areas shall be selected so that the final area of operation after the 30 percent increase is not greater than 557.4 m²

13.2. Preferred K-factors of Sprinkler Heads for Storage Occupancies

13.2.1. Testing has shown that when greater than 3.05 m clearance between storage top and sprinklers is inevitable, larger orifice sprinklers (K-11.2 and larger) will produce better results than smaller orifice sprinklers due to larger droplets penetrating the fire plume and/or more water discharging, thereby creating more cooling of atmosphere and building and more water penetration to the burning surfaces. Therefore, using larger orifice sprinklers is normally better not only as density requirements go higher but also as clearances exceed 13.05 m.

13.3. Table 9.8 suggests preferred K-factors of certain design densities for Storage applications.

Table 9.8: Preferred K-factors for Storage applications		
STORAGE APPLICATION	DESIGN DENSITIES	PREFERRED K-FACTORS
General Storage	Less than 0.20 gpm (8.2 LPM)	K-5.6 (80) or Larger
Rack Storage	0.20 gpm (8.2 LPM) – 0.34 gpm (13.9 LPM)	K-8 (115) or Larger
Rubber Tire Storage, Roll Paper Storage, Baled Cotton Storage	More than 0.34 gpm (13.9 LPM)	K-11.2 (161) or Larger

13.4. The use of quick-response spray sprinklers for storage applications shall be permitted when listed for such use.

13.5. Large drop, control mode specific application and ESFR sprinklers are permitted to protect ordinary hazard, storage of Class I through Class IV commodities, plastic commodities, miscellaneous storage, and other storages.

14. Design criteria for Storage Occupancies

14.1. Design criteria for Storage occupancies shall be as per following tables which depict Commodity Classification, Storage Type, Storage Height, required Design density, Sprinkler Area of operation, Hose Stream allowance and duration of discharge requirements.

14.2. Idle Wooden Pallets

14.2.1. Wood pallets can be stored outside or outside in a detached structure. Where wooden idle pallets are stored indoors, such arrangement in an occupancy shall be protected with automatic sprinkler system.

14.2.2. Control Mode (design/area) design criteria for idle wooden pallets stored indoors shall be as per Table 9.9.

14.2.3. Large Drop design requirement for idle wooden pallets stored indoors and on floor shall be as per Table 9.10.



Table 9.9: Control Mode (design/area) design requirement for idle wooden pallets stored indoors

TABLE 9.9:: CONTROL MODE (DESIGN/AREA) DESIGN REQUIREMENT FOR IDLE WOODEN PALLETS STORED INDOORS							
INDOOR STORAGE ARRANGEMENT	K-FACTOR	MAXIMUM STORAGE HEIGHT	MAXIMUM CEILING HEIGHT	REQUIRED DESIGN DENSITY Gpm (LPM)	AREA OF SPRINKLER OPERATION FT ² (m ²)		TOTAL COMBINED INSIDE AND OUTSIDE HOSE Gpm (LPM)
					HIGH TEMP SPRINKLER	ORDINARY TEMP SPRINKLER	
ON FLOOR	8 (115) or Larger	< 1.8 m	6.1 m	0.20 (8.2)	2000 (186)	3000 (279)	500 (1900)
	11.2 (160) or larger	< 2.4 m	9.1 m	0.45(18.3)	2500 (232)	4000 (372)	500 (1900)
	16.8 (242)	< 6.1	9.1 m	0.60(24.5)	-	2000 (186)	500 (1900)
ON FLOOR OR RACK WITHOUT SOLID SHELVES	11.2 (161) or larger	2.4 m - 3.7 m	9.1 m	0.60(24.5)	3500 (325)	6000 (557)	500 (1900)
		3.7 m - 6.1 m	9.1 m	0.60(24.5)	4500 (418)	-	500 (1900)
							90
							90
							90
							90
							90

Table 9.10: Large Drop design requirement for idle wooden pallets stored indoors and on floor

TABLE 9.10: LARGE DROP SPRINKLER DESIGN REQUIREMENT FOR IDLE WOODEN PALLETS STORED INDOORS AND ON FLOOR							
TYPE OF SYSTEM	K-FACTOR / ORIENTATION	MAXIMUM STORAGE HEIGHT	MAXIMUM CEILING HEIGHT	NUMBER OF DESIGN SPRINKLERS BY MINIMUM PRESSURE			TOTAL COMBINED INSIDE AND OUTSIDE HOSE Gpm (LPM)
				25 psi	50 psi	75 psi	
WET	11.2 (160) Upright	< 6.1 m	9.1 m	15	15	15	500 (1900)
90							
DRY	11.2 (160) Upright	< 6.1 m	9.1 m	25	25	25	500 (1900)
120							



14.2.4. Specific Application (K-factor 16.8) design requirement for idle wooden pallets stored indoors and on floor shall be as per [Table 9.11](#).

14.2.5. Specific Application (K-factor 19.6) design requirement for idle wooden pallets stored indoors and on floor shall be as per [Table 9.12](#).

14.2.6. ESFR design requirement for idle wooden pallets stored indoors and on floor shall be as per [Table 9.13](#).

14.3. Idle Plastic Pallets

14.3.1. Plastic idle pallets can be stored outside or in a detached structure. Where Plastic idle pallets are stored indoors, such arrangement in an occupancy shall be protected with automatic sprinkler system.

14.3.2. Indoor storage of plastic pallets shall be permitted to be protected with automatic sprinkler system in accordance with the following arrangement:

- i. Maximum storage height of 3.05 m
- ii. Maximum ceiling height of 9.1 m
- iii. Sprinkler density 0.6 gpm/ft² (24.4 mm/min) over 2000 ft² (186 m²)
- iv. Minimum sprinkler K-factor of 16.8

14.3.3. Where stored in cutoff rooms, the following shall apply:

- i. The cutoff rooms shall have at least one exterior wall.
- ii. The plastic pallet storage shall be separated from the remainder of the building by 3 hour-rated fire walls.
- iii. The storage shall be protected by sprinklers designed to deliver 0.6 gpm/ft² (24.5 LPM) for the entire room or by high-expansion foam and sprinklers designed to deliver 0.30 gpm/ft² (12.2 LPM) for the entire room.

14.3.4. ESFR design requirement for Plastic idle pallets stored indoors shall be as per [Table 9.14](#).

14.4. Class I, II, III and IV Commodities, Stored Palletized, solid piled or on shelves

14.4.1. Up to 3.7 m storage height

14.4.1.1. Design requirements for palletized, solid piled, in shelf or in racks Storage of commodities, Class I through Class IV, with storage height of less than 3.7 m shall be as per [Table 9.15](#).



14.4.2. 3.7 m to 6.1 m storage height

14.4.2.1. Design requirements for palletized, solid piled, in shelf or in racks Storage of commodities, Class I through Class IV, with storage height of 3.7 m to 6.1 shall be as per **Table 9.16**.

14.4.3. 6.1 m to 6.7 m storage height

14.4.3.1. Design requirements for palletized, solid piled, in shelf or in racks Storage of commodities, Class I through Class IV, with storage height of 6.1 m to 6.7 m shall be as per **Table 9.17**.

14.4.4. 6.7 m to 7.6 m storage height

14.4.4.1. Design requirements for palletized, solid piled, in shelf or in racks Storage of commodities, Class I through Class IV, with storage height of 6.7 m to 7.6 m shall be as per **Table 9.18**.

14.4.4.2. The densities selected from **Table 9.16**, **Table 9.17** and **Table 9.18** shall be modified in accordance with storage heights as per **Figure 9.13** without revising the design area.



Table 9.12: Specific Application (K-factor 19.6) design requirement for idle wooden pallets stored indoors and on floor

Copyright © 2011, General Headquarters of Civil Defence, Ministry of Interior, United Arab Emirates

Table 9.13: ESFR design requirement for idle wooden pallets stored indoors

TABLE 9.13: ESFR SPRINKLER REQUIREMENTS FOR IDLE WOODEN PALLETS STORED INDOORS						
STORAGE ARRANGEMENT	COMMODITY	MAXIMUM STORAGE HEIGHT (m)		NOMINAL K-FACTORS FOR THE TYPE OF SPRINKLER ORIENTATION		WATER TANK DURATION (MINUTES)
				UPRIGHT	PENDENT	
ON FLOOR OR RACKS WITHOUT SOLID SHELVES	IDLE WOODEN PALLETS	7.6		-	14 (201)	50
				-	16.8 (242)	35
				-	22.4 (322)	25
				-	25.2 (363)	15
		9.8		-	14 (201)	60
				-	16.8 (242)	42
				-	-	-
				-	-	-
		10.7		-	-	-
				-	22.4 (322)	35
				-	25.4 (360)	30
		12.2		-	14 (201)	75
				-	16.8 (242)	52
				-	22.4 (322)	40
				-	25.2 (363)	25
ON FLOOR	IDLE WOODEN PALLETS	7.6		-	22.4 (322)	25
				-	25.2 (363)	40
				-	-	-
				-	-	-
		9.1		-	-	-
				-	14 (201)	50
				-	16.8 (240)	35
				-	14 (201)	75
		10.7		-	16.8 (240)	35
				-	14 (201)	75
				-	16.8 (240)	35
				-	16.8 (240)	35

250 GPM (950) LPM

250 GPM (950) LPM

**Table 9.15: Class I, II, III and IV Commodities Stored Palletized, solid piled or on shelves
with storage height of Up to 3.7 m**

TABLE 9.15: CLASS I – CLASS IV COMMODITIES STORED UP TO 3.7 M HEIGHT								
STORAGE ARRANGEMENT	COMMODITY CLASS	MAXIMUM STORAGE HEIGHT	MAXIMUM CEILING HEIGHT	REQUIRED DESIGN DENSITY Gpm (LPM)	AREA OF SPRINKLER OPERATION FT ² (m ²)	IN RACK SPRINKLER	TOTAL COMBINED INSIDE AND OUTSIDE HOSE, Gpm (LPM)	WATER TANK DURATION (MINUTES)
PALLETIZED, BIN BOX, SHELF, IN RACK,	I	< 3.7 m	-	0.15 (6.1)	1500 (140)	No need	250 (950)	90
	II	< 3 m	-	0.15 (6.1)	1500 (140)	No need	250 (950)	90
		3 m – 3.7 m	-	0.20 (8.1)	1500 (140)	No need	250 (950)	90
	IN RACK,	III	< 3.7 m	-	0.20 (8.1)	1500 (140)	No need	250 (950)
IV		< 3 m	-	0.20 (8.1)	1500 (140)	No need	250 (950)	90
PALLETIZED, BIN BOX, SHELF	IV	3 m – 3.7 m	-	0.20 (8.1)	1500 (140)	No need	250 (950)	90
		IV	3 m – 3.7 m	-	0.30 (12.2)	2500 (232)	No need	500 (1900)

Table 9.16: Class I, II, III and IV Commodities Stored Palletized, solid piled or on shelves with storage height 3.7 m to 6.1 m storage height

AISLE WIDTH & ENCAPSULATION		COMMODITY CLASS	IN RACK SPRINKLERS	CEILING SPRINKLER WATER DEMAND , gpm (LPM)							
				WITH IN RACK SPRINKLERS		WITHOUT IN RACK SPRINKLERS				MULTIPLE ROW RACKS	
				HIGH TEMPERATURE CEILING SPRINKLER & ORDINARY TEMPERATURE RACK SPRINKLER	ORDINARY TEMPERATURE SPRINKLER & ORDINARY SPRINKLER	SINGLE OR DOUBLE ROW RACKS		SINGLE OR DOUBLE ROW RACKS		HIGH TEMPERATURE CEILING SPRINKLERS	ORDINARY TEMPERATURE CEILING SPRINKLERS
						ORDINARY TEMPERATURE SPRINKLER	TEMPERATURE CEILING SPRINKLER	HIGH TEMPERATURE CEILING SPRINKLERS	TEMPERATURE CEILING SPRINKLERS		
1.2 M ENCAPSULATED	I	No Need	No Need	0.30			0.35		0.55*		-
	II	No Need	No Need	0.30			0.35		0.55*		-
	III	1 LEVEL	1 LEVEL	0.35			0.39		-		-
	IV	1 LEVEL	1 LEVEL	0.48			0.55 (22.4)		-		-
1.2 M NOT ENCAPSULATED	I	No Need	No Need	0.23			0.26		0.32		-
	II	No Need	No Need	0.26			0.3		0.38		-
	III	No Need	No Need	0.29			0.33		0.43		-
	IV	No Need	No Need	0.39			0.44		0.58		-
2.4 M ENCAPSULATED	I	No Need	No Need	0.25			0.28		0.47		-
	II	No Need	No Need	0.25			0.28		0.47		-
	III	1 LEVEL	1 LEVEL	0.28			0.32		-		-
	IV	1 LEVEL	1 LEVEL	0.39			0.45 (18.3)		-		-
2.4 M NOT ENCAPSULATED	I	No Need	No Need	0.19			0.22		0.29		-
	II	No Need	No Need	0.21			0.24		0.33		-
	III	No Need	No Need	0.24			0.28		0.37		-
	IV	No Need	No Need	0.32			0.37		0.49		-

- Single Point Design Only



Table 9.17: Class I, II, III and IV Commodities Stored Palletized, solid piled or on shelves with storage height 6.1 m to 6.7 m storage height

AISLE WIDTH & ENCAPSULATION		COMMODITY CLASS	IN RACK SPRINKLERS	CEILING SPRINKLER WATER DEMAND , gpm (LPM)				WITHOUT IN RACK SPRINKLERS			
				WITH IN RACK SPRINKLERS		SINGLE OR DOUBLE ROW RACKS		WITHOUT IN RACK SPRINKLERS		MULTIPLE ROW RACKS	
				HIGH TEMPERATURE CEILING SPRINKLER & ORDINARY TEMPERATURE RACK SPRINKLER	ORDINARY TEMPERATURE CEILING SPRINKLER & ORDINARY TEMPERATURE RACK SPRINKLER	HIGH TEMPERATURE CEILING SPRINKLER	ORDINARY TEMPERATURE CEILING SPRINKLERS	ORDINARY TEMPERATURE CEILING SPRINKLERS	HIGH TEMPERATURE CEILING SPRINKLERS	ORDINARY TEMPERATURE CEILING SPRINKLERS	ORDINARY TEMPERATURE CEILING SPRINKLERS
1.2 M ENCAPSULATED	I	I	1 LEVEL	0.30	0.35	-	-	-	-	-	-
	II	II	1 LEVEL	0.30	0.35	-	-	-	-	-	-
	III	III	1 LEVEL	0.35	0.39	-	-	-	-	-	-
	IV	IV	1 LEVEL	0.47	0.55	-	-	-	-	-	-
1.2 M NOT ENCAPSULATED	I	I	No Need	0.23	0.26	0.32	0.37	0.37	0.37	-	-
	II	II	No Need	0.26	0.29	0.385	0.44	0.44	0.44	-	-
	III	III	No Need	0.29	0.33	0.43	0.49	0.49	0.49	-	-
	IV	IV	No Need	0.39	0.44	0.58	0.60*	0.60*	0.60*	-	-
2.4 M ENCAPSULATED	I	I	1 LEVEL	0.24	0.275	-	-	-	-	-	-
	II	II	1 LEVEL	0.24	0.275	-	-	-	-	-	-
	III	III	1 LEVEL	0.28	0.32	-	-	-	-	-	-
	IV	IV	1 LEVEL	0.39	0.45	-	-	-	-	-	-
2.4 M NOT ENCAPSULATED	I	I	No Need	0.19	0.22	0.29	0.33	0.33	0.33	-	-
	II	II	No Need	0.21	0.24	0.325	0.37	0.37	0.37	-	-
	III	III	No Need	0.24	0.28	0.37	0.42	0.42	0.42	-	-
	IV	IV	No Need	0.32	0.37	0.495	0.57	0.57	0.57	-	-

Table 9.18: Class I, II, III and IV Commodities Stored Palletized, solid piled or on shelves with storage height 6.7 m to 7.6 m storage height

		CEILING SPRINKLER WATER DEMAND , gpm (LPM)									
		WITH IN RACK SPRINKLERS				WITHOUT IN RACK SPRINKLERS					
		SINGLE OR DOUBLE ROW RACKS		IN RACK SPRINKLERS		SINGLE OR DOUBLE ROW RACKS		HIGH TEMPERATURE CEILING SPRINKLERS		MULTIPLE ROW RACKS	
AISLE WIDTH & ENCAPSULATION	COMMODITY CLASS	IN RACK SPRINKLERS	COMMODITY CLASS	IN RACK SPRINKLERS	COMMODITY CLASS	SINGLE OR DOUBLE ROW RACKS	IN RACK SPRINKLERS	SINGLE OR DOUBLE ROW RACKS	HIGH TEMPERATURE CEILING SPRINKLERS	MULTIPLE ROW RACKS	ORDINARY TEMPERATURE CEILING SPRINKLERS
1.2 M ENCAPSULATED	I	1 LEVEL	I	1 LEVEL	I	0.305	0.35	-	-	-	-
	II	1 LEVEL	II	1 LEVEL	II	0.305	0.35	-	-	-	-
	III	1 LEVEL	III	1 LEVEL	III	0.35	0.39	-	-	-	-
	IV	1 LEVEL	IV	1 LEVEL	IV	0.475	0.55	-	-	-	-
1.2 M NOT ENCAPSULATED	I	No Need	I	No Need	I	0.23	0.26	0.32	0.355	-	-
	II	No Need	II	No Need	II	0.255	0.29	0.38	0.44	-	-
	III	No Need	III	No Need	III	0.275	0.325	0.43	0.49	-	-
	IV	1 LEVEL	IV	1 LEVEL	IV	0.39	0.44	-	-	-	-
2.4 M ENCAPSULATED	I	1 LEVEL	I	1 LEVEL	I	0.24	0.275	-	-	-	-
	II	1 LEVEL	II	1 LEVEL	II	0.24	0.275	-	-	-	-
	III	1 LEVEL	III	1 LEVEL	III	0.28	0.32	-	-	-	-
	IV	1 LEVEL	IV	1 LEVEL	IV	0.39	0.45	-	-	-	-
2.4 M NOT ENCAPSULATED	I	No Need	I	No Need	I	0.19	0.22	0.29	0.28	-	-
	II	No Need	II	No Need	II	0.21	0.24	0.325	0.37	-	-
	III	No Need	III	No Need	III	0.24	0.275	0.37	0.42	-	-
	IV	1 LEVEL	IV	1 LEVEL	IV	0.32	0.37	-	-	-	-

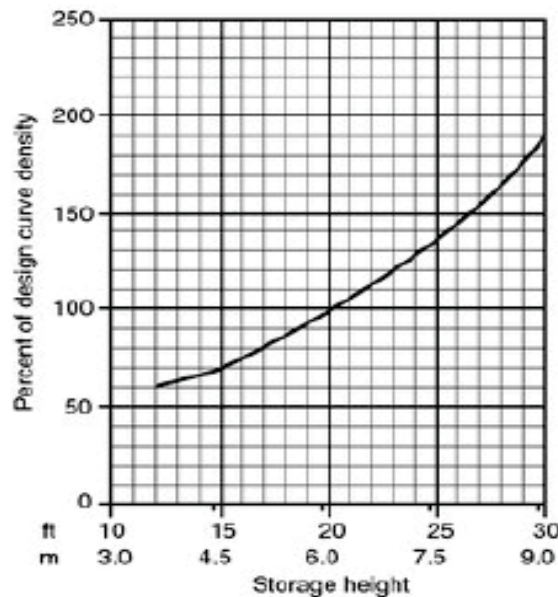


Figure 9.13: Ceiling Sprinkler Density modification according to Height of Storage

14.5. Large drop and Nominal K-factor Design for palletized or solid piled commodities

- 14.5.1.** The Pre-action or dry-type sprinkler system is only allowed for palletized or solid piled class I, II and III commodities with storage height of 7.6 m or less and design number of sprinklers for such systems shall be 25 with design pressure of 25 psi.
- 14.5.2.** Design Requirements for large drop and nominal k-factor wet sprinkler design criteria shall be as per [Table 9.19](#).

14.6. ESFR Sprinkler System for palletized or solid piled commodities

14.6.1. ESFR Systems

- 14.6.1.1.** ESFR (Early Suppression Fast Response) protection as defined shall not apply to the following:

- i. Rack storage involving solid shelves
- ii. Rack storage involving combustible, open-top cartons or containers

- 14.6.2.** ESFR sprinkler systems shall be designed such that the minimum operating pressure is not less than that indicated in Table for type of storage, commodity, storage height, and building height involved.

- 14.6.3.** The design area shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of four sprinklers on each of three branch lines.



14.6.4. Where ESFR sprinklers are installed above and below obstructions, the discharge for up to two sprinklers for one of the levels shall be included with those of the other level in the hydraulic calculations.

14.6.5. Design requirements for ESFR sprinkler design criteria for palletized or solid piled class I, II, III & IV commodities shall be as per [Table 9.20](#).

14.7. Class I, II, III & IV Commodities Stored in Single, Double or Multiple Racks

14.7.1. Up to 7.6 m storage height

14.7.1.1. Large drop and K-factor Sprinkler system for racks up to 7.6 m:

14.7.1.1.1. Design requirements for large drop and nominal k-factor wet sprinkler design criteria for class I, II, III & IV commodities stored in single, Double or Multiple Racks up to 7.6 m height shall be as per [Table 9.21](#).

14.7.1.2. ESFR Sprinkler system for racks up to 7.6 m height:

14.7.1.2.1. ESFR design requirements for large drop and nominal k-factor wet sprinkler design criteria for class I, II, III & IV commodities stored in single, Double or Multiple Racks up to 7.6 m height shall be as per [Table 9.22](#).

14.7.2. Over 7.6 m storage height

14.7.2.1. Large drop and K-factor Sprinkler system for racks over 7.6 m height:

14.7.2.1.1. The large drop design and specific control K-factor design criteria are not applicable to Class III and IV commodities stored in excess of 7.6 m.

14.7.2.1.2. The large drop design and specific control K-factor design criteria for class I & II commodities stored in excess of 7.6 m shall be as per [Table 9.23](#).

14.7.2.2. ESFR Sprinkler system for racks over 7.6 m height:

14.7.2.2.1. Requirements for ESFR sprinkler design criteria for Class I, II, III & IV commodities stored in single, Double or Multiple Racks over 7.6 m height shall be as per [Table 9.24](#).

14.8. In-Rack Sprinkler Location for Rack Storages of Class I Through Class IV Commodities Stored Up to 7.6 m in Height.

14.8.1. In single- or double-row racks without solid shelves, Stored from 3.7 m up to 7.6 m, in-rack sprinklers shall be installed in accordance with [Table 9.30](#).



IN-RACK SPRINKLER SPACING FOR CLASS I, II, III, AND IV COMMODITIES
STORED UP TO 7.6M

AISLE WIDTH	COMMODITY CLASS		
	I & II	III	IV
1.2	3.7 m	2.4 m	2.4 m
2.4	3.7 m	3.7 m	2.4 m

- 14.8.2.** In single- or double-row racks without solid shelves, Stored from 6.1 m up to 6.7 m, in-rack sprinklers shall be installed in accordance with [Table 9.31](#)
- 14.8.3.** In single- or double-row racks without solid shelves, Stored from 6.7 m up to 7.6 m, in-rack sprinklers shall be installed in accordance with [Table 9.32](#)
- 14.8.4.** In multiple-row racks no deeper than 4.9 m with aisles 2.4 or wider, with storage height upto 7.6 m, in-rack sprinklers shall be installed in accordance with [Table 9.33](#)
- 14.8.5.** In multiple-row racks deeper than 4.9 m or with aisles less than 2.4 m wide, with storage height over 7.6 m in-rack sprinklers shall be installed in accordance with [Table 9.33](#).
- 14.8.6.** In-rack sprinklers at one level only for storage up to and including 7.6 m high shall be located at the first tier level at or above one-half of the storage height.
- 14.8.7.** In-rack sprinklers at two levels only for storage up to and including 7.6 m high shall be located at the first tier level at or above one-third and two-thirds of the storage height.



Table 9.19: Large drop and Nominal K-factor Design for palletized or solid piled commodities, plastic and rubber Stored up to 7.6 m

TABLE 9.19: LARGE DROP AND NOMINAL K-FACTOR WET SPRINKLER SYSTEM DESIGN REQUIREMENTS FOR ALL COMMODITIES, PLASTIC AND RUBBER, STORED UPTO 7.6 M									
STORAGE ARRANGEMENT	COMMODITY CLASS	MAXIMUM STORAGE HEIGHT	MAXIMUM CEILING HEIGHT	LARGE DROP TYPE NOMINAL K-FACTOR 11.2 (161)		K-FACTOR 16.8 (242) NUMBER OF SPRINKLERS BY MINIMUM DESIGN PRESSURE		HOSE ALLOWANCE	WATER TANK DURATION (MINUTES)
				NUMBER OF SPRINKLERS	DESIGN PRESSURE	10 psi (0.7 bar)	22 psi (1.5 bar)		
PALLETIZED	I	7.6	10.7	15	25 psi	-	-	500 (1900)	120
	II	7.6	10.7	15	25 psi	-	-	500 (1900)	120
	III	7.6	10.7	15	25 psi	-	-	500 (1900)	120
	I or II	7.6	9.1	-	-	15	-	500 (1900)	120
	III or IV	7.6	9.1	-	-	-	15	500 (1900)	120
	IV	6.1	9.1	15	50 psi	-	-	500 (1900)	120
	PLASTICS AND RUBBER CARTONED OR EXPOSED UNEXPANDED	6.1	9.1	25	25 psi	-	-	500 (1900)	120
		7.6	9.1	-	-	-	15		
	PLASTIC AND RUBBER CARTONED OR EXPOSED EXPANDED	5.5	7.9	15	50 psi	-	-	500 (1900)	120
	SOLID PILED	PLASTICS AND RUBBER CARTONED OR EXPOSED UNEXPANDED	6.1	9.1	15	50 psi	-	-	500 (1900)
7.6			9.1	-	-	-	15		
I		6.1	9.1	15	25	-	-	500 (1900)	120
I		7.6	9.1	-	-	15	-	500 (1900)	120
II		6.1	9.1	15	25	-	-	500 (1900)	120
II		7.6	9.1	-	-	15	-	500 (1900)	120
III		6.1	9.1	15	25	-	-	500 (1900)	120
III		7.6	9.1	-	-	-	15	500 (1900)	120
IV		6.1	9.1	15	50	-	-	500 (1900)	120
IV		7.6	9.1	-	-	-	15	500 (1900)	120

Table 9.20: ESFR Sprinkler System for palletized or solid piled I, II, III and IV commodities

TABLE 9.20: ESFR REQUIREMENTS FOR PALLETIZED OR SOLID PILED CLASS I, II, III AND IV COMMODITIES STORAGE							
STORAGE ARRANGEMENT	COMMODITY	MAXIMUM STORAGE HEIGHT	MAXIMUM CEILING HEIGHT	NOMINAL K-FACTORS FOR THE TYPE OF SPRINKLER ORIENTATION		MINIMUM OPERATING PRESSURE (PSI)	HOSE ALLOWANCE
				UPRIGHT	PENDENT		
PALLETIZED OR SOLID PILED	CLASS I, II, III, IV	6.1	7.6	14 (201)	14 (201)	50	250 GPM (950 LPM)
				16.8 (242)	16.8 (242)	35	
				-	22.4 (322)	20	
				-	25.2 (363)	15	
		7.6	9.1	14 (201)	14 (201)	50	
				16.8 (242)	16.8 (242)	35	
				-	22.4 (322)	20	
				-	25.2 (363)	15	
		7.6	9.8	14 (201)	14 (201)	60	
				-	16.8 (242)	42	
		9.1	10.7	14 (201)	14 (201)	75	
				16.8 (242)	16.8 (242)	52	
				-	22.4 (322)	-	
				-	25.2 (363)	-	
		10.7	12.2	-	14 (201)	75	
				16.8 (242)	16.8 (242)	52	
				-	22.4 (322)	40	
				-	25.2 (363)	25	
		10.7	13.7	-	22.4 (322)	40	
				-	25.2 (363)	40	
		12.2	13.7	-	22.4 (322)	40	
				-	25.2 (363)	40	

Table 9.21: Commodities I, II, III & IV Stored in Single, Double or Multiple Racks Up to 7.6 m storage height

TABLE 9.21: LARGE DROP AND NOMINAL K-FACTOR WET SPRINKLER SYSTEM DESIGN REQUIREMENTS FOR CLASS I, II, III & IV COMMODITIES STORED IN SINGLE, DOUBLE OR MULTIPLE RACKS UP TO 7.6 M														
TYPE OF SYSTEM	COMMODITY CLASS	MAXIMUM STORAGE HEIGHT	MAXIMUM CEILING HEIGHT	LARGE DROP TYPE NOMINAL K-FACTOR 11.2 (160) / ORIENTATION		K-FACTOR 16.8 (240) NUMBER OF SPRINKLERS BY MINIMUM DESIGN PRESSURE / ORIENTATION				K-FACTOR 19.6 (280) NUMBER OF SPRINKLERS BY MINIMUM DESIGN PRESSURE / ORIENTATION		HOSE ALLOWANCE	DURATION MINUTES	
				NUMBER OF SPRINKLERS	DESIGN PRESSURE	10 PSI (0.7 BAR)	15 PSI (1 BAR)	22 PSI (1.5 BARS)	35 PSI (2.4 BARS)	16 PSI (1.1 BARS)	25 PSI (1.7 BARS)			30PSI (2.1 BARS)
WET	I, II	6.1	9.1	15 / upright	25 psi	15 / upright	-	-	-	15 / pendent	-	500 (1900)	120	
		7.6	9.1	20 / upright	25 psi	15 / upright	-	-	-	15 / pendent	-	500 (1900)	120	
		6.1	9.1	15 / upright	25 psi	-	15 / upright	-	-	15 / pendent	-	500 (1900)	120	
		7.6	9.1	15+ 1 level of in-rack/upright	25 psi	-	15 / upright	-	-	15 / pendent	-	500 (1900)	120	
	III	7.6	10.6	15+ 1 level of in-rack/upright	25 psi	-	15+ 1 level of in-rack / upright	-	-	-	15 / pendent	500 (1900)	120	
				15 / upright	-	-	-	-	-	-	-	-	-	-
				15 / upright	-	-	-	-	-	-	-	-	-	-
		IV	6.1	7.6	15/upright	50 psi	-	-	15 / upright	-	15 / pendent	-	500 (1900)	120
	6.1		9.1	20/ upright	50 psi	-	-	15 / upright	-	15 / pendent	-	500 (1900)	120	
	PRE-ACTION OR DRY	I,II	6.1	9.1	25 / upright	25 psi	-	25 / upright	-	-	-	-	500 (1900)	120
7.6			9.1	30 / upright	25 psi	-	30 / upright	-	-	-	-	500 (1900)	120	
III			6.1	9.1	25 / Upright	25 psi	-	25 / upright	-	-	-	-	500 (1900)	120
			7.6	9.1	30 / Upright	25 psi	-	30 / upright	-	-	-	-	500 (1900)	120

Table 9.22: ESFR Sprinkler system for Commodities I, II, III & IV Stored in Single, Double or Multiple Racks
Up to 7.6 m storage height

TABLE 9.22: ESFR FOR CLASS I, II, III AND IV COMMODITIES STORED IN SINGLE, DOUBLE OR MULTIPLE ROW RACKS UP TO 7.6 M HEIGHT						
STORAGE ARRANGEMENT	COMMODITY	MAXIMUM STORAGE HEIGHT (m)	MAXIMUM CEILING HEIGHT (m)	NOMINAL K-FACTORS FOR THE TYPE OF SPRINKLER ORIENTATION		MINIMUM OPERATING PRESSURE (PSI)
				UPRIGHT	PENDENT	
SINGLE-ROW, DOUBLE-ROW, AND MULTIPLE-ROW RACK (NO OPEN-TOP CONTAINERS)	CLASS I, II, III, OR IV, ENCAPSULATED OR NOT ENCAPSULATED	6.1	7.6	14 (201)	14 (201)	50
				16.8 (242)	16.8 (242)	35
				-	22.4 (322)	25
				-	25.2 (363)	15
				14 (201)	14 (201)	50
			9.1	16.8 (242)	16.8 (242)	35
				-	22.4 (322)	25
				-	25.2 (363)	15
				14 (201)	14 (201)	60
				16.8 (242)	16.8 (242)	42
		7.6	10.7	14 (201)	14 (201)	75
				16.8 (242)	16.8 (242)	52
				-	22.4 (322)	35
				-	25.2 (363)	20
				-	14 (201)	75
			12.2	-	16.8 (242)	52
				-	22.4 (322)	40
				-	25.2 (363)	25
				-	14 (201)	90
			13.7	-	16.8 (242)	63
				-	22.4 (322)	40
				-	25.2 (363)	40

* Not applicable to storage height of 6.1 m

Table 9.23: LARGE DROP AND NOMINAL K-FACTOR WET SPRINKLER SYSTEM DESIGN REQUIREMENTS FOR CLASS I,II,III & IV COMMODITIES STORED IN SINGLE, DOUBLE OR MULTIPLE RACKS OVER 7.6 M

TABLE 9.23: LARGE DROP AND NOMINAL K-FACTOR WET SPRINKLER SYSTEM DESIGN REQUIREMENTS FOR CLASS I,II,III & IV COMMODITIES STORED IN SINGLE, DOUBLE OR MULTIPLE RACKS OVER 7.6 M												
TYPE OF SYSTEM	COMMODITY CLASS	MAXIMUM STORAGE HEIGHT	MAXIMUM CEILING HEIGHT	LARGE DROP TYPE NOMINAL K-FACTOR 11.2 (160)/ ORIENTATION		K-FACTOR 16.8 (240) NUMBER OF SPRINKLERS BY MINIMUM DESIGN PRESSURE / ORIENTATION	K-FACTOR 19.6 (280) NUMBER OF SPRINKLERS BY MINIMUM DESIGN PRESSURE / ORIENTATION	HOSE ALLOWANCE	DURATION MINUTES			
				NUMBER OF SPRINKLERS	DESIGN PRESSURE							
WET	I, II	9.1	10.6	20 + 1 level of in rack / upright	25 PSI	20 + 1 level of in rack / upright	-	15 / pendent	-	500 (1900)	120	
		10.6	12.1	-	-	-	-	-	15 / pendent	500 (1900)	120	
	III, IV	9.1	10.6	-	-	-	-	15 / pendent	-	500 (1900)	120	
		10.6	12.1	-	-	-	-	-	15 / pendent	500 (1900)	120	
PRE - ACTION OR DRY	I, II	9.1	10.6	30 + 1 level of in rack / upright	25 PSI	30 + 1 level of in rack / upright	-	-	-	500 (1900)	120	
		10.6	12.1	36 /upright	55 psi	36 /upright	-	-	-	500 (1900)	120	

Table 9.24: ESFR Sprinkler system for Commodities I, II, III & IV Stored in Single, Double or Multiple Racks over 7.6 m height

TABLE 9.24: ESFR REQUIREMENT FOR CLASS I, II, III AND IV COMMODITIES STORED IN SINGLE, DOUBLE OR MULTIPLE ROW RACKS OVER 7.6 M HEIGHT										
STORAGE ARRANGEMENT	COMMODITY	MAXIMUM STORAGE HEIGHT (m)		MAXIMUM CEILING HEIGHT (m)	NOMINAL K-FACTORS FOR THE TYPE OF SPRINKLER ORIENTATION		MINIMUM OPERATING PRESSURE	HOSE ALLOWANCE	WATER TANK DURATION (MINUTES)	
					UPRIGHT	PENDENT				
SINGLE-ROW, DOUBLE-ROW, AND MULTIPLE-ROW RACK (NO OPEN-TOP CONTAINERS)	CLASS I, II, III, OR IV, ENCAPSULATED OR NOT ENCAPSULATED	9.1	10.7	10.7	14 (201)	14 (201)	75	250 GPM (950) LPM	60	
					16.8 (242)	16.8 (242)	52			
					-	22.4 (322)	35			
					-	25.2 (363)	20			
					-	14 (201)	75			
					-	16.8 (242)	52			
		10.7	12.2	-	22.4 (322)	40				
				-	25.2 (363)	20				
				-	14 (201)	90				
				-	16.8 (242)	63				
				-	22.4 (322)	40				
				-	25.2 (363)	40				
		12.2	13.7	12.2	-	-	-			-
					-	-	-			-

14.9. Group A Plastic**14.9.1. Up to 3.7 m storage height**

14.9.1.1. Requirements for palletized, in shelf or in racks Storage of Group A Plastic with storage height of less than 3.7 m shall be as per **Table 9.25**.

14.10. Group B plastics and free-flowing Group A plastics shall be protected the same as Class IV commodities.

14.11. Group C plastics shall be protected the same as Class III commodities.

14.12. Design requirements for ESFR sprinkler system for palletized or solid piled plastic and rubber shall be as per **Table 9.26**.

14.13. Tires**14.13.1. Up to 3.7 m storage height**

14.13.1.1. Requirements for solid piled, in shelf or in racks Storage of Tires with storage height of less than 3.7 m shall be as per **Table 9.27**.

14.14. Rolled Paper**14.14.1. Up to 3.7 m storage height**

14.14.1.1. Requirements for Storage of Rolled Paper with storage height of less than 3.7 m shall be as per **Table 9.28**.

14.15. Single, Double or Multiple row Rack Storage of Class I,II, III and IV Commodities**14.15.1. 3.7 m to 6.1 m storage height**

14.15.1.1. Requirements for single or double row racks with storage height of 3.7 m to 6.1 m shall be as per **Table 9.29**.

14.15.1.2. Requirements for Multiple row racks with storage height of up to 7.6 m shall be as per **Table 9.32** and **9.33**.

14.15.2. 6.1 m to 6.7 m storage height

14.15.2.1. Requirements for single or double row racks with storage height of 6.1 m to 6.7 m shall be as per **Table 9.30**.

14.15.3. 6.7 m to 7.6 m storage height

14.15.3.1. Requirements for single or double row racks with storage height of 6.7 m to 7.6 m shall be as per **Table 9.31**.



- 14.15.3.2.** For storage height over 3.7 m up to and including 6.1 m protected with ceiling sprinklers only and for storage height over 3.7 m up to and including 6.1 m protected with ceiling sprinklers and minimum required in-rack sprinklers, densities obtained from [Table 9.29](#), [Table 9.30](#), [Table 9.31](#), [Table 9.32](#) and [Table 9.33](#) shall be adjusted in accordance with [figure 9.14](#).

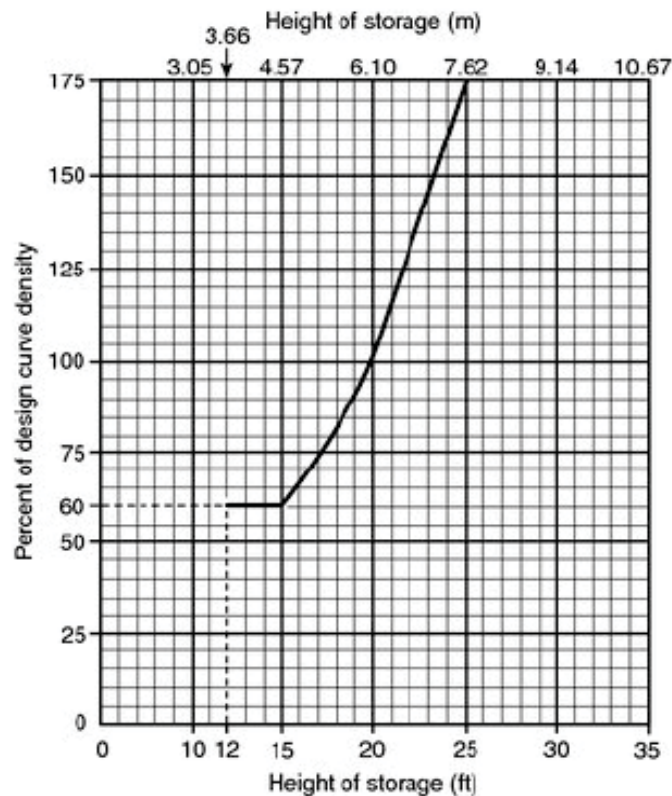


Figure 9.14: Ceiling sprinkler densities modification in accordance with storage heights



Table 9.25: Group A Plastic Stored Palletized, Bin Box, Shelf or in Racks with storage height of up to 3.7 m

TABLE 9.25: GROUP A PLASTIC STORED UP TO 3.7 M								
COMMODITY CLASS	STORAGE ARRANGEMENT	MAXIMUM STORAGE HEIGHT	MAXIMUM CEILING HEIGHT	REQUIRED DESIGN DENSITY Gpm (LPM)	AREA OF SPRINKLER OPERATION FT ² (m ²)	IN RACK SPRINKLER	TOTAL COMBINED INSIDE AND OUTSIDE HOSE Gpm (LPM)	DURATION MIN
GROUP A PLASTIC CARTONED UNEXPANDED AND EXPANDED	PALLETIZED BIN BOX, SHELF, IN RACK	< 1.5 m	-	0.20 (8.1)	1500 (140)	No need	250 (950)	90
		1.5 m – 3 m	4.6 m	0.30 (12.2)	2500 (232)	No need	500 (1900)	120
		1.5 m – 3 m	6.1 m	0.40 (16.3)	2500 (232)	No need	500 (1900)	120
		3 m – 3.7 m	5.2 m	0.40 (16.3)	2500 (232)	No need	500 (1900)	120
	PALLETIZED BIN BOX, SHELF	3 m – 3.7 m	8.2 m	0.20 (8.1)	1500 (140)	1 LEVEL	250 (950)	90
		3 m – 3.7 m	8.2 m	0.40 (16.3)	2500 (232)	No need	500 (1900)	120
GROUP A PLASTIC EXPOSED	PALLETIZED BIN BOX, SHELF, IN RACK	3 m – 3.7 m	8.2 m	0.20 (8.1)	1500 (140)	1 LEVEL	250 (950)	90
		< 1.5 m	-	0.20 (8.1)	1500 (140)	No need	250 (950)	90
		1.5 m – 3 m	4.6 m	0.40 (16.3)	2500 (232)	No need	500 (1900)	120
		1.5 m – 2.4 m	8.5 m	0.40 (16.3)	2500 (232)	No need	500 (1900)	120
	PALLETIZED BIN BOX, SHELF	3 m – 3.7 m	5.2 m	0.40 (16.3)	2500 (232)	No need	500 (1900)	120
		3 m – 3.7 m	5.2 m	0.40 (16.3)	2500 (232)	No need	500 (1900)	120
	PALLETIZED BIN BOX, SHELF, IN RACK	3 m – 3.7 m	8.2 m	0.20 (8.1)	1500 (140)	1 LEVEL	250 (950)	90
		1.5 m – 3 m	6.1 m	0.40 (16.3)	2500 (232)	No need	500 (1900)	120
EXPANDED	PALLETIZED BIN BOX, SHELF, IN RACK	1.5 m – 3 m	6.1 m	0.20 (8.1)	1500 (140)	1 LEVEL	250 (950)	90
		1.5 m – 3 m	6.1 m	0.20 (8.1)	1500 (140)	1 LEVEL	250 (950)	90

Table 9.26: ESFR sprinkler system for palletized or solid piled plastic and rubber

STORAGE ARRANGEMENT	COMMODITY	MAXIMUM STORAGE HEIGHT (m)	MAXIMUM CEILING HEIGHT (m)	NOMINAL K-FACTORS FOR THE TYPE OF SPRINKLER ORIENTATION		MINIMUM OPERATING PRESSURE	HOSE ALLOWANCE	DURATION MINUTES
				UPRIGHT	PENDENT			
PALLETIZED OR SOLID PILED	PLASTIC CARTONED UNEXPANDED	6.1	7.6	14 (201)	14 (201)	50	250 GPM (950) LPM	60
				16.8 (242)	16.8 (242)	35		
				-	22.4 (322)	25		
				-	25.2 (363)	15		
				14 (201)	14 (201)	50		
				16.8 (242)	16.8 (242)	35		
				-	22.4 (322)	25		
				-	25.2 (363)	15		
				14 (201)	14 (201)	75		
				16.8 (242)	16.8 (242)	52		
				-	22.4 (322)	40		
				-	25.2 (363)	25		
				-	22.4 (322)	25		
				-	25.2 (363)	40		
PALLETIZED OR SOLID PILED	PLASTIC EXPOSED UNEXPANDED	6.1	7.6	14 (201)	14 (201)	50	250 GPM (950) LPM	60
				-	16.8 (242)	35		
				-	14 (201)	50		
				-	16.8 (242)	35		
				-	14 (201)	50		
				-	16.8 (242)	35		
				-	14 (201)	75		
				-	16.8 (242)	52		
				-	14 (201)	25		
				-	16.8 (242)	52		
				-	25.2 (363)*	25		
				14 (201)	14 (201)	50		
				16.8 (242)	16.8 (242)	35		
				14 (201)	14 (201)	50		
PALLETIZED OR SOLID PILED	PLASTIC CARTONED EXPANDED	6.1	7.6	14 (201)	14 (201)	50	250 GPM (950) LPM	60
				16.8 (242)	16.8 (242)	35		
				14 (201)	14 (201)	50		
				16.8 (242)	16.8 (242)	35		
PALLETIZED OR SOLID PILED	PLASTIC EXPOSED & EXPANDED	7.5	12.2	14 (201)*	14 (201)*	75	250 GPM (950) LPM	60
				16.8 (242)*	16.8 (242)*	52		
				14 (201)	14 (201)	50		
				16.8 (242)	16.8 (242)	35		

* Not applicable to storage height of 6.1 m

Table 9.27: Tires Stored solid piled, on shelf or in racks with storage height up to 3.7 m

TABLE 9.27: TIRES STORED UP TO 3.7 M								
COMMODITY CLASS	STORAGE ARRANGEMENT	MAXIMUM STORAGE HEIGHT	MAXIMUM CEILING HEIGHT	REQUIRED DESIGN DENSITY Gpm (LPM)	AREA OF SPRINKLER OPERATION FT ² (m ²)	IN RACK SPRINKLER	TOTAL COMBINED INSIDE AND OUTSIDE HOSE, Gpm (LPM)	DURATION MINUTES
TIRES	ON FLOOR, ON SIDE	1.5 m – 3.7 m	8.2 m	0.30 (12.2)	2500 (232)	No need	500 (1900)	120
	ON FLOOR, ON TREAD OR ON SIDE	<1.5 m		0.20 (8.1)	1500 (140)	No need	250 (950)	90
	SINGLE DOUBLE OR MULTIPLE-ROW ON RACKS ON TREAD OR ON SIDE	<1.5 m		0.20 (8.1)	1500 (140)	No need	250 (950)	90
	SINGLE-ROW RACK, PORTABLE, ON TREAD OR ON SIDE	1.5 m – 3.7 m	8.2 m	0.30 (12.2)	2500 (232)	No need	500 (1900)	120
	SINGLE-ROW RACK, FIXED, ON TREAD OR ON SIDE	1.5 m – 3.7 m	8.2 m	0.30 (12.2)	2500 (232)	No need	500 (1900)	120
		1.5 m – 3.7 m	8.2 m	0.20 (8.1)	1500 (140)	1 LEVEL	250 (950)	90

Table 9.28: Rolled Paper with storage height up to 3.7 m height

TABLE 9.28: ROLLED PAPER STORED UP TO 3.7 M						
COMMODITY CLASS	STORAGE ARRANGEMENT	MAXIMUM STORAGE HEIGHT	MAXIMUM CEILING HEIGHT	REQUIRED DESIGN DENSITY Gpm (LPM)	AREA OF SPRINKLER OPERATION FT ² (m ²)	IN RACK SPRINKLER
ROLLED PAPER HEAVY AND MEDIUM WEIGHT	ON END	< 3 m	8 m	0.20 (8.1)	1500 (140)	No Need
ROLLED PAPER, TISSUE AND LIGHT WEIGHT	ON END	< 3 m	8 m	0.30 (12.2)	2500 (232)	No need

Table 9.29: Single or Double Row Racks – Storage Height Over 12 ft (3.7 m) up to and including 20 ft (6.1 m) (6.1 m) without solid shelves.

Single or Double Row Racks – Storage Height Over 12 ft (3.7 m) up to and including 20 ft (6.1 m)									
		WITH IN RACK SPRINKLERS				WITHOUT IN RACK SPRINKLERS			
		SINGLE OR DOUBLE ROW RACKS		SINGLE OR DOUBLE ROW RACKS		SINGLE OR DOUBLE ROW RACKS		SINGLE OR DOUBLE ROW RACKS	
		HIGH TEMPERATURE CEILING SPRINKLER & ORDINARY TEMPERATURE RACK SPRINKLER	ORDINARY TEMPERATURE CEILING SPRINKLER & ORDINARY TEMPERATURE RACK SPRINKLER	ORDINARY TEMPERATURE CEILING SPRINKLER	HIGH TEMPERATURE CEILING SPRINKLERS	ORDINARY TEMPERATURE CEILING SPRINKLERS	ORDINARY TEMPERATURE CEILING SPRINKLERS	ORDINARY TEMPERATURE CEILING SPRINKLERS	ORDINARY TEMPERATURE CEILING SPRINKLERS
AISLE WIDTH & ENCAPSULATION	COMMODITY CLASS	IN RACK SPRINKLERS	CEILING SPRINKLER WATER DEMAND , Gpm (LPM)						
1.2 M ENCAPSULATED	I	No Need	0.30 (12.2)	0.35 (14.3)	0.35 (14.3)	0.55 (22.4)	0.55 (22.4)	0.55 (22.4)	0.55 (22.4)
	II	No Need	0.30 (12.2)	0.35 (14.3)	0.35 (14.3)	0.55 (22.4)	0.55 (22.4)	0.55 (22.4)	0.55 (22.4)
	III	1 LEVEL	0.35 (14.3)	0.39 (15.9)	0.39 (15.9)	---	---	---	---
	IV	1 LEVEL	0.47 (19.1)	0.55 (22.4)	0.55 (22.4)	---	---	---	---
1.2 M NOT ENCAPSULATED	I	No Need	0.23 (9.3)	0.26 (10.6)	0.26 (10.6)	0.32 (13.0)	0.32 (13.0)	0.37 (15.0)	0.37 (15.0)
	II	No Need	0.26 (10.6)	0.30 (12.2)	0.30 (12.2)	0.38 (15.5)	0.38 (15.5)	0.44 (17.9)	0.44 (17.9)
	III	No Need	0.29 (11.8)	0.33 (13.4)	0.33 (13.4)	0.43 (17.5)	0.43 (17.5)	0.49 (20.0)	0.49 (20.0)
	IV	No Need	0.39 (15.9)	0.44 (17.9)	0.44 (17.9)	0.58 (23.6)	0.58 (23.6)	0.60 (24.5)	0.60 (24.5)
2.4 M ENCAPSULATED	I	No Need	0.24 (9.8)	0.27 (11.0)	0.27 (11.0)	0.47 (19.1)	0.47 (19.1)	0.54 (22.0)	0.54 (22.0)
	II	No Need	0.24 (9.8)	0.27 (11.0)	0.27 (11.0)	0.47 (19.1)	0.47 (19.1)	0.54 (22.0)	0.54 (22.0)
	III	1 LEVEL	0.28 (11.4)	0.32 (13.0)	0.32 (13.0)	---	---	---	---
	IV	1 LEVEL	0.39 (15.9)	0.45 (18.3)	0.45 (18.3)	---	---	---	---
2.4 M NOT ENCAPSULATED	I	No Need	0.19 (7.7)	0.22 (9.0)	0.22 (9.0)	0.29 (11.8)	0.29 (11.8)	0.33 (13.4)	0.33 (13.4)
	II	No Need	0.21 (8.6)	0.24 (9.8)	0.24 (9.8)	0.32 (13.0)	0.32 (13.0)	0.37 (15.0)	0.37 (15.0)
	III	No Need	0.24 (9.8)	0.27 (11.0)	0.27 (11.0)	0.37 (15.0)	0.37 (15.0)	0.42 (17.1)	0.42 (17.1)
	IV	No Need	0.32 (13.0)	0.37 (15.0)	0.37 (15.0)	0.49 (20.0)	0.49 (20.0)	0.57 (23.2)	0.57 (23.2)

- Single Point Design Only

Table 9.30: Single or Double Row Racks – Storage Height Over 20 ft (6.1 m) up to and including 22 ft (6.7 m) without solid shelves.

Single or Double Row Racks – Storage Height Over 20 ft (6.1 m) up to and including 22 ft (6.7 m) without solid shelves.							
AISLE WIDTH & ENCAPSULATION	COMMODITY CLASS	IN RACK SPRINKLERS	CEILING SPRINKLER WATER DEMAND , Gpm (LPM)				
			WITH IN RACK SPRINKLERS		WITHOUT IN RACK SPRINKLERS		
			SINGLE OR DOUBLE ROW RACKS		SINGLE OR DOUBLE ROW RACKS		
			HIGH TEMPERATURE CEILING SPRINKLER & ORDINARY TEMPERATURE RACK SPRINKLER	ORDINARY TEMPERATURE CEILING SPRINKLER & ORDINARY TEMPERATURE RACK SPRINKLER	HIGH TEMPERATURE CEILING SPRINKLERS	ORDINARY TEMPERATURE CEILING SPRINKLERS	
1.2 M ENCAPSULATED	I	1 LEVEL	0.30 (12.2)	0.35 (14.3)	---	---	
	II	1 LEVEL	0.30 (12.2)	0.35 (14.3)	---	---	
	III	1 LEVEL	0.35 (14.3)	0.39 (15.9)	---	---	
	IV	1 LEVEL	0.47 (19.1)	0.55 (22.4)	---	---	
1.2 M NOT ENCAPSULATED	I	No Need	0.23 (9.3)	0.26 (10.6)	0.32 (13.0)	0.37 (15.0)	
	II	No Need	0.26 (10.6)	0.30 (12.2)	0.38 (15.5)	0.44 (17.9)	
	III	No Need	0.29 (11.8)	0.33 (13.4)	0.43 (17.5)	0.49 (20.0)	
	IV	No Need	0.39 (15.9)	0.44 (17.9)	0.58 (23.6)	0.60 (24.5)	
2.4 M ENCAPSULATED	I	1 LEVEL	0.24 (9.8)	0.27 (11.0)	---	---	
	II	1 LEVEL	0.24 (9.8)	0.27 (11.0)	---	---	
	III	1 LEVEL	0.28 (11.4)	0.32 (13.0)	---	---	
	IV	1 LEVEL	0.39 (15.9)	0.45 (18.3)	---	---	
2.4 M NOT ENCAPSULATED	I	No Need	0.19 (7.7)	0.22 (9.0)	0.29 (11.8)	0.33 (13.4)	
	II	No Need	0.21 (8.6)	0.24 (9.8)	0.32 (13.0)	0.37 (15.0)	
	III	No Need	0.24 (9.8)	0.27 (11.0)	0.37 (15.0)	0.42 (17.1)	
	IV	No Need	0.32 (13.0)	0.37 (15.0)	0.49 (20.0)	0.57 (23.2)	

- Single Point Design Only

Table 9.31: Single or Double Row Racks – Storage Height Over 22 ft (6.7 m) up to and including 25 ft (7.6 m) without solid shelves.

Single or Double Row Racks – Storage Height Over 22 ft (6.7 m) up to and including 25 ft (7.6 m) without solid shelves.							
AISLE WIDTH & ENCAPSULATION	COMMODITY CLASS	IN RACK SPRINKLERS	CEILING SPRINKLER WATER DEMAND , Gpm (LPM)				
			WITH IN RACK SPRINKLERS		WITHOUT IN RACK SPRINKLERS		
			HIGH TEMPERATURE CEILING SPRINKLER & ORDINARY TEMPERATURE RACK SPRINKLER	ORDINARY TEMPERATURE CEILING SPRINKLER & ORDINARY TEMPERATURE RACK SPRINKLER	HIGH TEMPERATURE CEILING SPRINKLERS	ORDINARY TEMPERATURE CEILING SPRINKLERS	
1.2 M ENCAPSULATED	I	1 LEVEL	0.30 (12.2)	0.35 (14.3)	0.35 (14.3)	0.35 (14.3)	0.35 (14.3)
	II	1 LEVEL	0.30 (12.2)	0.35 (14.3)	0.35 (14.3)	0.35 (14.3)	0.35 (14.3)
	III	1 LEVEL	0.35 (14.3)	0.39 (15.9)	0.39 (15.9)	0.39 (15.9)	0.39 (15.9)
	IV	1 LEVEL	0.47 (19.1)	0.55 (22.4)	0.55 (22.4)	0.55 (22.4)	0.55 (22.4)
1.2 M NOT ENCAPSULATED	I	No Need	0.23 (9.3)	0.26 (10.6)	0.32 (13.0)	0.37 (15.0)	0.37 (15.0)
	II	No Need	0.26 (10.6)	0.30 (12.2)	0.38 (15.5)	0.44 (17.9)	0.44 (17.9)
	III	No Need	0.29 (11.8)	0.33 (13.4)	0.43 (17.5)	0.49 (20.0)	0.49 (20.0)
	IV	No Need	0.39 (15.9)	0.44 (17.9)	0.44 (17.9)	0.44 (17.9)	0.44 (17.9)
2.4 M ENCAPSULATED	I	1 LEVEL	0.24 (9.8)	0.27 (11.0)	0.27 (11.0)	0.27 (11.0)	0.27 (11.0)
	II	1 LEVEL	0.24 (9.8)	0.27 (11.0)	0.27 (11.0)	0.27 (11.0)	0.27 (11.0)
	III	1 LEVEL	0.28 (11.4)	0.32 (13.0)	0.32 (13.0)	0.32 (13.0)	0.32 (13.0)
	IV	1 LEVEL	0.39 (15.9)	0.45 (18.3)	0.45 (18.3)	0.45 (18.3)	0.45 (18.3)
2.4 M NOT ENCAPSULATED	I	No Need	0.19 (7.7)	0.22 (9.0)	0.29 (11.8)	0.33 (13.4)	0.33 (13.4)
	II	No Need	0.21 (8.6)	0.24 (9.8)	0.32 (13.0)	0.37 (15.0)	0.37 (15.0)
	III	No Need	0.24 (9.8)	0.27 (11.0)	0.37 (15.0)	0.42 (17.1)	0.42 (17.1)
	IV	No Need	0.32 (13.0)	0.37 (15.0)	0.37 (15.0)	0.37 (15.0)	0.37 (15.0)

- Single Point Design Only

Table 9.32: Multiple – Row Racks – Rack Depth Up to and Including 16 ft (4.9 m), Aisles 8 ft (2.4 m) or wider, Storage Height Over 12 ft (3.7 m) Up to 25 ft (7.6 m)

Multiple – Row Racks – Rack Depth Up to and Including 16 ft (4.9 m), Aisles 8 ft (2.4 m) or wider, Storage Height Over 12 ft (3.7 m) Up to 25 ft (7.6 m)						
HEIGHT	COMMODITY CLASS	ENCAPSULATION	IN RACK SPRINKLERS	CEILING SPRINKLER WATER DEMAND, Gpm (LPM)		
				WITH IN RACK SPRINKLERS		WITHOUT IN RACK SPRINKLERS
				MULTIPLE ROW RACKS		MULTIPLE ROW RACKS
				HIGH TEMPERATURE CEILING SPRINKLER & ORDINARY TEMPERATURE RACK SPRINKLER	ORDINARY TEMPERATURE CEILING SPRINKLER & ORDINARY TEMPERATURE RACK SPRINKLER	ORDINARY TEMPERATURE CEILING SPRINKLERS
Over 12 ft (3.7 m) up to and including 15 ft (4.6 m)	I	No	No Need	0.23 (9.3)	0.26 (10.6)	0.37 (15.1)
		Yes		0.29 (11.7)	0.33 (13.2)	0.46 (18.8)
	II	No	No Need	0.26 (10.6)	0.30 (12.2)	0.42 (17.1)
		Yes		0.33 (13.2)	0.38 (15.2)	0.52 (21.4)
	III	No	No Need	0.29 (11.7)	0.33 (13.2)	0.47 (19.1)
		Yes		0.36 (14.6)	0.41 (16.7)	N/A
IV	No	No Need	0.39 (15.7)	0.44 (17.9)	0.39 (15.7)	
	Yes		0.48 (19.5)	0.56 (22.6)	N/A	
Over 15 ft (4.6 m) up to and including 20 ft (6.1 m)	I	No	No Need	0.23 (9.3)	0.26 (10.6)	0.37 (15.1)
		Yes		0.29 (11.7)	0.33 (13.2)	0.46 (18.8)
	II	No	No Need	0.26 (10.6)	0.30 (12.2)	0.42 (17.1)
		Yes		0.33 (13.2)	0.38 (15.2)	0.52 (21.4)
	III	No	No Need	0.29 (11.7)	0.33 (13.2)	0.47 (19.1)
		Yes		0.36 (14.6)	0.41 (16.7)	N/A
	IV	No	1 Level	0.39 (15.7)	0.44 (17.9)	N/A
		Yes		0.48 (19.5)	0.56 (22.6)	N/A

Table 9.32: Multiple – Row Racks – Rack Depth Up to and Including 16 ft (4.9 m), Aisles 8 ft (2.4 m) or wider, Storage Height Over 12 ft (3.7 m) Up to 25 ft (7.6 m)

HEIGHT	COMMODITY CLASS	ENCAPSULATION	IN RACK SPRINKLERS	CEILING SPRINKLER WATER DEMAND, Gpm (LPM)			
				WITH IN RACK SPRINKLERS		WITHOUT IN RACK SPRINKLERS	
				MULTIPLE ROW RACKS		MULTIPLE ROW RACKS	
Over 20 ft (6.1 m) up to and including 25 ft (7.6 m)	I	No	No Need	0.23 (9.3)	0.26 (10.6)	0.37 (15.1)	0.41 (16.7)
		Yes	1 Level	0.29 (11.7)	0.33 (13.2)		
	II	No	1 Level	0.26 (10.6)	0.30 (12.2)	N/A	N/A
		Yes		0.33 (13.2)	0.38 (15.2)		
	III	No		0.29 (11.7)	0.33 (13.2)		
		Yes		0.36 (14.6)	0.41 (16.7)		
	IV	No	2 Levels	0.39 (15.7)	0.44 (17.9)		
		Yes		0.48 (19.5)	0.56 (22.6)		

- Single Point Design Only

Table 9.33: Multiple – Row Racks – Rack Depth Over 16 ft (4.9 m) or Aisles Narrower Than 8 ft (2.4 m), Storage Height Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m)

Table 9.33. Multiple – Row Racks – Rack Depth Over 16 ft (4.9 m) or Aisles Narrower Than 8 ft (2.4 m), Storage Height Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m)									
HEIGHT	COMMODITY CLASS	ENCAPSULATION	IN RACK SPRINKLERS	CEILING SPRINKLER WATER DEMAND, Gpm (LPM)					
				WITH IN RACK SPRINKLERS MULTIPLE ROW RACKS		WITHOUT IN RACK SPRINKLERS MULTIPLE ROW RACKS		ORDINARY TEMPERATURE CEILING SPRINKLERS	
Over 12 ft (3.7 m) up to and including 15 ft (4.6 m)	I	No	No Need	HIGH TEMPERATURE CEILING SPRINKLER & ORDINARY TEMPERATURE RACK SPRINKLER	ORDINARY TEMPERATURE CEILING SPRINKLER & ORDINARY TEMPERATURE RACK SPRINKLER	HIGH TEMPERATURE CEILING SPRINKLERS	ORDINARY TEMPERATURE CEILING SPRINKLERS	N/A	
				0.23 (9.3)	0.26 (10.6)	0.37 (15.1)	0.41 (16.7)		
		Yes		0.29 (11.7)	0.33 (13.2)	0.46 (18.8)	0.51 (20.8)		
				No	0.26 (10.6)	0.30 (12.2)	0.42 (17.1)		0.47 (19.1)
		Yes			0.33 (13.2)	0.38 (15.2)	0.52 (21.4)		0.59 (23.9)
	II		No	1 Level	0.29 (11.7)	0.33 (13.2)	0.47 (19.1)	0.52 (21.4)	N/A
		Yes			0.36 (14.6)	0.41 (16.7)	N/A	N/A	
			No		0.39 (15.7)	0.44 (17.9)	0.39 (15.7)	0.44 (17.9)	
		Yes			0.58 (23.6)	0.66 (26.9)	N/A	N/A	
			Over 15 ft (4.6 m) up to and including 20 ft (6.1 m)		I	No	1 Level	0.23 (9.3)	
Yes	0.29 (11.7)	0.33 (13.2)							
	No	0.26 (10.6)		0.30 (12.2)					
Yes		0.33 (13.2)		0.38 (15.2)					
	II	No		0.29 (11.7)		0.33 (13.2)		N/A	N/A
Yes				0.36 (14.6)	0.41 (16.7)				
		No		0.39 (15.7)	0.44 (17.9)				
Yes				0.58 (23.6)	0.66 (26.9)				

Table 9.33: Multiple – Row Racks – Rack Depth Over 16 ft (4.9 m) or Aisles Narrower Than 8 ft (2.4 m), Storage Height Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m)

HEIGHT	COMMODITY CLASS	ENCAPSULATION	IN RACK SPRINKLERS	CEILING SPRINKLER WATER DEMAND , Gpm (LPM)			
				WITH IN RACK SPRINKLERS MULTIPLE ROW RACKS		WITHOUT IN RACK SPRINKLERS MULTIPLE ROW RACKS	
				HIGH TEMPERATURE CEILING SPRINKLER & ORDINARY TEMPERATURE RACK SPRINKLER	ORDINARY TEMPERATURE CEILING SPRINKLER & ORDINARY TEMPERATURE RACK SPRINKLER	HIGH TEMPERATURE CEILING SPRINKLERS	ORDINARY TEMPERATURE CEILING SPRINKLERS
Over 20 ft (6.1 m) up to and including 25 ft (7.6 m)	I	No	1 Level	0.23 (9.3)	0.26 (10.6)	N/A	N/A
		Yes		0.29 (11.7)	0.33 (13.2)		
	II	No		0.26 (10.6)	0.30 (12.2)		
		Yes		0.33 (13.2)	0.38 (15.2)		
	III	No		0.29 (11.7)	0.33 (13.2)		
		Yes		0.36 (14.6)	0.41 (16.7)		
	IV	No	2 Levels	0.39 (15.7)	0.44 (17.9)		
		Yes		0.58 (23.6)	0.66 (26.9)		

- Single Point Design Only

15. Refrigerated Spaces (Cold Room Application)

15.1. General

- 15.1.1.** Where sprinkler pipe passes through a wall or floor into the refrigerated space, a section of pipe arranged for removal shall be provided immediately inside the space. The removable length of pipe required shall be a minimum of 762 mm.

15.2. Low Air Pressure Alarm

- 15.2.1.** A low air pressure alarm to a constantly attended location shall be installed.
- 15.2.2.** Systems equipped with local low pressure alarms and an automatic air maintenance device shall not be required to alarm to a constantly attended location.

15.3. Air or Nitrogen Supply

- 15.3.1.** Air or nitrogen supply for systems shall be one of the following:
- Air from the room of lowest temperature to reduce the moisture content
 - Air compressor/dryer package listed for the application utilizing ambient air
 - Compressed nitrogen gas from cylinders used in lieu of compressed air

15.4. Control Valve

- 15.4.1.** An indicating-type control valve for operational testing of the system shall be provided on each sprinkler riser outside of the refrigerated space.

15.5. Check Valve

- 15.5.1.** A check valve with a 2.4mm diameter hole in the clapper shall be installed in the system riser below the test valve.
- 15.5.2.** Check valves shall not be required where dry pipe or pre-action valves are used and designed to completely drain all water above the seat and that are listed for installation without priming water remaining and where priming water is not used in the system riser.

15.6. Air or Nitrogen Supply Piping

- 15.6.1.** The supply piping shall be equipped with two easily removable supply lines at least 1.9 m long and at least 25.4 mm in diameter as shown in **Figure 9.15**.



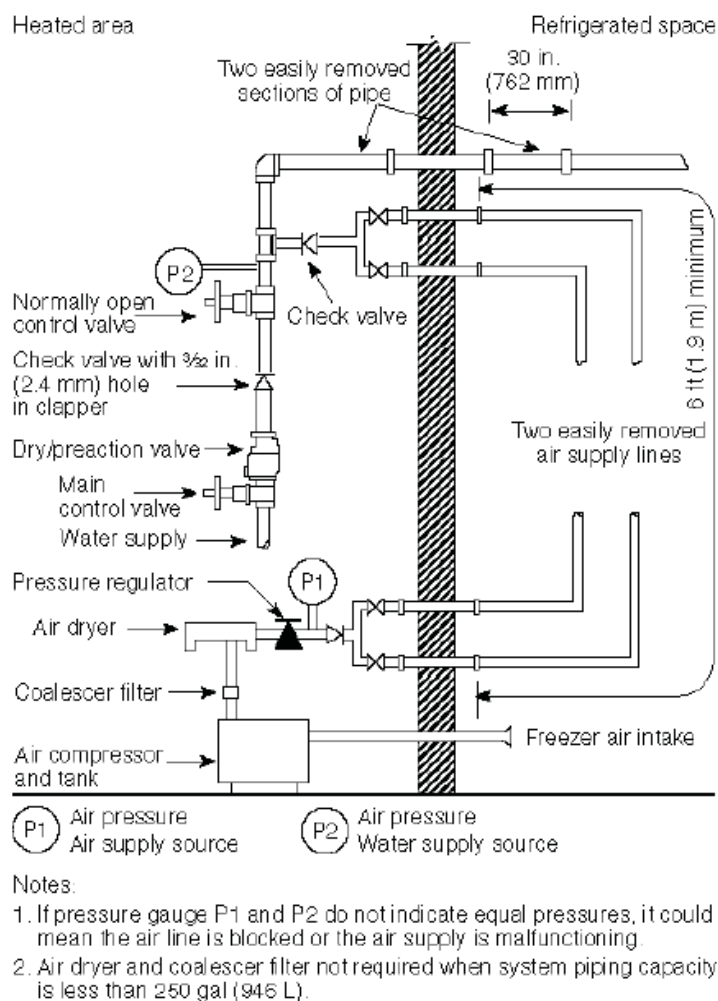


Figure 9.15: Refrigerator Area Sprinkler System Used to Minimize the Chances of Developing Ice Plugs.

15.7. Nitrogen Supply

- 15.7.1.** The supply piping shall be equipped with a single easily removable supply line at least 6 ft (1.9 m) long and at least 1 in. (25.4 mm) in diameter.
- 15.7.2.** Each supply line shall be equipped with control valves located in the warm area.
- 15.7.3.** Only one air supply line shall be open to supply the system air at any one time.

16. Piping Requirements

16.1. Above Ground Piping

- 16.1.1.** The pipes used for sprinkler system installed within or outside the building shall be Factory Galvanized steel, ERW or Seamless pipe manufactured in accordance with ASTM A 53 Gr. B or ASTM A 795 Gr. B, Sch-40 or manufactured as per BS-1387, Class-C (Heavy grade). The pipes used for the entire sprinkler system shall have the approval of Civil Defence.

16.2. Above Ground Pipe Fittings

- 16.2.1.** Pipe fittings of 50 mm and smaller diameter used in above ground piping shall be of factory galvanized, malleable iron or ductile iron, threaded fittings confirming to B16.3, having working pressure not less than 16 bar.

- 16.2.2.** Pipe fittings of 65 mm and larger diameter used in above ground piping shall be of factory galvanized, ductile iron, grooved fittings or Butt welded conforming to ASME B 16.9 & pipe flanges confirming to ASME B16.5, having working pressure not less than system working pressure.

16.3. Under Ground Pipes & Fittings

- 16.3.1.** The pipes used for fire fighting system laid underground shall comply any one of the following requirements:
- Ductile Iron pipe manufactured conforming to AWWA C 151 & Fittings conforming to AWWA C110 & Joints conforming to AWWA C115 and Anticorrosive protection conforming to AWWA C 105;
 - Factory Galvanized steel, Seamless pipe manufactured in accordance with ASTM A 53 Gr. B or ASTM A 795 Gr. B, Sch-40 or manufactured as per BS-1387, Class-C (Heavy grade) with epoxy coat and anticorrosive surface protection. The fittings shall be butt welded or socket welded and joints shall be flanged. All the proposed materials shall have the Civil Defence approval.
 - Approved HDPE pipes and fittings manufactured conforming to AWWA C906-07 with temperature & pressure rating not less than the system working pressure by taking in to consideration of de-ration factor for temperature, recurring surge & occasional surge pressures.



17. Isolation / Section or floor Control valves

- 17.1.** All the isolation and section control valves installed in the sprinkler system shall be of supervised O.S. & Y gate valve or supervised butterfly valves installed with a tamper or supervisory switch connected to the building fire alarm system for monitoring or secured in open position by a padlock or riveted strap unless other wise specified and approved by the Civil Defence.
- 17.2.** All isolating valves installed in sprinkler system shall be so constructed that in order to shut the valve the spindle must turn clockwise. The hand wheels of all stop valves shall be clearly marked to indicate which direction the wheel is to be turned to close the valve.
- 17.3.** An indication shall also be provided which shows whether the valve is open or shut.
- 17.4.** An isolation valves shall be installed in each sprinkler riser on upstream side of an alarm check valve such that the isolation of single sprinkler riser will not interrupt the water supply to other sprinkler risers from the same source of supply.
- 17.5.** The valve on downstream side of flow meter in the fire pump test line shall be globe type valve for ease of throttling.
- 17.6.** The valves of suction side of fire pumps and water tank outlets shall be O.S.&Y type gate valve only.
- 17.7.** All the valves shall be rated for the system working pressure and water temperature service and approved by the Civil Defence department.
- 17.8.** All the isolation / section or floor control valves shall be installed in an easily accessible & visible locations.
- 17.9.** Isolation and control valves shall be provided with an identification sign board in a visible location in both Arabic & English languages.
- 17.10.** Where isolation / control valves are located in a closed room or shaft, access door or panel shall be provided with an identification sign board in visible location in both Arabic & English languages.

18. Check Valves

- 18.1.** If case of combined riser pipe is proposed for both sprinkler and landing valves, an approved check valve shall be installed after supervisory control valve of sprinkler zone control valve assembly.
- 18.2.** All the check valves shall be rated for the system working pressure and water temperature service. Same shall be approved by the Civil Defence.
- 18.3.** All the check valves shall be installed in an easily accessible & visible locations.



- 18.4.** Where there is more than one source of water supply, a check valve shall be installed in each connection.
- 18.5.** Where sprinklers are installed on two adjacent sides of a building, protecting against two separate and distinct exposures, with separate control valves for each side, the end lines shall be connected with check valves located so that one sprinkler around the corner will operate. The intermediate pipe between the two check valves shall be arranged to drain. See [Figure 9.16](#) for illustrations.

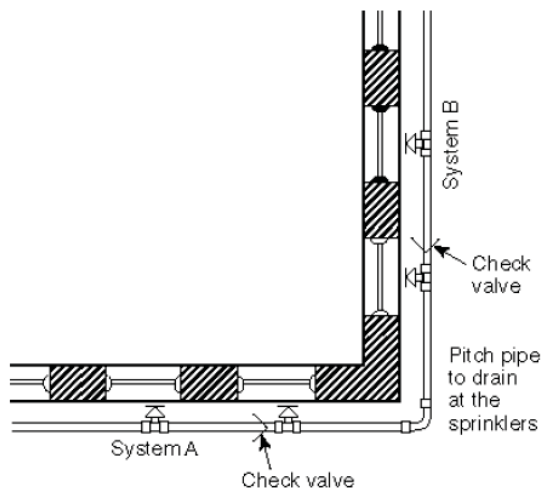


Figure 9.16: Typical Arrangement of Check Valves.

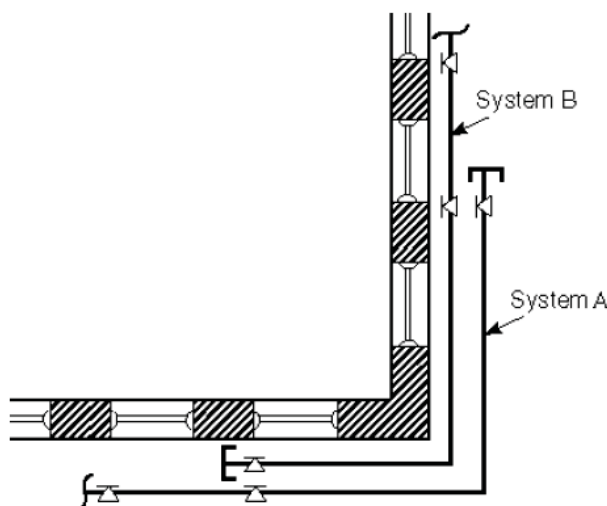


Figure 9.17: Alternate Arrangement for Check Valves

- 18.6.** As an alternate solution, an additional sprinkler shall be installed on each system located around the corner from the system involved. See [Figure 9.17](#) for illustrations.
- 18.7.** A listed backflow prevention device shall be considered a check valve, and an additional check valve shall not be required.



- 18.8.** Where cushion tanks are used with automatic fire pumps, no check valve is required in the cushion tank connection.
- 18.9.** Check valves shall be installed in a vertical or horizontal position in accordance with their listing.
- 18.10.** Where a single wet pipe sprinkler system is equipped with a fire department connection, the alarm valve is considered a check valve, and an additional check valve shall not be required.

19. Alarm Check Valve (ACV) Assembly

- 19.1.** An Alarm check valve assembly shall be installed in each sprinkler system riser as per the maximum sprinkler protection zone area limitations, which shall consists of the following equipments and accessories.

- i. Alarm check Valve complete with trim kits & retarding device;
- ii. Water Motor Alarm Gong;
- iii. Electric Alarm pressure switch;
- iv. Pressure Guages (Upstream & Down stream)

19.2. Alarm Check Valves

- 19.2.1.** Alarm valve shall be installed in each sprinkler system supply risers complete with required trims in all sprinkler system installations in the office buildings.
- 19.2.2.** The Alarm valve trims shall consist of basic trim with all required pipes, fitting & valves, water motor alarm gong, retard chamber, electric alarm pressure switch, upstream & down stream pressure gauges etc.
- 19.2.3.** The alarm pressure switch shall be interconnected with building fire alarm system to activate the fire alarm.
- 19.2.4.** A 20 mm dia by pass line shall be provided connecting upstream and downstream side of the alarm check to allow the water pressure surge with out lifting the valve clapper off its seat, which will prevent the false alarm.
- 19.2.5.** Alarm check valves shall be rated for the system working pressure and water temperature service and approved by the Civil Defence department.
- 19.2.6.** All the check valves shall be installed in an easily accessible & visible locations.
- 19.2.7.** Alarm check valves shall be installed vertically with adequate clearance space around it for testing and maintenance purposes.
- 19.2.8.** Retarding device shall be installed in the alarm line to prevent the false alarm due to the water pressure fluctuation in sprinkler system.



19.3. Water Motor Alarm Gong

- 19.3.1.** The sprinkler system shall be fitted with an approved water motor alarm, which shall be located at a distance not exceeding 25 m from the alarm valve, and at a height not to exceed 6m above the alarm valve.
- 19.3.2.** The pipe work and fittings used shall be galvanized and to the sizes determined by the manufacturers data sheet.
- 19.3.3.** The pipe work shall be arranged to drain through a fitting having an orifice not exceeding 3 mm in diameter. The orifice plate may form an integral part of the fitting but shall be manufactured from a non-ferrous material to prevent the hole from becoming blocked by corrosion or foreign matter.
- 19.3.4.** A 15 mm test valve shall be installed on the installation side of each alarm valve.
- 19.3.5.** Approved identification signs, as shown in **Figure 9.18** shall be provided for outside alarm devices. The sign should be located near the device in a conspicuous position and should be worded as follows:

**SPRINKLER FIRE ALARM — WHEN BELL RINGS
CALL FIRE DEPARTMENT OR POLICE.**



Figure 9.18: Alarm Identification Sign

19.4. Electric Alarm Pressure Switch

- 19.4.1.** Electric alarm pressure switches shall be installed in the system and they shall be mounted on a vertical branch pipe at least 300 mm long.
- 19.4.2.** The pressure switch may be of the diaphragm bellows or bourdon tube operated type, and shall be sufficiently sensitive to operate when only one sprinkler is discharging.



19.4.3. The pressure switch shall be provided with volt free contacts to interconnect with the building fire alarm system for monitoring.

19.4.4. The pressure switch shall be rated for the system working pressure and water temperature service and approved by the Civil Defence department.

20. Control Valves

20.1. Each sprinkler system shall be provided with a listed indicating valve in an accessible location, so located as to control all automatic sources of water supply.

20.2. At least one listed indicating valve shall be installed in each source of water supply but not for fire department connections. There shall be no shutoff valve in the fire department connection. See [Figure 9.19](#).

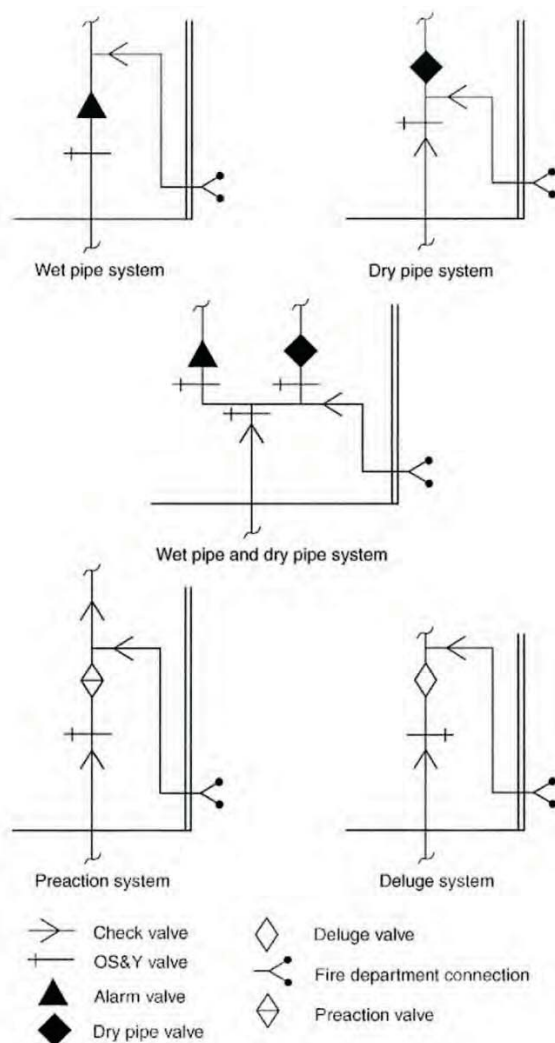


Figure 9.19: Examples of Acceptable Valve Arrangements



21. Supervision.

- 21.1.** Valves on connections to water supplies, sectional control and isolation valves, and other valves in supply pipes to sprinklers and other fixed water-based fire suppression systems shall be supervised by one of the following methods:
- Central station, proprietary, or remote station signalling service
 - Local signalling service that will cause the sounding of an audible signal at a constantly attended point
 - Valves locked in the correct position
 - Valves located within fenced enclosures under the control of the owner, sealed in the open position, and inspected weekly as part of an approved procedure

22. Pressure Gauges

- 22.1.** Pressure gauges with a control valve (gauge cock) having drain arrangement shall be installed on upstream and downstream side of alarm check valves to read supply and system pressures.
- 22.2.** Pressure gauges shall be installed on top of each sprinkler riser and in each zone control valve assembly.
- 22.3.** The pressure gauges shall be rated for the system working pressure and water temperature service and approved by the Civil Defence department.
- 22.4.** The maximum reading of the scale shall be 150% of the maximum system pressure and each scale shall have divisions not exceeding 0.2bar.
- 22.5.** All the pressure gauges shall be filled with glycerin liquid to prevent damage of its needles due to the system water pressure surge.

23. Pressure-Reducing Valves

- 23.1.** In portions of systems where all components are not listed for pressure greater than 12.1 bar and the potential exists for normal (non-fire condition) water pressure in excess of 12.1 bar, a listed pressure-reducing valve shall be installed and set for an outlet pressure not exceeding 2.4 bar at the maximum inlet pressure.
- 23.2.** Pressure gauges shall be installed on the inlet and outlet sides of each pressure-reducing valve.
- 23.3.** A relief valve of not less than 13 mm in size shall be provided on the discharge side of the pressure-reducing valve set to operate at a pressure not exceeding 12.1 bar.



- 23.4.** A listed indicating valve shall be provided on the inlet side of each pressure-reducing valve, unless the pressure-reducing valve meets the listing requirements for use as an indicating valve.
- 23.5.** Means shall be provided downstream of all pressure-reducing valves for flow tests at sprinkler system demand.

24. Section or Floor Zone Control Valve (ZCV) Assembly

24.1. Sectional or floor zone control valve (ZCV) assembly shall be installed where the tapping is taken from the sprinkler riser for each floor and where the floor area exceeds the limit as specified in [Table 9.7](#). See [Figure 9.20](#) for illustrations. Each zone control valve assembly installed in sprinkler system shall comprise:

- i. Supervised Butterfly valve, fitted with an indicator showing "OPEN" and "CLOSE" positions, and complete with padlocked securing straps. The valve shall be mounted on the upstream side of the flow switch.
- ii. Water flow alarm switch having paddle type water flow detector suitable for the size of the pipe in which it is installed shall be fixed after the butterfly valve, on the main supply pipe and before any sprinkler connection is taken off.
- iii. Inspector test and drain connections having not less than 25 mm diameter shall be installed on downstream side of flow switch.
- iv. Dial pressure gauges suitable for the water pressures shall be fitted so arranged that it can be easily removed for testing and checking without shutting down the water supply. Pressure gauge shall be installed between butterfly valve and water flow switch.
- v. The minimum distance between water flow switch to the butterfly valve and to the test & drain valve shall be not less than 600mm.
- vi. The water flow switch shall be mounted on top of the pipe or as recommended by the original equipment manufacturer's data sheet.
- vii. All the equipments of ZCV assembly shall be rated for the system working pressure and water temperature service and approved by the Civil Defence department.
- viii. The ZCV assembly shall be installed in an easily accessible & visible locations, preferably inside the stair enclosure above the required headroom height.
- ix. ZCV assembly shall be provided with an identification sign board in a visible location in both Arabic & English languages.
- x. Where ZCV assembly is located in a closed room or shaft, access door or panel shall be provided with an identification sign board in visible location in both Arabic & English languages.



- xi. ZCV assembly shall be installed such that it has adequate clearance space around it for testing and maintenance purposes.

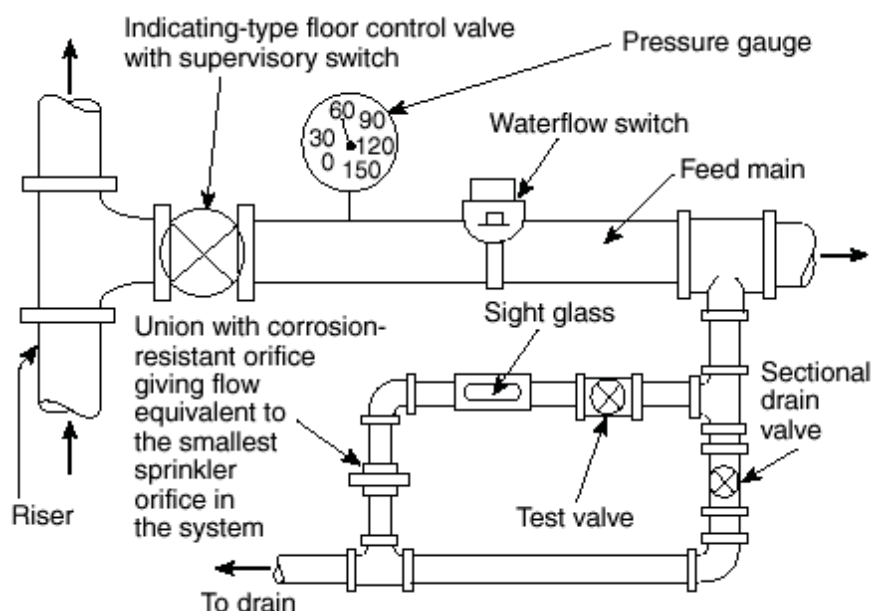


Figure 9.20: Floor Zone Control Valve.

25. Sprinkler Heads Installation

25.1. General

- 25.1.1.** Sprinkler heads shall be installed throughout the building as per the design requirements based on the type of hazard occupancy classifications in all office buildings.
- 25.1.2.** Sprinklers shall be installed in such a way that its maximum protection area does not exceeding the limit according to the hazard occupancy.
- 25.1.3.** Sprinkler shall be installed based on its construction type and performance characteristics without obstructing its discharge pattern. See [Figure 9.21](#) for the discharge pattern for standard upright or pendent sprinkler.



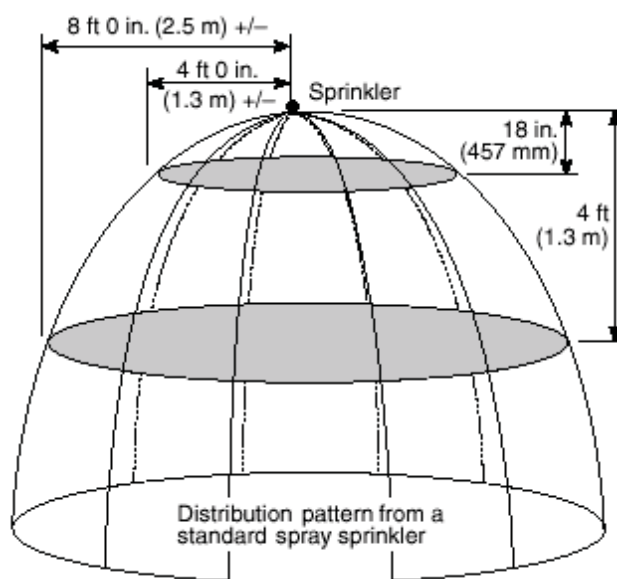


Figure 9.21: Obstructions to Sprinkler Discharge Pattern Development for Standard Upright or Pendent Spray Sprinklers.

25.2. Upright Sprinkler Heads

- 25.2.1.** Upright sprinkler heads shall be installed in such a way that its deflector is facing upright position only with the frame arms parallel to the branch line to minimize the obstruction of its discharge pattern.
- 25.2.2.** Upright sprinklers shall be installed where there is no false ceiling, such as car park, stores, plant rooms, concealed spaces above false ceiling areas etc.
- 25.2.3.** The distance between upright sprinkler deflector to the ceiling shall be not less 25mm and shall be not more than 300 mm.
- 25.2.4.** Where situation does not permits to locate the sprinkler head within 300mm from the ceiling and exceeds 300mm, shall be fitted with a deflector plate made of stainless steel having diameter not less 200mm shall be installed attaching to the deflector.
- 25.2.5.** Upright sprinkler protective caps and straps shall be removed immediately after the commissioning of the sprinkler system.
- 25.2.6.** Upright sprinklers shall be fitted with a protective guard where there is possibilities for accidental damage of sprinkler bulbs.
- 25.2.7.** The minimum distance between the sprinkler to the adjacent sprinkler shall be not less than 1.8 mtrs.



- 25.2.8.** The maximum distance between the standard upright sprinkler to the adjacent standard sprinkler shall be not more than 4.5 mtrs. Where the extended coverage upright sprinklers are used, the maximum distance between sprinkler to sprinkler shall be not more than its approval listing as per the Original equipment manufacturers technical data sheet.
- 25.2.9.** The minimum distance between a upright sprinkler to a wall shall be not less than 100mm.
- 25.2.10.** The maximum distance between a standard upright sprinkler to a wall shall be not more than 2.25 mtrs or $\frac{1}{2}$ of the spacing between the sprinkler.
- 25.2.11.** There should not be any continuous or non-continuous obstructions such as columns, beams, truss webs and chords, pipes, ducts, and other fixtures that could prevent discharge pattern below the sprinkler head for less than or equal to 500 mm.
- 25.2.12.** Sprinklers shall be installed under fixed obstructions over 1.2 m wide such as ducts, cable trays, decks, open grate floorings etc.
- 25.2.13.** The minimum clearance between top of storage to the sprinkler head shall be not less than 500mm and shall be 1000mm in special situations for special sprinklers such as ESFR & ELO sprinklers.
- 25.2.14.** Sprinklers under glass or plastic skylights exposed to the direct rays of the sun shall be of the intermediate-temperature classification.
- 25.2.15.** Where there is a vertical change in ceiling elevation within the area of coverage of the sprinkler creating a distance of more than 900 mm between the upper ceiling and the sprinkler deflector, a vertical plane extending down from the ceiling at the change in elevation shall be considered a wall for the purpose of sprinkler spacing.
- 25.2.16.** Where the distance between the upper ceiling and the sprinkler deflector is less than or equal to 900 mm, the sprinklers shall be permitted to be spaced as though the ceiling was flat, provided the obstruction rules and ceiling pocket rules are observed.
- 25.2.17.** Under obstructed construction, the sprinkler shall be installed in each bay of obstructed construction with the sprinkler deflector located not less than 25 mm to not more than 300mm from the ceiling.
- 25.2.18.** Sprinklers shall be located so as to minimize obstructions to discharge or additional sprinklers shall be provided to ensure adequate coverage of the hazard.
- 25.2.19.** Sprinklers shall be permitted to be spaced on opposite sides of obstructions not exceeding 1.2 m in width, provided the distance from the center line of the obstruction to the sprinklers does not exceed one-half the allowable distance permitted between sprinklers.



- 25.2.20.** Obstructions located against the wall and that are not over 762 mm in width shall be permitted to be protected.
- 25.3.** Under obstructed construction, the sprinklers shall be permitted to install as per the [Table 9.34](#) to avoid obstructions of discharge pattern of an upright sprinkler. See [Figure 9.22](#) for illustration.

Table 9.34: Positioning of Standard upright sprinklers to avoid obstruction of discharge pattern

DISTANCE FROM SPRINKLERS TO SIDE OF OBSTRUCTION (A)	MAXIMUM ALLOWABLE DISTANCE OF DEFLECTOR ABOVE BOTTOM OF OBSTRUCTION (B)
Less than 300 mm	0 mm
300mm to 450 mm	65 mm
450mm to 600mm	90mm
600mm to 750mm	140mm
750mm to 900mm	190mm
900mm to 1050mm	240mm
1050mm to 1200mm	305mm
1200mm to 1350mm	355mm
1350mm to 1500mm	420mm
1500mm to 1650mm	457mm
1650mm to 1800mm	508mm

25.4. Pendant Sprinkler Heads

- 25.4.1.** Pendant sprinkler heads shall be installed in such a way that its deflector is facing downwards pendent position only with the frame arms parallel to the branch line to minimize the obstruction of its discharge pattern.
- 25.4.2.** Pendant sprinklers shall be installed where there is no false ceiling, such as car park, stores, plant rooms, concealed spaces above false ceiling areas etc.
- 25.4.3.** The distance between pendant sprinkler deflector to the ceiling shall be not less 25mm and shall be not more than 300 mm.
- 25.4.4.** Where situation does not permits to locate the sprinkler head within 300mm from the ceiling and exceeds 300mm, shall be fitted with a deflector plate made of stainless steel having diameter not less 200mm shall be installed attaching to the sprinkler or its deflector.
- 25.4.5.** Pendant sprinkler protective caps and straps shall be removed immediately after the commissioning of the sprinkler system.



- 25.4.6.** Pendent sprinklers shall be fitted with a protective guard where there is possibilities for accidental damage of sprinkler bulbs.
- 25.4.7.** The minimum distance between the sprinkler to the adjacent sprinkler shall be not less than 1.8 m.
- 25.4.8.** The maximum distance between the standard pendent sprinkler to the adjacent standard sprinkler shall be not more than 4.5 mtrs. Where the extended coverage upright sprinklers are used, the maximum distance between sprinkler to sprinkler shall be not more than its approval listing as per the Original equipment manufacturers technical data sheet.
- 25.4.9.** The minimum distance between a pendent sprinkler to a wall shall be not less than 100mm.
- 25.4.10.** The maximum distance between a standard pendent sprinkler to a wall shall be not more than 2.25 mtrs or $\frac{1}{2}$ of the spacing between the sprinkler.
- 25.4.11.** There should not be any continuous or non-continuous obstructions such as columns, beams, truss webs and chords, pipes, ducts, and other fixtures that could prevent discharge pattern below the sprinkler head for less than or equal to 500 mm.
- 25.4.12.** Sprinklers shall be installed under fixed obstructions over 1.2 m wide such as ducts, cable trays, decks, open grate floorings etc.
- 25.4.13.** The minimum clearance between top of storage to the sprinkler head shall be not less than 500mm and shall be 1000mm in special situations for special sprinklers such as ESFR & ELO sprinklers.
- 25.4.14.** Sprinklers under glass or plastic skylights exposed to the direct rays of the sun shall be of the intermediate-temperature classification.
- 25.4.15.** Where there is a vertical change in ceiling elevation within the area of coverage of the sprinkler creating a distance of more than 900 mm between the upper ceiling and the sprinkler deflector, a vertical plane extending down from the ceiling at the change in elevation shall be considered a wall for the purpose of sprinkler spacing.
- 25.4.16.** Where the distance between the upper ceiling and the sprinkler deflector is less than or equal to 900 mm, the sprinklers shall be permitted to be spaced as though the ceiling was flat, provided the obstruction rules and ceiling pocket rules are observed.
- 25.4.17.** Under obstructed construction, the sprinkler shall be installed in each bay of obstructed construction with the sprinkler deflector located not less than 25 mm to not more than 300mm from the ceiling.



- 25.4.18.** Sprinklers shall be located so as to minimize obstructions to discharge or additional sprinklers shall be provided to ensure adequate coverage of the hazard.
- 25.4.19.** Sprinklers shall be permitted to be spaced on opposite sides of obstructions not exceeding 1.2 m in width, provided the distance from the center line of the obstruction to the sprinklers does not exceed one-half the allowable distance permitted between sprinklers.
- 25.4.20.** Obstructions located against the wall and that are not over 762 mm in width shall be permitted to be protected.
- 25.5.** Under obstructed construction, the sprinklers shall be permitted to install as per the [Table 9.35](#) to avoid obstructions of discharge pattern of a pendent sprinkler. See [Figure 9.22](#) for illustrations.

Table 9.35: Positioning of Standard pendent sprinklers to avoid obstruction of discharge pattern

DISTANCE FROM SPRINKLERS TO SIDE OF OBSTRUCTION (A)	MAXIMUM ALLOWABLE DISTANCE OF DEFLECTOR ABOVE BOTTOM OF OBSTRUCTION (B)
Less than 300 mm	0 mm
300mm to 450 mm	65 mm
450mm to 600mm	90mm
600mm to 750mm	140mm
750mm to 900mm	190mm
900mm to 1050mm	240mm
1050mm to 1200mm	305mm
1200mm to 1350mm	355mm
1350mm to 1500mm	420mm
1500mm to 1650mm	457mm
1650mm to 1800mm	508mm

25.6. Recessed / Concealed Pendent Sprinkler Heads

- 25.6.1.** Recessed or Concealed type Pendent sprinkler heads shall be installed in such a way that its deflector is facing downwards pendent position only.
- 25.6.2.** Recessed or Concealed type pendent sprinklers shall be installed in the false ceiling areas, such as Main entrance lobbies, public corridors, office units, restaurants, retail show rooms etc.
- 25.6.3.** Where the ceiling & interior architectural decorative finish is required with good aesthetic look in sensitive areas, the concealed sprinklers with cover plate is recommended according to the interior architect finish.



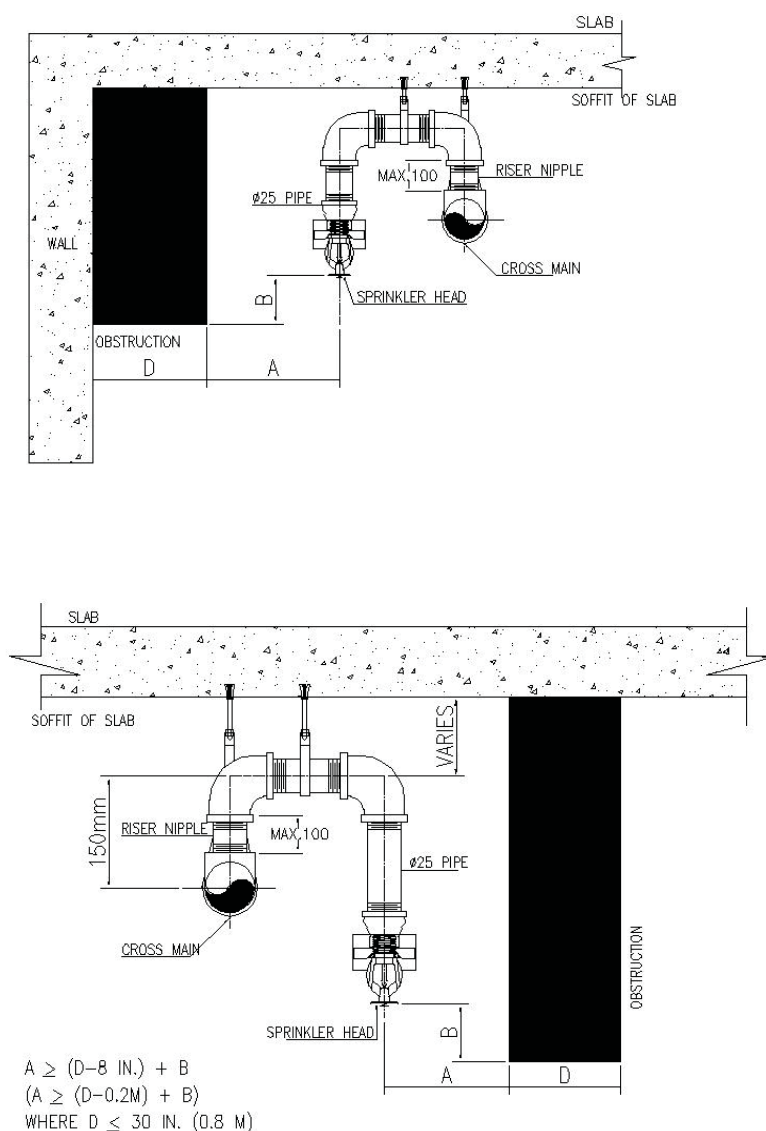


Figure 9.22: Positioning of Standard Pendant (also Upright and recessed) Sprinklers to Avoid Obstructions

- 25.6.4.** Quick / fast response type sprinklers shall be installed in the light hazard areas.
- 25.6.5.** The recessed / concealed pendant sprinklers shall be installed as per the installation guidelines recommended by the original equipment manufacturer.
- 25.6.6.** A listed & approved type flexible drop pipes shall be used for extending the sprinkler drop pipe from the branch pipe to the sprinkler along with approved ceiling support fittings and hardware.



- 25.6.7.** Pendent sprinkler protective caps and straps shall be removed immediately after the commissioning of the sprinkler system.
- 25.6.8.** The minimum distance between the sprinkler to the adjacent sprinkler shall be not less than 1.8 m.
- 25.6.9.** The maximum distance between the standard pendent sprinkler to the adjacent standard sprinkler shall be not more than 4.5 mtrs. Where the extended coverage upright sprinklers are used, the maximum distance between sprinkler to sprinkler shall be not more than its approval listing as per the Original equipment manufacturers technical data sheet.
- 25.6.10.** The minimum distance between a pendent sprinkler to a wall shall be not less than 100mm.
- 25.6.11.** The maximum distance between a standard pendent sprinkler to a wall shall be not more than 2.25 mtrs or ½ of the spacing between the sprinkler.
- 25.6.12.** There should not be any continuous or non-continuous obstructions such as columns, beams, truss webs and chords, pipes, ducts, and other fixtures that could prevent discharge pattern below the sprinkler head for less than or equal to 500 mm.
- 25.6.13.** The minimum clearance between top of storage to the sprinkler head shall be not less than 500mm and shall be 1000mm in special situations for special sprinklers such as ESFR & ELO sprinklers.
- 25.6.14.** Sprinklers under glass or plastic skylights exposed to the direct rays of the sun shall be of the intermediate-temperature classification.
- 25.6.15.** Where there is a vertical change in ceiling elevation within the area of coverage of the sprinkler creating a distance of more than 900 mm between the upper ceiling and the sprinkler deflector, a vertical plane extending down from the ceiling at the change in elevation shall be considered a wall for the purpose of sprinkler spacing.
- 25.6.16.** Where the distance between the upper ceiling and the sprinkler deflector is less than or equal to 900 mm, the sprinklers shall be permitted to be spaced as though the ceiling was flat, provided the obstruction rules and ceiling pocket rules are observed.
- 25.6.17.** Under obstructed construction, the sprinkler shall be installed in each bay of obstructed construction with the sprinkler deflector located flush to the ceiling.
- 25.6.18.** Sprinklers shall be located so as to minimize obstructions to discharge or additional sprinklers shall be provided to ensure adequate coverage of the hazard.
- 25.6.19.** Sprinklers shall be permitted to be spaced on opposite sides of obstructions not exceeding 1.2 m in width, provided the distance from the center line of the



obstruction to the sprinklers does not exceed one-half the allowable distance permitted between sprinklers.

- 25.6.20.** Obstructions located against the wall and that are not over 762 mm in width shall be permitted to be protected.

- 25.7.** Under obstructed construction, the sprinklers shall be permitted to install as per the [Table 9.36](#) to avoid obstructions of discharge pattern of a recessed or concealed sprinkler. Refer to [Figure 9.22](#).

Table 9.36: Positioning of Standard Recessed / concealed pendent sprinklers to avoid obstruction of discharge pattern

DISTANCE FROM SPRINKLERS TO SIDE OF OBSTRUCTION (A)	MAXIMUM ALLOWABLE DISTANCE OF DEFLECTOR ABOVE BOTTOM OF OBSTRUCTION (B)
Less than 300 mm	0 mm
300mm to 450 mm	65 mm
450mm to 600mm	90mm
600mm to 750mm	140mm
750mm to 900mm	190mm
900mm to 1050mm	240mm
1050mm to 1200mm	305mm
1200mm to 1350mm	355mm
1350mm to 1500mm	420mm
1500mm to 1650mm	457mm
1650mm to 1800mm	508mm

25.8. Sidewall Sprinkler Heads

- 25.8.1.** Sidewall sprinkler heads shall be installed along a wall side, or side of a beam or beneath the flat smooth ceiling where upright or pendent sprinklers with open piping may not be desirable due to aesthetics issues.
- 25.8.2.** Sidewall sprinklers shall be installed such that its deflectors are aligned parallel to the ceiling or roof.
- 25.8.3.** Sidewall sprinkler shall be installed in the ramps, for the protection of any office or room where there is no false ceiling and open piping is not desirable due to aesthetic point.
- 25.8.4.** Quick / fast response type sprinklers shall be installed in the light hazard areas.
- 25.8.5.** The recessed / concealed pendent sprinklers shall be installed as per the installation guidelines recommended by the original equipment manufacturer.



- 25.8.6.** Sidewall sprinkler protective caps and straps shall be removed immediately after the commissioning of the sprinkler system.
- 25.8.7.** Sidewall sprinklers shall be fitted with a protective guard where there is possibilities for accidental damage of sprinkler bulbs.
- 25.8.8.** The distance between side wall sprinkler deflector to the ceiling shall be not less 100mm and shall be not more than 150 mm. However in non combustible ceiling areas the distance between side wall sprinkler deflector to the ceiling shall be permitted to be 150mm to 300mm and 300mm to 450 mm if the sprinklers are listed for such use as per original equipment manufacturers technical data sheets.
- 25.8.9.** Where soffits used for the installation of sidewall sprinklers exceed 203 mm in width or projection from the wall, additional sprinklers shall be installed below the soffit.
- 25.8.10.** The minimum distance between the sprinkler to the adjacent sprinkler shall be not less than 1.8 m.
- 25.8.11.** In light hazard occupancies, the maximum distance between the standard sidewall sprinkler to the adjacent standard sprinkler shall be not more than 4.25 m. and the room width shall be not more than 3.6 m. Where the extended coverage upright sprinklers are used, the maximum spacing between sprinklers along the wall and room width shall be not more than its approval listing as per the Original equipment manufacturers technical data sheet.
- 25.8.12.** In ordinary hazard occupancies, the maximum distance between the standard sidewall sprinkler to the adjacent standard sprinkler shall be not more than 3.0 m. and the room width shall be not more than 3.0 m. Where the extended coverage upright sprinklers are used, the maximum spacing between sprinklers along the wall and room width shall be not more than its approval listing as per the Original equipment manufacturers technical data sheet.
- 25.8.13.** The minimum distance between a sidewall sprinkler to a wall shall be not less than 100mm.
- 25.8.14.** The maximum distance between a standard sidewall sprinkler to a wall shall be not more than 2.125 m. in light hazard and shall be not more than 1.5 m. in ordinary hazard or $\frac{1}{2}$ of the spacing between the sprinkler.
- 25.8.15.** There should not be any continuous or non-continuous obstructions such as columns, beams, truss webs and chords, pipes, ducts, and other fixtures that could prevent discharge pattern below the sprinkler head for less than or equal to 500 mm.
- 25.8.16.** Sprinklers shall be installed under fixed obstructions over 1.2 m wide such as ducts, cable trays, decks, open grate floorings etc.



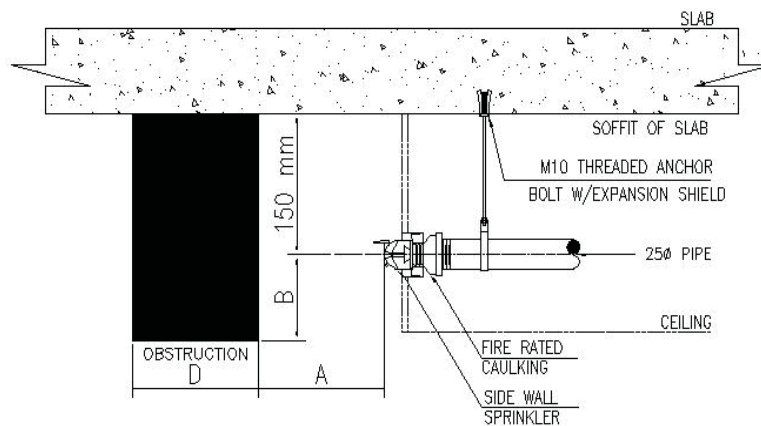
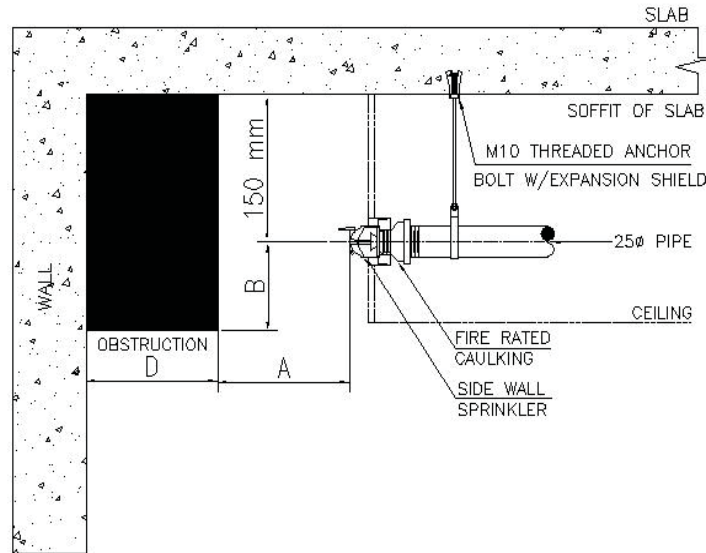
- 25.8.17.** The minimum clearance between top of storage to the sidewall sprinkler head shall be not less than 500mm.
- 25.8.18.** Sidewall sprinklers under glass or plastic skylights exposed to the direct rays of the sun shall be of the intermediate-temperature classification.
- 25.8.19.** Sidewall sprinklers shall be located so as to minimize obstructions to discharge or additional sprinklers shall be provided to ensure adequate coverage of the hazard.
- 25.8.20.** Sidewall sprinklers shall be installed no closer than 1.2 m. from light fixtures or similar obstructions.
- 25.9.** The distance between light fixtures or similar obstructions located more than 1.2 m. from the sprinkler shall be in compliance with [Table 9.37](#) and [Figure 9.23](#)

Table 9.37: Positioning of Standard sidewall Sprinklers to Avoid Obstructions

DISTANCE FROM SIDEWALL SPRINKLER TO SIDE OF OBSTRUCTION (A)	MAXIMUM ALLOWABLE DISTANCE OF DEFLECTOR ABOVE BOTTOM OF OBSTRUCTION (MM) (B)
Less than 1200 mm	Not Allowed
1200mm to 1500 mm	25 mm
1500mm to 1650mm	50mm
1650mm to 1800mm	75mm
1800mm to 1950mm	100mm
1950mm to 2100mm	150mm
2100mm to 2250mm	175mm
2250mm to 2400mm	225mm
2400mm to 2550mm	275mm
2550mm & above	350mm

- 25.10.** Obstructions projecting from the same wall as the one on which the sidewall sprinkler is mounted shall be in accordance with [Table 9.38](#) and [Figure 9.24](#)





$$A \geq (D - 8 \text{ IN.}) + B$$

$$(A \geq (D - 0.2 \text{ M}) + B)$$

WHERE $D \leq 30 \text{ IN. (0.8 M)}$

Figure 9.23 (top) and 9.24 (bottom): Positioning of Standard sidewall Sprinklers to Avoid Obstructions Along the Wall



Table 9.38: Positioning of Standard sidewall Sprinklers to Avoid Obstructions Along the Wall

DISTANCE FROM SIDEWALL SPRINKLER TO SIDE OF OBSTRUCTION (A)	MAXIMUM ALLOWABLE DISTANCE OF DEFLECTOR ABOVE BOTTOM OF OBSTRUCTION (MM) (B)
Less than 150 mm	25 mm
150mm to 300mm	50mm
300mm to 450 mm	75 mm
450mm to 600mm	110mm
600mm to 750mm	145mm
750mm to 900mm	175mm
900mm to 1050mm	200mm
1050mm to 1200mm	235mm
1200mm to 1350mm	250mm
1350mm to 1500mm	280mm
1500mm to 1650mm	320mm
1650mm to 1800mm	350mm
1800mm to 1950mm	375mm
1950mm to 2100mm	406mm
2100mm to 2250mm	440mm

26. Obstruction from structural members, pipe, columns and fixtures for upright and pendent sprinklers

- 26.1.** Sprinklers shall be positioned away from obstructions a minimum distance of three times the maximum dimension of the obstruction (e.g., structural members, pipe, columns, and fixtures). The maximum clear distance required shall be 609 mm in accordance with **Figure 9.25** below.

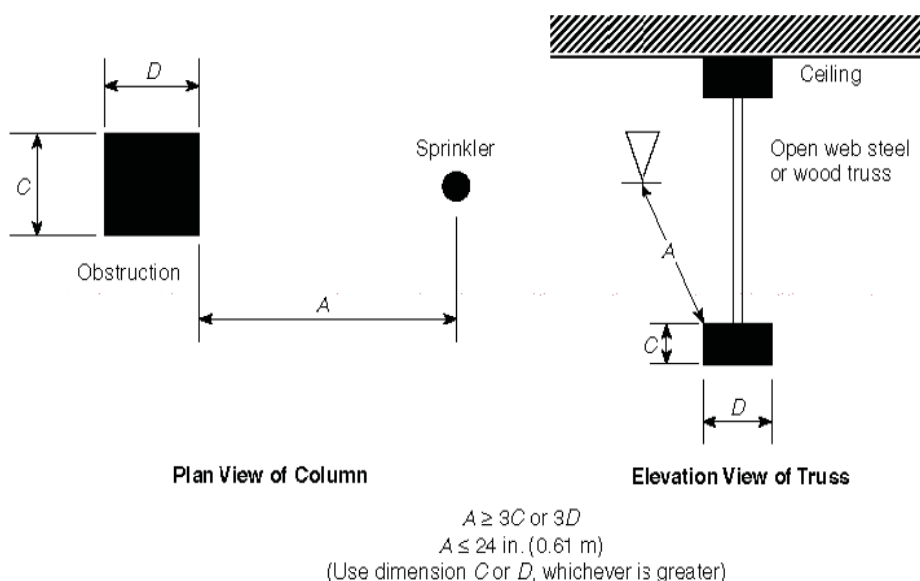


Figure 9.25: Minimum Distance from structural obstruction for pendent and upright sprinklers



27. Suspended or Floor-Mounted Vertical Obstructions for upright or pendent sprinklers

- 27.1.** The distance from sprinklers to privacy curtains, free standing partitions, room dividers, and similar obstructions in light hazard occupancies shall be in accordance with [Table 9.39](#) and [Figure 9.26](#).

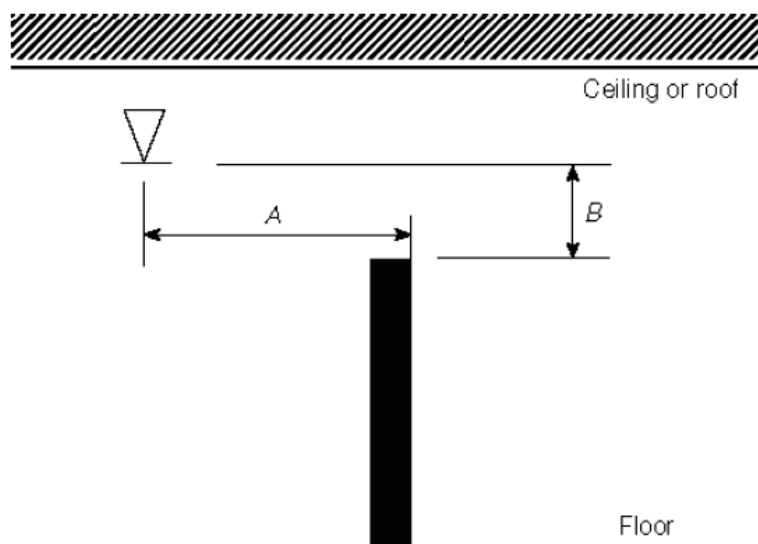


Figure 9.26: Distance from floor mounted vertical obstruction for pendent and upright sprinklers

Table 9.39: Distance to avoid obstruction for upright and pendent sprinklers

HORIZONTAL DISTANCE (A)	MINIMUM VERTICAL DISTANCE BELOW DEFLECTOR (B)
150 mm or less	75 mm
More than 150mm to 230mm	100mm
More than 230mm to 305 mm	150 mm
More than 305mm to 380mm	200mm
More than 380mm to 455mm	240mm
More than 455mm to 610mm	315mm
More than 610mm to 760mm	390mm
More than 760mm	455mm



28. Obstructions that Prevent Sprinkler Discharge from Reaching the Hazard

- 28.1.** Continuous or non continuous obstructions that interrupt the water discharge in a horizontal plane more than 457 mm below the sprinkler deflector in a manner to limit the distribution from reaching the protected hazard.
- 28.2.** Sprinklers shall be installed under fixed obstructions over 1.2 m wide such as ducts, decks, open grate flooring, cutting tables, and overhead doors.
- 28.3.** Sprinklers shall not be required below obstructions that are not fixed in place, such as conference tables.
- 28.4.** Sprinklers installed under open gratings shall be of the intermediate level/rack storage type or otherwise shielded from the discharge of overhead sprinklers.
- 28.5.** The clearance between the deflector and the top of storage shall be 457 mm or greater.

29. Obstructions to Sprinkler Discharge Pattern Development for sidewall sprinklers

- 29.1.** Sprinklers shall be positioned away from obstructions a minimum distance of three times the maximum dimension of the obstruction (e.g., truss webs and chords, pipe, columns, and fixtures). The maximum clear distance required shall be 609 mm and shall be positioned in accordance with **Figure 9.27** below where obstructions are present.

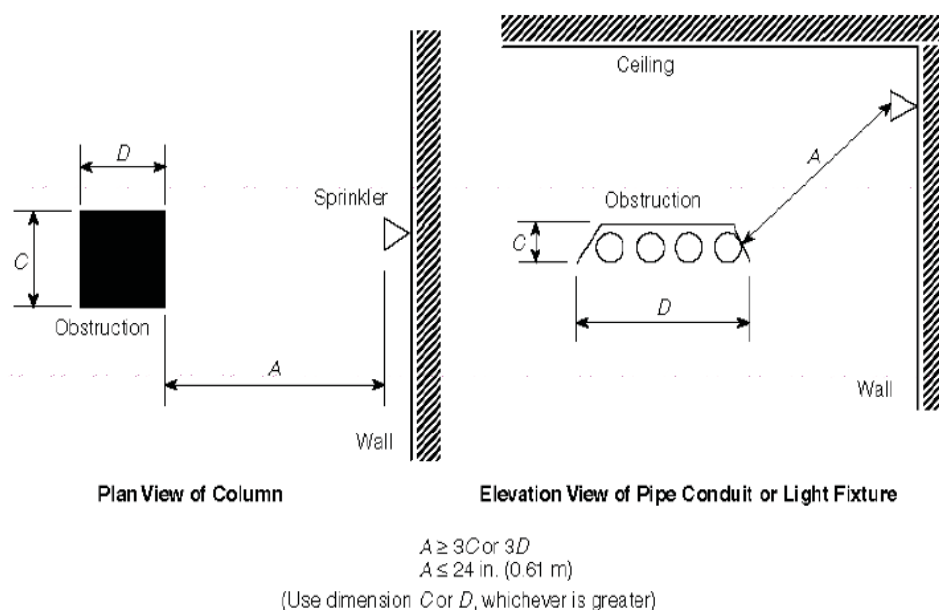


Figure 9.27: Minimum Distance from Obstruction (Standard Sidewall Spray Sprinkler)

30. Suspended or Floor-Mounted Vertical Obstructions for sidewall sprinklers

- 30.1.** The distance from sidewall sprinklers to privacy curtains, free-standing partitions, room dividers, and similar obstructions in light hazard occupancies shall be in accordance with **Table 9.40** and **Figure 9.28**.

Table 9.40: Distances to avoid floor mounted vertical obstruction for sidewall sprinklers

HORIZONTAL DISTANCE (A)	MINIMUM VERTICAL DISTANCE BELOW DEFLECTOR (B)
150 mm or less	75 mm
More than 150mm to 230mm	100mm
More than 230mm to 305 mm	150 mm
More than 305mm to 380mm	200mm
More than 380mm to 455mm	240mm
More than 455mm to 610mm	315mm
More than 610mm to 760mm	390mm
More than 760mm	455mm

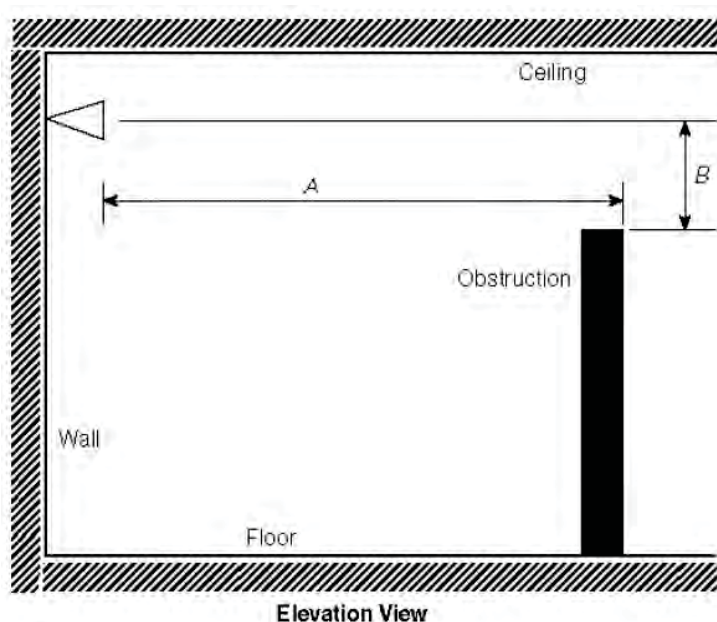


Figure 9.28: Suspended or Floor-Mounted Obstructions (Standard Sidewall Spray Sprinklers).

31. Distance Below Ceilings.

- 31.1.** Under unobstructed construction, the distance between the sprinkler deflector and the ceiling shall be a minimum of 25.4 mm and a maximum of 305 mm throughout the area of coverage of the sprinkler.



- 31.2.** Where there is a vertical change in ceiling elevation within the area of coverage of the sprinkler creating a distance of more than 0.91m between the upper ceiling and the sprinkler deflector, a vertical plane extending down from the ceiling at the change in elevation shall be considered a wall for the purpose of sprinkler spacing. Where the distance between the upper ceiling and the sprinkler deflector is less than or equal to 0.91m, the sprinklers shall be permitted to be spaced as though the ceiling was flat provided the obstruction rules and ceiling pocket rules are observed. See [Figure 9.29](#) for illustrations.

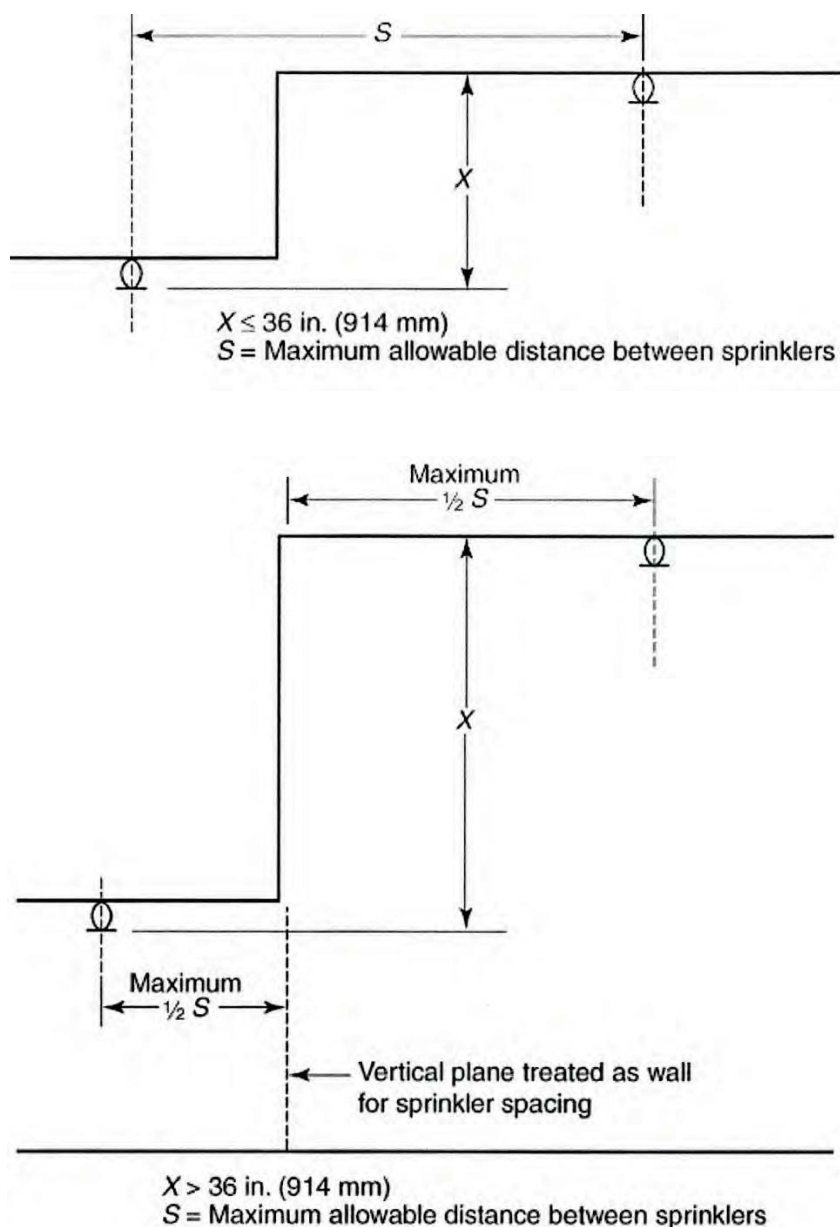


Figure 9.29: Vertical Changes in Ceiling Elevations.

- 31.3.** The minimum distance between the heat source to the sprinklers shall be not less than shown in [Table 9.41](#).



Table 9.41: Minimum spacing between sprinkler to the heat source

HEAT SOURCE	MINIMUM DISTANCE BETWEEN EDGE OF SOURCE TO ORDINARY TEMPERATURE RANGE SPRINKLERS	MINIMUM DISTANCE BETWEEN EDGE OF SOURCE TO ORDINARY TEMPERATURE RANGE SPRINKLERS
Electrical Light Fittings: 0 - 250 watts	300 mm	200mm
Electrical Light Fittings: >250 - 500 watts	450 mm	300mm
Hot water heater or furnace	300mm	150 mm
Front side of wall mounted HVAC diffuser	1000mm	500mm
Side of ceiling or wall mounted HVAC diffuser	750mm	450mm
Un-insulated heat ducts or hot water pipes	500mm	300mm

- 31.4.** Sprinklers shall be provided in concealed spaces (for example, suspended ceiling, raised floor and behind wall panels) where there are combustibles and services like mechanical ducts, fans, electrical cables and components.
- 31.5.** The depth of the concealed space (suspended ceiling and raised floor) shall not be less than 400mm to accommodate installation of sprinkler pipes.
- 31.6.** Sprinklers in concealed spaces can be exempted if the concealed space is fire compartmented in accordance with [Clause 34](#) of [Chapter 1](#) and that the concealed spaces of egress corridors and passageways are fire compartmented from the concealed spaces of other parts of the floor.

32. Location & Protection of Sprinkler Riser Pipe

- 32.1.** The protection of sprinkler riser pipe is not mandatory requirement in a building which is fully protected by an automatic sprinkler system,
- 32.2.** All steel pipes & fittings used for fire fighting service shall be painted in Red. Where the situation does not permit due to the interior architecture finish, the pipe may be painted in other colours by marking the sprinkler pipe with RED coloured band at every 3 meters with directional arrow marks.
- 32.3.** Feeder main pipes and riser pipes for sprinkler system shall be independent from the wet riser system piping. Common feeder main and riser piping shall not be permitted for wet riser and sprinkler system.



33. Stock of Spare Sprinklers

- 33.1. Spare sprinklers not less than six numbers in quantity in each type & temperature range installed within the building shall be kept maintained in stock within the premises.
- 33.2. Spare sprinklers shall be kept in a approved steel cabinet where the temperature will not exceed beyond 38°C at any time. Spare sprinkler cabinet shall be placed within the fire pump room or in the fire control room as approved by the Civil Defence.
- 33.3. At least a special sprinkler wrench (spanner) for each type of sprinkler shall be kept in stock along with the spare sprinklers inside the cabinet.
- 33.4. In high rise and bigger complex office buildings, the minimum stock of spare sprinklers required to be stored shall include all types and ratings installed and shall be according to the **Table 9.42** below.

Table 9.42: Minimum Stock of Spare Sprinklers

TOTAL NUMBER OF SPRINKLERS INSTALLED IN THE FACILITY	MINIMUM REQUIRED NUMBER OF SPRINKLERS IN STOCK
Where the facility has less than 300 Nos	Not less than 6 Nos
Where the facility has 300 to 1000 Nos	Not less than 12 Nos
Where the facility has more than 1000 Nos	Not less than 24 Nos

- 33.5. A special sprinkler wrench shall be provided and kept in the cabinet to be used in the removal and installation of sprinklers. One sprinkler wrench shall be provided for each type of sprinkler installed.
- 33.6. A list of the sprinklers installed in the property shall be posted in the sprinkler cabinet.
- 33.7. The list shall include the following:
 - i. Sprinkler Identification Number (SIN) if equipped; or the manufacturer, model, orifice, deflector type, thermal sensitivity, and pressure rating
 - ii. General description
 - iii. Quantity of each type to be contained in the cabinet
 - iv. Issue or revision date of the list

34. Civil Defence Breeching Inlets for Sprinkler System

- 34.1. Civil defence breeching inlets shall be located at ground level in an easily accessible, visible location, especially at front and back side of the buildings within 18 m from the civil defence vehicle access road.
- 34.2. Each breeching inlet shall be installed with in the cabinets with partially wired glass door front identified with signs as **SPRINKLER INLET** or **COMBINED WET / SPRK INLETS**.



- 34.3.** If more than one inlet is located at one location to serve for multiple towers or building or area, the same shall be clearly identified by providing a clear & legible sign board and mimic diagram.
- 34.4.** Civil Defence inlet shall be installed at a height of not less than 500mm and not more than 120 mm from the finished ground or floor level.

35. Support of Sprinkler Piping

- 35.1.** Sprinkler system pipe installations shall be adequately supported as per the good engineering practice in accordance with internationally accepted standards.
- 35.2.** All the supports provided for sprinkler system piping shall allow free movement for expansion or contraction of pipe work and shall be located by ensuring that the branch lines or fittings are not affected by the supports during expansion or contraction of the pipe installation.
- 35.3.** Sprinkler system main risers shall be supported by riser clamps or by hangers located on the horizontal connections within 600 mm of the center line of the riser. Riser clamps supporting risers by means of set screws and Riser clamps anchored to walls using hanger rods in the horizontal position shall not be permitted to vertically support risers.
- 35.4.** Vertical risers supported at the bottom of riser at lowest level, at each level, above & below the offsets and top of the risers. The maximum distance between each riser support shall not exceed 3 m.
- 35.5.** Anchor support shall be provided at the base (bottom) of each vertical riser pipes to withstand the total weight of pipe with water and to prevent the movement by an upward thrust in the sprinkler system.
- 35.6.** Horizontal runs of sprinkler pipes shall be supported in such that each support shall be designed to withstand the load 5 times the weight of water filled pipe, plus 115 kg.
- 35.7.** The minimum distance between hangar supports, size of hangar rods, fasteners, bolts, clamps etc shall be designed & selected and installed to withstand the load 5 times the weight of water filled pipe, plus 115 kg load.
- 35.8.** However the hangars spacing and hangar rod size which supports horizontal pipes shall be not less than the distance specified in **Table 9.43** below:

Table 9.43: Minimum spacing of hangar supports & hangar Rod size

PIPE SIZE	HANGAR SPACING	HANGAR ROD SIZE
25 - 50 mm dia	2 mtrs	10mm
65 - 100 mm dia	2.5 mtrs	12.5mm
150 & 200 mm dia	3 mtrs	16mm



36. Pipe Expansion Joints

- 36.1. Sprinkler pipes shall be supported in such a way that it allows free movement due to expansion and contraction and the supports shall be installed near the joints, elbows, tee branches as much as possible.
- 36.2. Where required special expansion joints & expansion loops shall be provided to allow free movement of pipe installation due expansion and contraction of the building structure and or the piping.

37. Water Hammering Arrestors

- 37.1. Surge arrestors of civil defence approved type shall be installed in the sprinkler system to prevent water hammering.

38. Installation of Sign Boards

- 38.1. Identification signs shall be provided for all sprinkler alarm check valve assemblies, floor zone control valve assemblies, pressure reducing valve stations, inspector test & drain valves, breeching inlets, spare sprinkler cabinets, fire pumps, water tanks, fire pump rooms etc made of non corrosive material and secured to the equipments or building wall by corrosion resistant chain & fasteners.
- 38.2. Hydraulic design information signs shall be posted for all sprinkler system near the alarm check valve assembly & in the fire pump room.

39. Installation Workmanship

- 39.1. Sprinkler system shall be installed by the Civil Defence approved, qualified and experienced technicians and engineers only.
- 39.2. The entire system shall be installed as per the good engineering practice in accordance with the internationally acceptable standards approved by the Civil Defence.

40. Inspection, Testing & Commissioning

40.1. Inspection

- 40.1.1. All the components and equipments of sprinkler system shall be thoroughly inspected prior to its installation that they are free from dirt and not mechanically damaged during its transportation.
- 40.1.2. Sprinkler system installations shall be regularly inspected during the construction stage to ensure that the installations are done in accordance with the Civil Defence approved drawings and good engineering practice in accordance with the internationally acceptable standards approved by the Civil Defence.



- 40.1.3.** In addition all the components of sprinkler system shall be visually inspected at regular intervals not less than quarterly after the commissioning to determine that components are free of corrosion, foreign material, physical damage, tampering, or other conditions that adversely affect system operation.

40.2. Testing & Commissioning

40.2.1. Flushing

- 40.2.1.1.** The complete sprinkler system piping shall be flushed with water to remove the foreign materials or other debris wastes trapped with in the pipe line during installation.
- 40.2.1.2.** Both underground and above ground portions of sprinkler system piping shall be subjected for flushing. The flushing operation shall be continuously done till the clear water comes out from the pipe line.
- 40.2.1.3.** The water shall be pumped in such that the velocity with in piping shall be not less than 3 meters per second sufficient to lift & flush out any debris. The minimum flow required for flushing shall be not less than hydraulically calculated water demand for the system to produce the velocity of not less than 3 meters per second.
- 40.2.1.4.** The flushing shall be done prior to the hydrostatic test of piping and installation of any sprinkler heads. The flushing outlet shall be freely let out through the remotest landing valve stand pipe.
- 40.2.1.5.** All the sprinkler cross mains shall be terminated with pipe size of not less than 40 mm diameter and fitted with a gate / ball valve having diameter not less than 40mm dia with a hose adapter fitting.
- 40.2.1.6.** In case of gridded piping arrangements, all branch lines shall be provided with flushing arrangements as per the requirements of Civil Defence.

40.2.2. Hydrostatic Test

- 40.2.2.1.** After flushing of sprinkler system piping, all sections of piping installation shall be subjected hydrostatic test for not less than 1.5 times of the system working pressure or 16 bar whichever is higher value.
- 40.2.2.2.** The hydrostatic test pressure shall be measured at lowest elevation of the riser pipes of the system and the riser pipe being tested.
- 40.2.2.3.** In addition, the pressure gauges shall be installed at top most point of the riser pipes and remotest point of the horizontal pipe section being tested and the pressure readings of all gauges shall be recorded at every regular interval of 4 hours and the results shall be satisfactory and acceptable.



40.2.2.4. The hydrostatic test pressure shall be kept in observation for the period of not less than 24 hours and shall be witnessed and certified the consulting engineer in charge of project.

40.2.2.5. If hydrostatic test of any section of piping is done without fixing of sprinkler heads & other valves, re-test shall be conducted after the installation of all sprinkler system equipments and the test results shall be satisfactory and must be recorded and approved by the engineer in charge. Test results shall be submitted to the Civil Defence Authorities as & when requested for the proof.

40.2.3. Pressure Settings

40.2.3.1. Pressure settings of pressure reducing valves installed in the PRV stations shall be verified prior to its installation that they are factory set to its required outlet pressure and pressure relief valve installed on downstream side of PRV is set not more than 12.1 bar as per the requirements.

40.2.3.2. All pressure reducing valves in the sprinkler system shall be verified prior to its installation that they factory set to the required pressure according to the hydraulic calculations and are sealed.

40.2.3.3. If factory pressure setting seal is found tampered, the same shall be replaced by new one or sent for factory set for validation.

40.2.4. Flow Test

40.2.4.1. Upon the satisfactory completion of the entire installation, flushing and hydrostatic testing of sprinkler system, performance flow test of sprinkler system shall be conducted by any one or more of the following methods as required by the Civil Defence Authorities:

- i. By shattering the sprinkler bulbs in a convenient floor / area;
- ii. By operating hose valves installed on fire test header at ground level.
- iii. By operating test line installed in the fire pump room with the help of flow meter & pressure gauge.

40.2.4.2. Flow test results shall be satisfactory & results shall be recorded and approved by a civil defence certified fire protection engineer.

40.2.4.3. A portable flow meter shall be used to test the flow & pressure of a sprinkler head at hydraulically top most & remotest locations.

40.2.4.4. In addition, Flow tests shall be performed during the inspection of Civil Defence Authorities as required and test results shall be satisfactory and recorded.



40.2.5. Physical Test

- 40.2.5.1.** All valves including isolation / control valves, test & drain valves shall be manually opened or closed by turning the hand wheel crank or wrench for its full range and returning it to its normal position.
- 40.2.5.2.** Supervisory alarm of isolation / control valves shall be tested by closing & opening of the valves and water flow monitoring alarms shall be tested opening test & drain valves. The interface signals at fire alarm control panel shall be verified and recorded.

41. Maintenance

- 41.1.** The entire sprinkler system shall be maintained throughout the year in good working condition by the competent fire protection system maintenance contractors who are enlisted in the latest Civil Defence comprehensive maintenance program.
- 41.2.** A tag should be attached to all major equipments such as fire pumps, breeching inlets, alarm valve assemblies, floor / zone control valve assemblies, pressure reducing valves, isolation & check valves etc. for recording the information indicating the date of visual inspection and the date of maintenance carried out and next due date for the inspection and maintenance.

42. Water Spray System

42.1. Introduction

- 42.1.1.** The term Water Spray refers to water that is discharged from specially designed nozzles or devices to produce a predetermined pattern, particle size, velocity and density. The primary distinction between a water spray and a sprinkler system is that of specific coverage versus general area coverage. Water spray systems have typically been provided to protect a specific piece of equipment with surface coverage.
- 42.1.2.** The pattern of the water spray discharged from spray nozzles onto a surface may be elliptical or Circular, and the cross section of the projected discharge is conical. The water spray is forcefully directed onto the object or surface being protected. The pattern of spray nozzle discharge must carry water spray over the distance between the nozzle and the target, compensate for wind and draft conditions, and effectively hit the surface to be protected. The required discharge density in gpm/ft² (L/min/m²) and complete coverage of the area to be protected are also essential elements.
- 42.1.3.** This chapter covers the use and applications of water spray systems for fire suppression, Control and extinguishment and describe the components of spray systems and the specialized Uses of the systems. Because of the similarities



between sprinkler systems and water spray systems, their water supply requirements, some of the equipment used in the systems, and the hydraulic Calculations for determining water supplies are briefed.

- 42.1.4.** A water spray system is a special fixed pipe system connected to a reliable supply of fire protection water and equipped with water spray nozzles for specific water discharge and distribution over the surface or area to be protected. The piping system is connected to a water supply through a deluge valve that can be actuated both automatically and manually to initiate the flow of water. Automatic system actuation valves for spray systems can be actuated electrically by the operation of automatic detection equipment, such as heat detectors, relay circuits, and gas detectors, or mechanically by hydraulic or pneumatic systems, depending on the operating mode of the individual valves.

42.2. Characteristics of Water Spray System

- 42.2.1.** Generally, water spray can be used effectively to extinguish a Fire, control a fire, protect exposures, and/or prevent a fire.
- 42.2.2.** Water spray extinguishes a fire by cooling it, smothering it with the steam produced, emulsifying or diluting some flammable Liquids, or by a combination of these factors.
- 42.2.3.** With its consequent limitation of fire spread, controlled burning may be applied if the burning combustibles cannot be extinguished by water spray or if extinguishment is not desirable.
- 42.2.4.** Exposures are protected by applying water spray directly to the exposed structures or equipment to remove or reduce the heat transferred to them from the exposing fire. Water spray curtains mounted at a distance from the exposed surface are less effective than direct application.
- 42.2.5.** It is sometimes possible to use water spray to dissolve, dilute, disperse, or cool flammable or combustible materials before they are ignited by an exposing ignition source.

42.3. Applications of Water Spray System

- 42.3.1.** The nature of the equipment to be protected, the physical and chemical properties of the material involved, and the environment of the hazard should be considered when determining the design and effectiveness of the water spray system.
- i. Ordinary combustible materials, such as paper, wood, and textiles, particularly to extinguish fires in such materials rather than control them.
 - ii. Electrical equipment installations, such as transformers, oil switches, and rotating electrical machinery.



- iii. Flammable gases and liquids, particularly to control fires in these materials and to extinguish types of fires involving combustible liquids.
- iv. Flammable liquid and gas tanks, processing equipment, and structures, as protection against exposure fires.
- v. Open cable trays and runs containing electrical cables or Tubing.

42.4. General Design Requirements and Procedures

42.4.1. When designing a deluge system for a particular installation, consideration must be given to the following:

- i. Type of hazard
- ii. System's overall purpose
- iii. Job specifications
- iv. Area to be protected by one Spray/deluge system
- v. Water supply
- vi. Drainage
- vii. Floatable combustible liquids
- viii. Equipment shut-down
- ix. Corrosive atmospheres
- x. Draft curtains
- xi. The necessity of explosion-proof electrical equipment
- xii. Appropriate equipment

42.4.2. The water density required to extinguish the fire or to absorb the expected heat from exposure or combustion is an important factor. When this has been determined, a nozzle may be selected that will provide that density at a velocity adequate to overcome air currents and to carry the spray to the equipment to be protected. Each nozzle must have the proper angle of discharge to cover the area to be protected by the nozzle.

42.4.3. Determining the proper density needed for extinguishment requires considerable engineering judgment and, in the case of flammable or combustible liquids, depends on such characteristics of the fuel as vapor pressure, flashpoint, viscosity, water solubility, and specific gravity. The density varies between 0.2 gpm and 0.5 gpm/ft² (8.1 to 20.4 L/min/m²) of protected surface.

42.4.4. For exposure protection of vessels, a density of 0.25 gpm/ft² (10.2 L/min/m²) should provide sufficient cooling to limit an exposure fire's heat input through the vessel walls. The water density required for exposure protection of structural supports and miscellaneous equipment, such as cable trays and runs, pipe racks, transformers, and belt conveyors, varies from 0.1 to 0.3 gpm/ft² (4.1 to 12.2 L/min/m²) of exposed surface area. Design densities should be taken care for various distributions.



- 42.4.5.** When water spray is used to protect oil-filled electrical equipment, such as transformers and large switch gear, special care must be taken to provide safe electrical clearances. Special fixed water spray nozzles have been developed to provide adequate spray density and range to accommodate wind, along with a simplified piping arrangement that is spaced safely from energized electrical parts.
- 42.4.6.** The practical location of the piping and nozzles with respect to the surface to which the spray is to be applied or to the zone in which the spray is to be effective is determined largely by the physical arrangement and protection needs of the installation requiring protection. Once the criteria are established, the size of the nozzles to be used, the angle of the nozzle discharge cone, and the water pressure needed can be determined.
- 42.4.7.** The above parameters shall also be coordinated with the manufacturer's recommendations for the Selection and use of Spray Nozzles, location, spacing to give the desired area coverage with hydraulic calculations to establish the appropriate pipe size and water supply requirements.
- 42.4.8.** Pipe size must be calculated hydraulically for each system so that the water at the spray nozzle will have an adequate pressure to provide the necessary flow and spray pattern.
- 42.4.9. Water Demand**
- 42.4.10.** The water supply must be adequate to supply the operating water spray system(s) with the required gpm (L/min) at effective pressure. Water spray systems adjacent to the hazard initially protected may require additional water.
- 42.4.11.** The water supply should be able to supply hose streams simultaneously. The total required water supply pressure and flow rates should be considered when the system is designed.
- 42.4.12.** The duration of the discharge required varies according to the nature of the hazard, the purpose for which the system is designed, and other factors that can be evaluated only for each installation.
- 42.4.13.** Water flow demand is specified in terms of the density of a uniformly distributed spray measured in gpm/ft² (L/min/m²) of area protected. The discharge rate per unit of area depends on whether the spray system is installed to extinguish a fire, to control a fire, or to protect an exposure, and on the characteristics of the materials involved.
- 42.4.14.** Following is an example, with procedure of Water Spray System for LPG gas Tank, which is generally a horizontal Tank. [See Figure 9.30.](#)



42.4.15. Water Spray System for Horizontal Tank

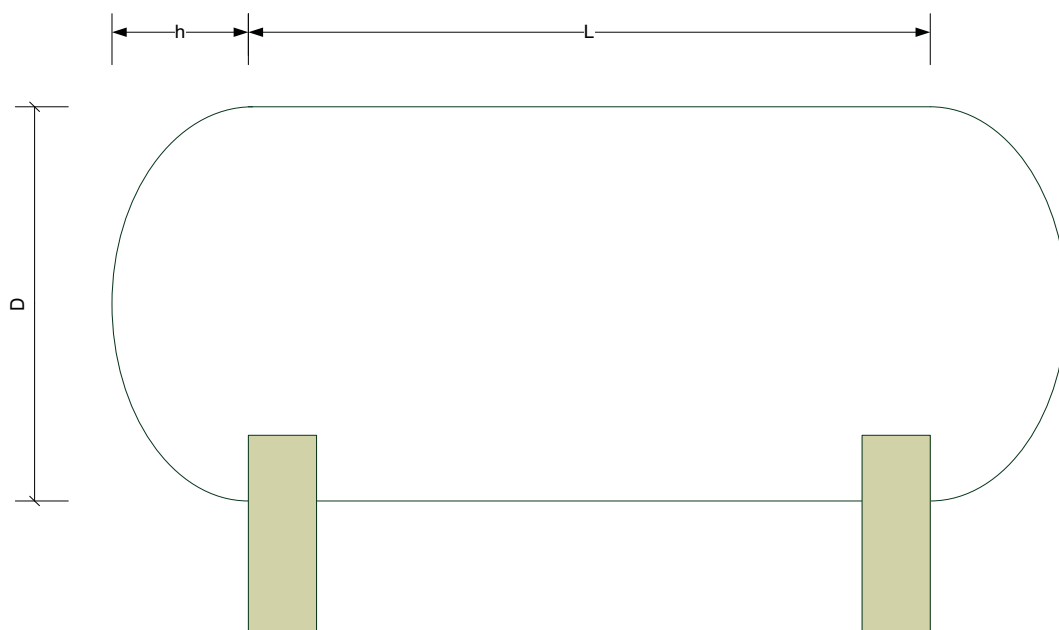


Figure 9.30: Typical Horizontal Tank Dimensions.

- i. Calculate the total area of the Tank
 - a. Calculate the surface area of the Shell, $A_1 = \pi DL$
 - b. Calculate the area of the flat ends, $A_2 = D^2/4$
 - c. Calculate the area of spherical (Concave or Convex) ends, $A_3 = (D^2/4 + h^2)$
 - d. Calculate the area of Hemispherical ends, $A_4 = D^2/2$
 - e. Total Area of Tank, $A = A_1 + A_2 + A_3 + A_4$
- ii. Design Density Water Application Rate shall be $d = 10.2 \text{ Lpm/M}^2$ (2.7 Gpm/M^2)
- iii. Water Application Rate Required (Theoretical – Lpm) = $A \times d$
- iv. Establish minimum Pressure (Bar) required at remotest Nozzle. (As per manufacturer's recommendations suitable to design density and area of application).
- v. Establish minimum Discharge (lpm) through each Nozzle at the above stated pressure (Bar).
- vi. Select number of Nozzles to be provided as per the coverage requirement.
- vii. Find water required from each nozzle, = $Q/\text{No of nozzles}$
- viii. Select appropriate Nozzle capacity i.e K-factor
- ix. Adjust design as per calculated Flow and Pressure required at the tap off point.
- x. Provide number of QBD Detectors as per the Coverage requirements.



- 42.4.16.** See **Figure 9.31** below for typical schematic of piping and nozzle arrangement for 2 LPG tanks.

42.5. Piping and Installation

- 42.5.1.** Refer to sections on Piping, Installation, Testing and Commissioning of Sprinkler Chapters along with Manufacturer's Manuals.

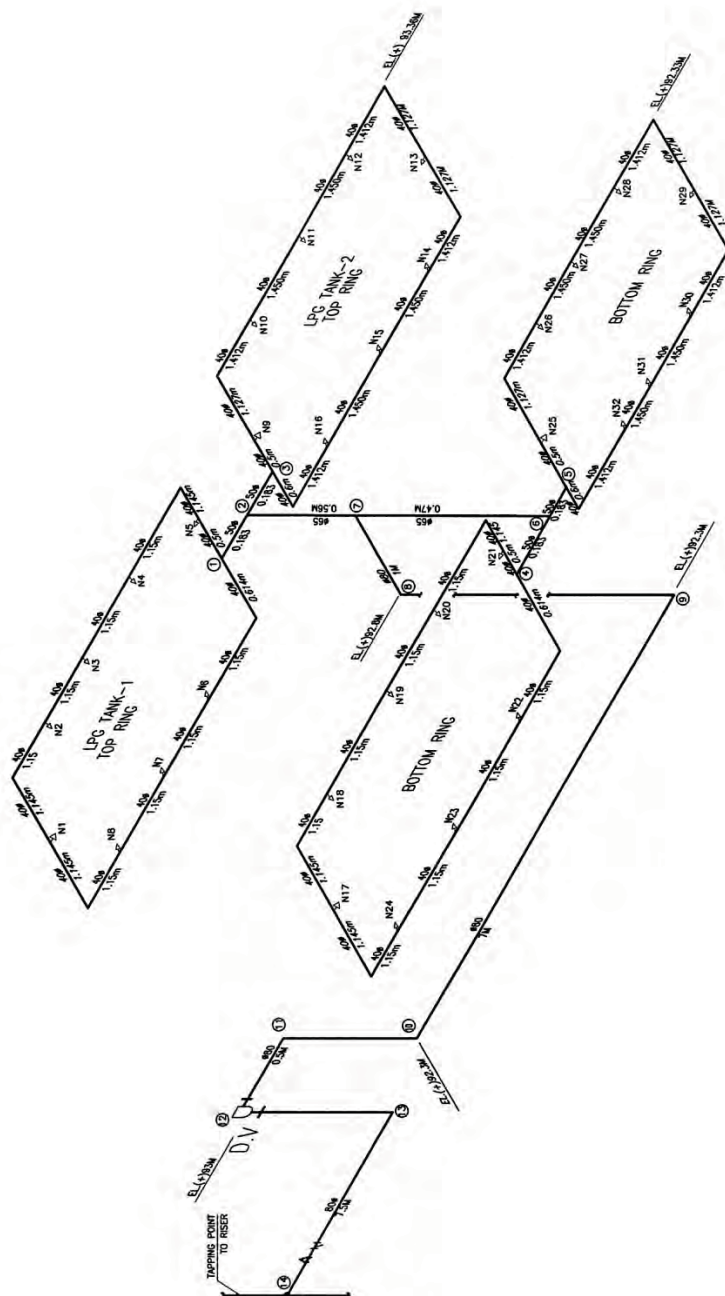


Figure 9.31: Typical Schematic for LPG Tank Water Spray System.



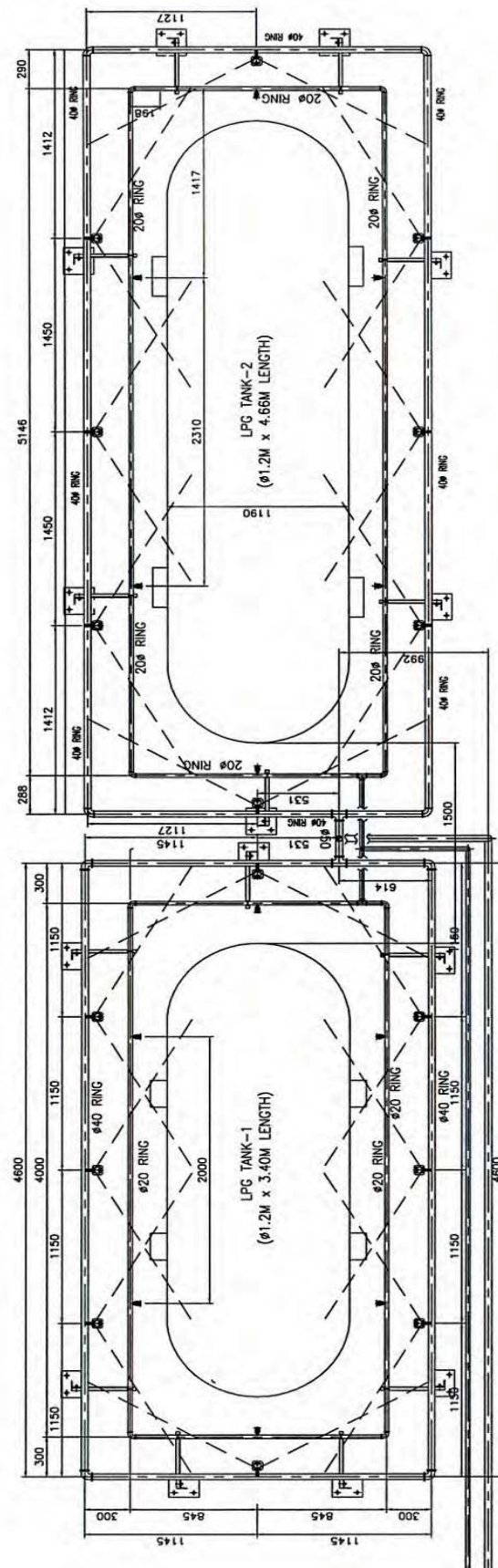


Figure 9.32: Typical Water Spray System Arrangement for 2 LPG Tanks



43. Water Mist Specifications

43.1. Introduction

Water mist systems whether low pressure, intermediate pressure or high pressure have been used internationally for 20 years. This relatively new and efficient Technology is gaining increased widespread use in marine, land and offshore applications. Using very small amounts of water in the form of a fine atomised mist or fog means that water usage is minimised and damage to buildings and contents is kept to a minimum. Water mist Technologies invariably use about 10% of the volume of water compared to traditional water sprinkler systems.

43.2. How Does Water Mist Function

Water mist Technologies suppress, control and extinguish fires in three primary ways:

- i. Oxygen dilution
- ii. Radiant heat attenuation
- iii. Cooling

Using small water droplets (<1,000 microns MVD) implies that the droplets have a large surface-area-to-volume ratio meaning that small droplets will absorb heat quickly and vaporise thereby removing the heat away from the fire plume and at the same time causing oxygen displacement. Water mist Technologies ingeniously use the energy of a fire against itself to cause smothering and extinguishment.

43.3. Advantages & Benefits

Some advantages and benefits of water mist Technologies compared to other fire suppression Technologies such as conventional water sprinklers and gaseous fire extinguishing agents are as follows:

43.3.1 Use less water

About 90% less than conventional sprinklers thereby saving costs on infrastructure, system footprint, smaller diameter pipes, fittings and components. This means greater efficiency and better usage of water resources whilst at the same time causing less water damage through flooding.

43.3.2 No airtight enclosure

Water mist systems do not require an air tight enclosure to function unlike gaseous fire agents that require completely air tight enclosures to function properly.

43.3.3 Rapid Cooling

Water mist systems are known to rapidly cool down ambient room temperatures thereby preventing other objects from combusting and lowering ceiling gas temperatures thus reducing the incidence of flash-over phenomena. Gases do not create significant cooling of ambient temperatures.



43.3.4 Toxin scrubbing

Water mist systems are known to scrub the environment inside the hazard and settle the toxic combustion by-products to the ground level thereby aiding visibility and improving life tenability. Live fire testing performed in third party accredited laboratories revealed remarkable reduction of carbon monoxide, carbon dioxide and hydrogen fluorides.

43.3.5 Environmentally safe

Water mist systems that do not use chemical additives are environmentally safe and are benign meaning they are safe to use in occupied spaces. Consequently fire protection systems can be activated much sooner thereby reducing smoke and fire related damage to buildings and contents.

43.3.6 Multitude of applications

Water mist systems have been tested and installed in a variety of applications and include Class A, Class B and Class E (electrical) installations.

43.3.7 Stainless steel components

Water mist systems invariably use Stainless steel pipes, fittings and components. This enhances system longevity and reduces maintenance costs spanning the life of the building. Use of Stainless steel pipes means no internal rusting inside pipes and fittings.

43.3.8 Less system clutter

Water mist systems are generally less cumbersome to install as they use less and smaller components thereby reducing clutter and improving aesthetics.

43.4. System Types

43.4.1 Dry Pipe Designs

Open deluge water mist nozzles are installed on the grid pipe work and often a system discharge will be a “total flooding” concept meaning that all nozzles in an opened section or zone will discharge water mist simultaneously during system activation. When a relatively large hazard is required to be protected like a warehouse or factory, it is often necessary to zone off the area into several zones or sections by using approved zone valves.

43.4.2 Wet Pipe Systems

Automatic glass bulb nozzles are used and installed on the grid pipe work. The distribution pipe work is filled and pressurized with water using a small approved jockey pump. The line pressure is maintained at a nominal standby pressure, for example, 16 bar. During a fire incident, only the automatic nozzle(s) that activates



will spray water mist onto the fire. If a fire develops quickly and spreads further, more glass bulbs will shatter and hence more nozzles will activate to flow water mist. In this case a water mist system will resemble a conventional water sprinkler system. Different approved temperature glass bulbs can be used to suit the specific application.

43.5. Nozzle Types

43.5.1 Single Fluid Nozzles

Use water alone and pressure derived from the pump (or pressurized by dry nitrogen gas when storage cylinders are used) and atomization occurs at the nozzle.

43.5.2 Twin-Fluid Nozzles

Use both water and air for water atomization which is created by the interaction of water and gas under pressure inside the nozzle. In this design, there are invariably two pipes to each water mist nozzle, ie one for gas and one for water media.

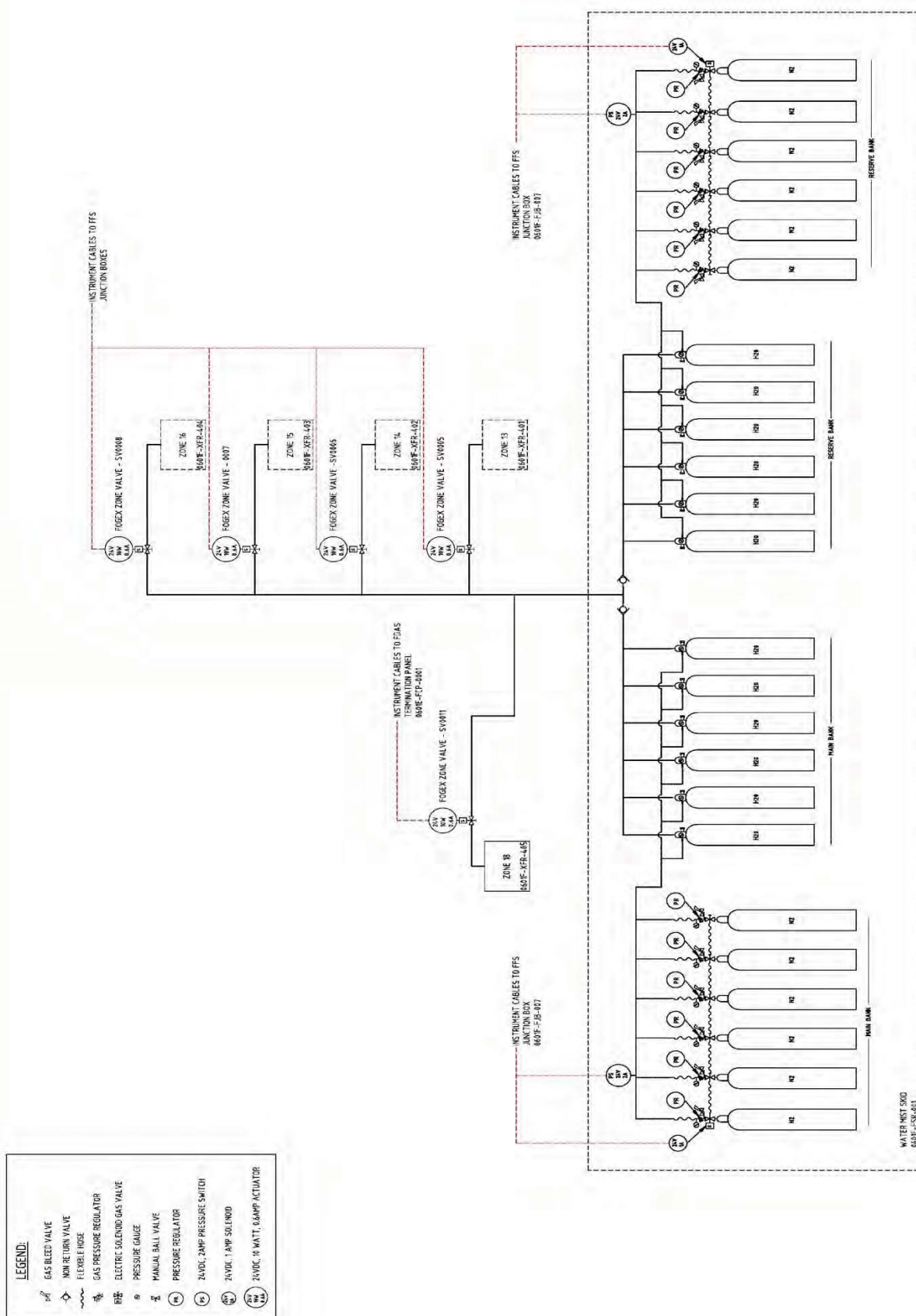
43.6. Pumps & Pressure Skid Modules

Water mist fire protection systems can use either approved fire pumps, ie electric and or Diesel driven fire pumps or pressure skid modules (PSM's). Depending on the customer preference and size and complexity of the project, approved electric driven or Diesel driven fire pumps can be used to pump and pressurize the media to the water mist nozzles. Usually lower pressure water mist systems use centrifugal type pumps whereas higher pressure water mist systems use positive displacement reciprocating piston pumps. The pumps must be connected to a clean and reliable water supply at all times. Invariably this includes a water supply tank of sufficient size and capacity. Fire pumps and controllers shall be either FM or ULI approved and conform to NFPA20 standards.

Water mist fire protection systems can be configured and supplied as a pressure skid module (PSM) meaning that approved high pressure water cylinders are used for storing the fire extinguishing media and dry nitrogen cylinders are used for pressurizing the system. The ratio of water storage cylinders to dry nitrogen gas cylinders has to be carefully worked out by the system engineer and must accord with the system product approvals, either FM or ULI etc. Enough water and gas cylinders must be supplied to ensure sufficient continuous water media discharge for adequate fire control and/or extinguishment.

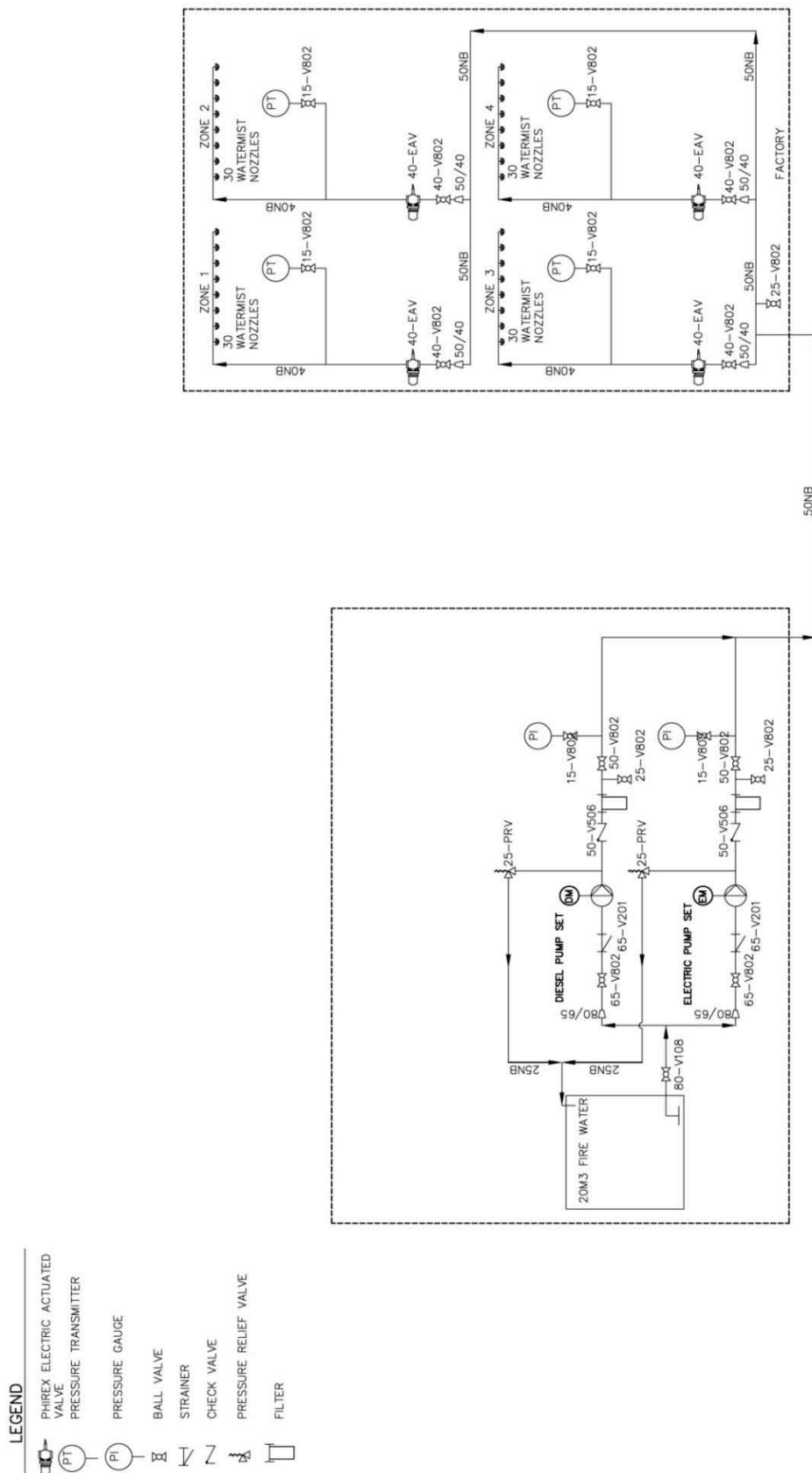
Typical illustrations are provided below for both fire pump installations and for pressure skid modules.





PRESSURE SKID MODULE TYPICAL ARRANGEMENT - MAIN & RESERVE BANK





PUMPED SYSTEM TYPICAL ARRANGEMENT - ONE ELECTRIC DUTY & ONE ELECTRIC STANDBY



Large scale projects often require multiple pumps to supply the total water demand. In this case pumps are manifolded together and are programmed to start sequentially to reduce the power load. FM or ULI Approved non-return valves must be installed between the pumps to prevent water from returning to an idle pump.

Main duty and standby fire pumps shall be supplied and installed wherever possible. If the main duty fire pump fails to start then the standby fire pump will start automatically. Fire pumps can be all electric provided an external dedicated power supply is available at all times otherwise a Diesel backup pump is to be supplied in addition to the main electric fire pump of the same size.

Fire pumps and controllers are to be designed and installed in accordance with NFPA20 & NFPA750 water mist standards latest edition. Pumps shall be designed and sized with 110% pumping capacity and their performance shall not fluctuate by no greater than $\pm 5\%$. All fire pumps to be used for fire fighting purposes must be factory acceptance tested (FAT) in the presence of an independent third party accredited witnessing authority and pump witnessing certificates and pump FAT test reports must accompany all pumps and be provided to the project owner or project consultant.

Pressure Skid modules where used shall have a main bank and a reserve bank to act as a second shot and to act as a standby fire protection system while the main bank is serviced or replenished. See typical arrangement drawing for a pressure skid module.

43.7. Filters & Strainers

It is essential that all water mist systems installed must have a suitable and approved water basket inline water filter and a suitably approved Y-strainer to capture any dirt from entering the pumps and causing nozzle blockages. Use of clean potable water is recommended at all times for water mist systems. Y-strainers act as the first stage of filtration and the basket inline filter acts as the second stage of filtration.

Every water mist nozzle shall have a suitable inbuilt Stainless steel sieve to prevent dirt from entering the nozzle and causing blockages. This is the third stage of filtration.

Pressure skid modules do not have to use Y-strainers or basket inline filters because the water inside the internally lined high pressure water storage containers should already have been filtered and be devoid of detritus material. Distilled water shall be used for filling the water storage cylinders.

43.8. Pressure Gauges

Suitable listed or approved pressure gauges shall be installed and used on all pumps and PSM's.

43.9. Section Valves

Suitable listed or approved Stainless steel electric 24VDC solenoid valves shall be used throughout for zoning off sections of the water mist project. Valves must be capable of withstanding the system pressure plus 1.5 times design pressure. Electric zone valves shall be supervised and report back to the main fire control and alarm panel (FACP).



43.10. Manual Ball Valves

Suitable listed or approved Stainless steel manual ball valves with lockable handles shall be supplied and used throughout the water mist project. Valves must be capable of withstanding the maximum system operating pressure plus 1.5 times design pressure. This is to include all drainage valves.

43.11. Pressure Switches

Suitable listed or approved pressure sender switches or pressure transducers shall be supplied and used throughout the water mist project. Their function is to monitor the system pressure and report back to the FACP. If multiple zones are used then each zone must have installed at least one pressure switch/transducer to monitor line pressure and report back to the FACP.

43.12. Fire Detection Systems

Listed or approved fire detection systems shall be supplied and installed. The fire detection systems proposed shall also be compatible with the water mist systems.

43.13. Project Designs & Hydraulics

Every water mist project shall be custom designed and engineered to manufacturers specifications and relevant NFPA standards. Engineering drawings are to be submitted to the Authority Having Jurisdiction for approval showing all details such as pipes, fittings, isometric views, system layout of all components, pumps and controllers etc. The water mist supplier shall also prepare and supply hydraulic calculations for the project using an approved hydraulic software program.

43.14. Design and O&M Manuals

The water mist system supplier shall provide at least one (1) typed and bound set of his systems design and operations and maintenance manual to the project owner or consultant after project completion.

43.15. Commissioning Certificates

Upon project finalization and prior to project handing over, the water mist system manufacturer shall commission the installed system and ensure that all functions are performing satisfactorily. This will usually involve a full system check-list and a cold system discharge test to ensure all pumps & controllers start as required and all nozzles discharge properly. Upon system commissioning, the water mist manufacturer or supplier is to submit to the project owner or consultant as the case may be, a final inspection report and commissioning certificate. Warranty certificates are also required to be submitted during this time.



43.16. Water Mist Applications

Water mist applications are numerous and varied. More water mist standards and test protocols are becoming available every year. Some applications where water mist systems have been installed successfully to date include:

- Electric transformer substations
- Computer and data rooms
- Electrical switch gear rooms
- Power generation facilities
- Electric cable tunnels
- Road tunnels
- Marine vessels
- Offshore platforms
- Large warehouses
- Petro-chemical refineries
- Residential dwellings and apartments
- High rise hotels and offices
- Airports and port terminals
- Rapid rail transit systems
- Museums, art galleries and libraries
- Military air craft hangars & bunkers
- Large mining machinery and earthmoving equipment
- Conveyor belt systems
- Combustion & gas turbines
- State penitentiaries
- Theatre buildings
- Powder factories
- Oil processing facilities, etc

Water mist manufacturers who have conducted live fire testing at recognized independent fire testing laboratories in the presence of witnessing authorities shall submit their laboratory fire test reports and product approvals obtained from approving authorities to Civil Defence for approval purposes. Applicants of water mist systems who require Civil Defence approvals must lodge the proper application forms with Civil Defence.

43.17. Design Considerations

The water mist manufacturer shall design his water mist fire protection systems as per product approvals based on live fire testing performed at independent fire testing laboratories. The system manufacturer shall also observe all relevant fire industry standards and applicable codes. Where industry standards or codes are not specific on a particular matter, then the manufacturer or AHJ recommendations shall be followed and reference to the manufacturer's design, installation and service manuals shall be cross referenced.

The fire system supplier shall not exceed his listings or approvals especially nozzle grid spacing which shall be observed. The nozzle grid spacing or effective coverage area per



nozzle will be stipulated inside the fire test reports as issued by the testing laboratory or approving authority. Distance of nozzles from walls should not exceed half the listed nozzle grid spacing. For example a system that has nozzle grid spacing approved at 4 metres x 4 metres, then the distance of a nozzle from the wall shall not exceed 2 metres.

Similarly, the system manufacturer shall not exceed his listed or approved nozzle vertical distance from floor level. Water mist fire protection system designs shall follow the manufacturer's design manual.

43.18. Standards

Water mist manufacturers and fire protection system designers shall design & supply their water mist fire protection systems to comply as far as is practicable with the following standards:

1. NFPA750 Water Mist Standard, 2003 edition
2. AS4587-1999 Water Mist Standard
3. FM5560 Water Mist Standard, 2008
4. IMO MSC/Circ. 668/728 for machinery spaces and cargo pump rooms
5. IMO MSC/Circ. 1165 for machinery spaces and cargo pump rooms
6. IMO MSC/Circ. 913 for local application systems
7. IMO 800(A) for accommodation spaces, corridors, luxury cabins
8. European Norm EN12845:2004
9. European Norm EN14972
10. NFPA20 Standards "Stationary Fire Pumps for Fire Protection", 1999 edition
11. NFPA13 Standards "Water Sprinkler Systems"
12. CEA 4001:2005-09
13. FM Global – Property Loss Prevention Data Sheets 3-7, "Fire Protection Pumps", June 2009
14. FM Global – Property Loss Prevention Data Sheets 3-7N, 13-4N "Stationary Pumps for Fire Protection", September 2001
15. FM Global – Property Loss Prevention Data Sheets 2-81, "Fire Protection System Inspection, Testing and Maintenance and other Fire Loss Prevention Inspections", January 2008

References shall be drawn from the latest editions for the above standards wherever applicable.

44. FOAM EXTINGUISHING SYSTEMS

44.1 Introduction

- 44.1.1.** Foam is produced by mixing a foam concentrate with water at the appropriate concentration, and then aerating and agitating the solution to form the bubble structure. Some foams are thick and viscous and form tough, heat-resistant blankets over burning liquid surfaces and vertical areas. Other foams are thinner and spread more rapidly. Some foams are capable of producing a vapor-sealing film of surface-active water solution on a liquid surface. Some, such as medium- or high-expansion



foam, are meant to be used as large volumes of wet gas cells for inundating surfaces and filling cavities.

44.1.2. Foams are defined by their expansion ratio, which is the ratio of final foam volume to original foam solution volume before adding air. They are arbitrarily subdivided into three ranges:

- i. Low-expansion foam—expansion up to 20:1
- ii. Medium-expansion foam—expansion 20 to 200:1
- iii. High-expansion foam—expansion 200 to 1000:1.

44.1.3. Fire-fighting foams are used in fixed and portable fire extinguishing systems.

44.1.4. Foam is generated by proportioning foam concentrate with water. Various fixed and portable proportioning devices are used. Discharge devices include nozzles, foam monitors, and sprinklers.

44.2. Different types of Foams and their Applications

44.2.1. A number of types of foaming agents are available, known as foam concentrates, some of which are designed for specific applications. Some are suitable for extinguishing all types of flammable liquids, including water-soluble and foam-destructive liquids. Below are descriptions of the common types of foam agents.

- i. Aqueous Film-Forming Foam Agents (AFFF).
- ii. Fluoroprotein (FP) Foaming Agents.
- iii. Fluoroprotein (FP) Foaming Agents.
- iv. Protein (P) Foaming Agents.
- v. Low-Temperature Foaming Agents.
- vi. Alcohol-Type Foaming Agents (AR).
- vii. Medium- and High-Expansion Foaming Agents.
- viii. Other Synthetic Hydrocarbon Surfactant Foaming Agents.

44.2.2. Low-expansion foam is used principally to extinguish burning flammable or combustible liquid spill or tank fires by application to develop a cooling, coherent blanket.

44.2.3. A foam blanket covering a tank's liquid surface can prevent vapor transmission for some time, depending on the stability and depth of the foam. Fuel spills are quickly rendered safe by foam blanketing. The blanket may be removed after a suitable period of time; typically it has no detrimental effect on the product with which it comes into contact.

44.2.4. Foams can be used to diminish or halt the generation of flammable vapors from non-burning liquids or solids and may be used to fill cavities or enclosures where toxic or flammable gases may collect.

44.2.5. Foam is of great importance where aircrafts are fueled and operated. Sudden, large fuel spills resulting from aircraft accidents or malfunction require rapid foam



application. Hangar fire protection is best accomplished by properly designed foam systems.

- 44.2.6.** Increasingly, warehouses and buildings storing large quantities of combustible and flammable liquids are protected by foam-water sprinkler systems. The protection required is a function of the type and quantity of liquid stored, building height, and storage configuration.
- 44.2.7.** Foams of the medium- or high-expansion type (20 to 1000 times) may be used to fill enclosures such as basement room areas or holds of ships where fires are difficult or impossible to reach. Here foams act to halt convection and access to air for combustion. Their water content also cools and diminishes oxygen by steam displacement. Foams of this type (with expansion ratios of 400 to 500) may be used to control liquefied natural gas (LNG) spill fires and help disperse the resulting vapor cloud.

44.3. Foam Proportioning

- 44.3.1.** The process of producing and applying fire-fighting air-foams to hazards requires three separate operations, each of which consumes energy. They are (1) the proportioning process, (2) the foam generation phase, and (3) the distribution method.
- 44.3.2.** It is very important that foam concentrate be proportioned accurately into the water stream. Proportioning equipment, foam concentrate, and discharge equipment must be matched to produce the proper solution concentration at system design operating pressures.
- 44.3.3.** If proportioning is low, the foam will be relatively weak and unstable; if too high, the foam may be stiff and concentrate will be wasted, thus reducing effective system operating time. So that a predetermined volume of liquid foam concentrate may be mixed with a water stream to form a foam solution of fixed concentration, the following two general methods are used:
- i. Methods that use the pressure energy of the water stream by venturi action and orifices to induct concentrate.
 - ii. Methods that use external pumps or pressure heads to inject concentrate into the water stream at a fixed ratio to flow.

- 44.3.4.** Following figures show some typical foam system arrangements.



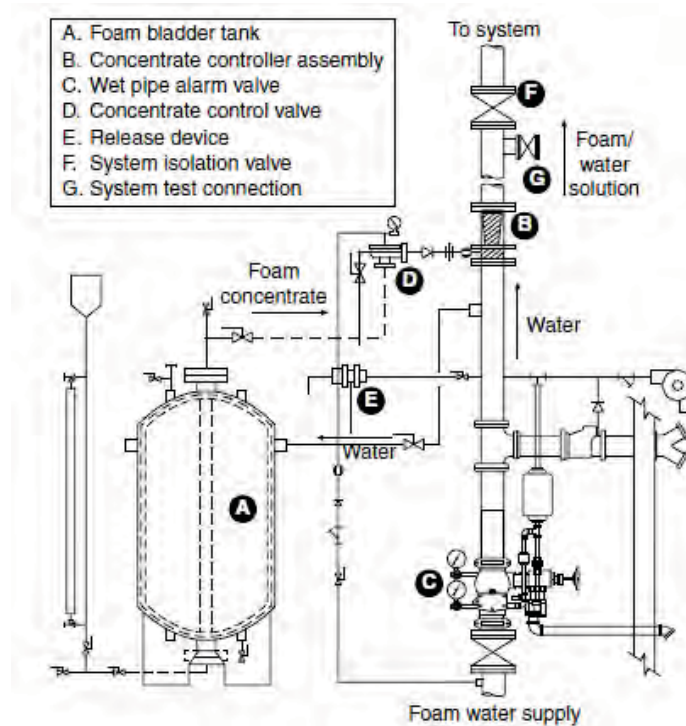


Figure 9.33: Typical Wet Pipe Bladder Tank arrangement for Foam System using water pressure

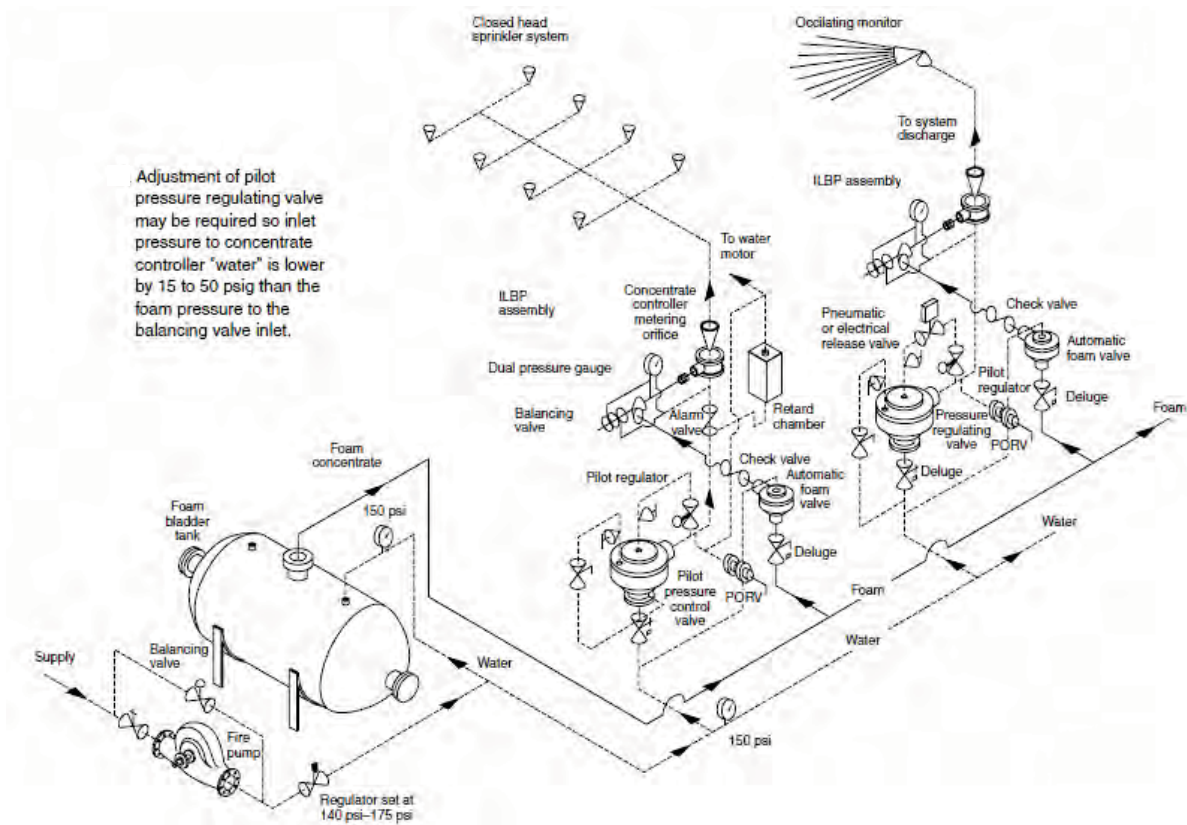


Figure 9.34: Typical Low Foam arrangements for Multi discharge areas

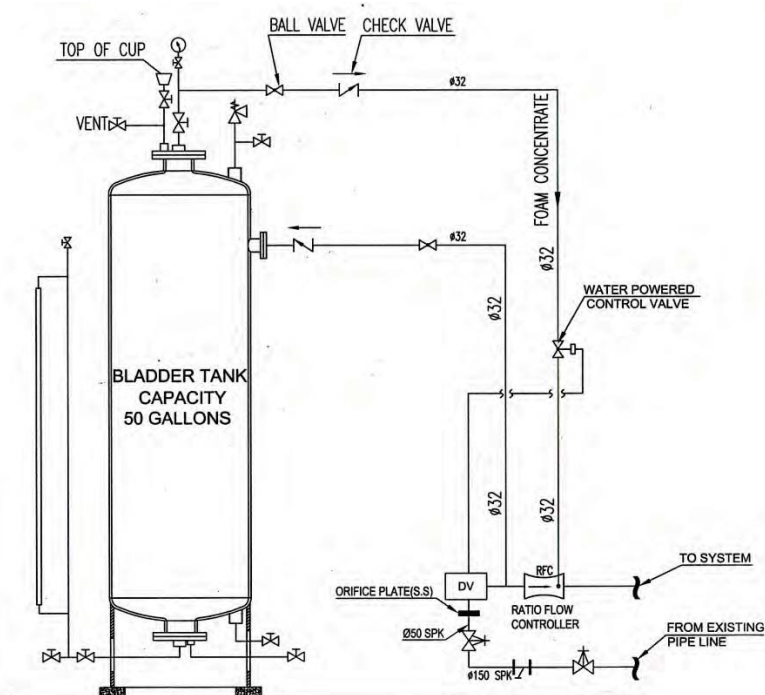
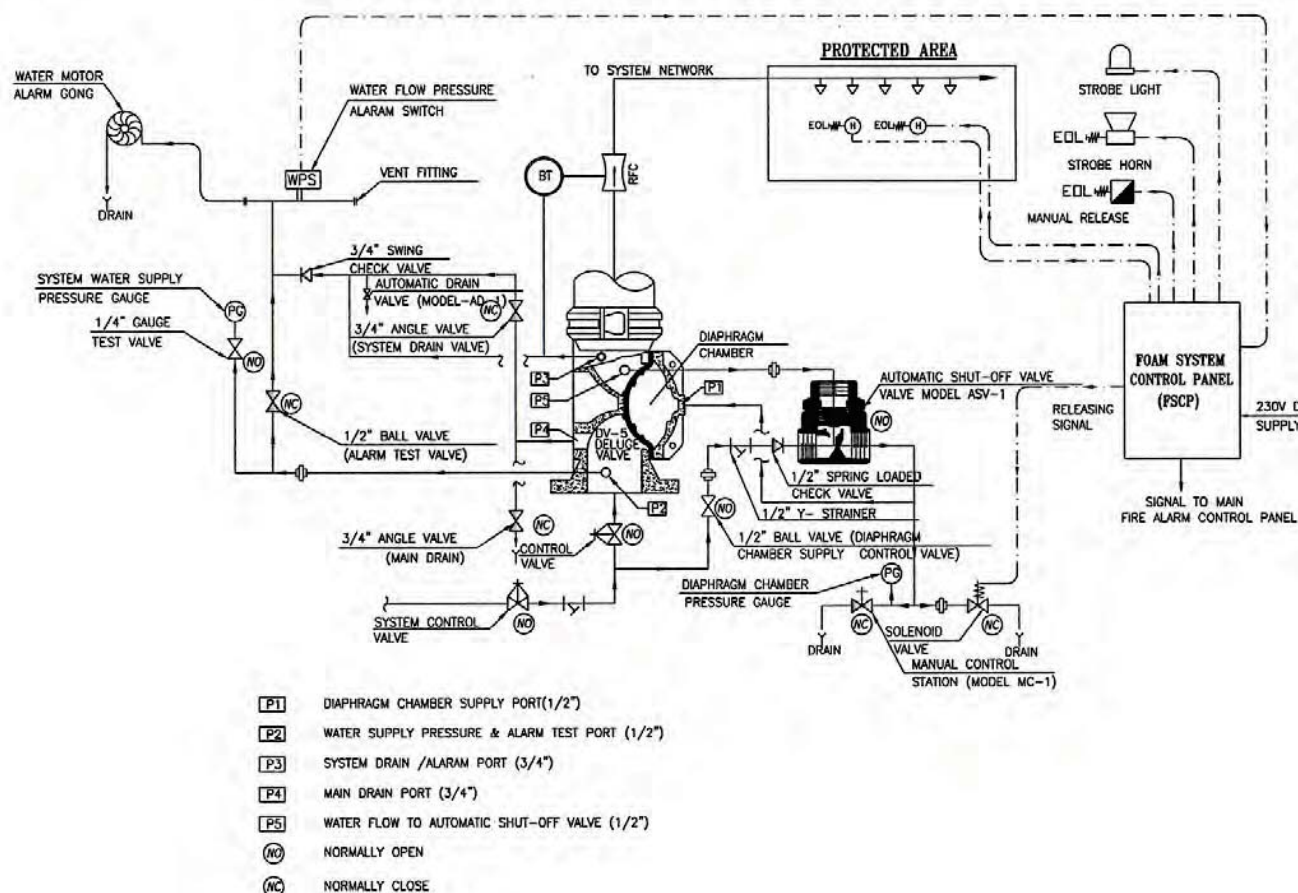


Figure 9.42: Schematic showing an example of Foam System with Fire detection



44.4. Characteristics and Limitations

- 44.4.1.** Application of foam through solid streams that plunge into the flammable liquid could result as the source of ignition of the ensuing fire. The ignitions could be because of static discharges resulting from splashing and turbulence. Therefore, any application of foam to an unignited flammable liquid should be as gentle as possible. Correct application methods include a spray pattern or banking the foam stream off a backboard so that the foam flows gently onto the liquid surface.
- 44.4.2.** Foam breaks down and vaporizes its water content under attack by heat and flame. It therefore must be applied to a burning liquid surface in sufficient volume and rate to compensate for this loss, with an additional amount applied to guarantee a residual foam layer over the extinguished liquid.
- 44.4.3.** Foam is unstable and may be broken down easily by a physical or mechanical force, such as a water hose stream.
- 44.4.4.** Certain chemical vapors or fluids may also destroy foam quickly. When certain other extinguishing agents are used in conjunction with foam, severe breakdown of the foam may occur.
- 44.4.5.** Turbulent air or violently uprising combustion gases from fires may divert foam from the burning area.
- 44.4.6.** Foam solutions are conductive and therefore not recommended for use on electrical fires. If foam is used, a spray is less conductive than a straight stream. However, because foam is cohesive and contains materials that allow water to conduct electricity, foam spray is more conductive than water spray.
- 44.4.7.** Medium- and high-expansion foam systems shall not be used on fires in the following hazards:
- i. Chemicals, such as cellulose nitrate, that release sufficient oxygen or other oxidizing agents to sustain combustion
 - ii. Energized unenclosed electrical equipment
 - iii. Water-reactive metals such as sodium, potassium, and NaK (sodium-potassium alloys)
 - iv. Hazardous water-reactive materials, such as triethyl-aluminum and phosphorus pentoxide
 - v. Liquefied flammable gas
- 44.4.8.** The ability of foam to rapidly extinguish flammable liquid fires has contributed to life safety and property conservation. However, with the increasing global environmental awareness, fire-fighting foams are being scrutinized for their potential environmental impact. The primary concerns are toxicity, biodegradability, persistence, treatability in wastewater treatment plants, and nutrient loading. (See II. COMMITMENT TO BEST PRACTICE, Section on Environmental Management and Sustainability)



44.5. Design Criteria

- 44.5.1.** Manufacturer's Engineering design requirements and recommended application methods must be followed for successful use of foams.
- 44.5.2.** Water-soluble and certain flammable and combustible liquids and polar solvents that are destructive to nonalcohol-resistant foams shall require the use of alcohol-resistant foams.
- 44.5.3.** Automatic Fire detection shall be used for fixed systems except for certain outdoor situations where manually triggered systems can be acceptable based on hazard evaluation.
- 44.5.4.** Minimum of 3% foam-water solution shall be discharged.
- 44.5.5.** Maximum area per sprinkler head shall be of 100 ft² (9.5 m²) and maximum 12 foot (3.7 m) spacing shall be maintained between sprinklers.
- 44.5.6.** Minimum of 60 minute water supply shall be ensured.
- 44.5.7.** Minimum design area for closed-sprinkler systems shall be 5000ft². (476m²). Open-sprinkler systems must discharge over the entire hazard area.
- 44.5.8.** Maximum sprinkler temperature rating of 250 to 300 ° F (121 to 149 °C) at a roof or ceiling, and 135 to 170 °F (57 to 77 °C) for intermediate sprinklers.
- 44.5.9.** The following design criteria shall be followed for foam protection to be fully effective for the flammable and hazardous liquid hazards.
- 44.5.9.1.1.1.1.** The liquid must be below its boiling point at the ambient conditions of temperature and pressure.
 - 44.5.9.1.1.1.2.** Care must be taken in application of foam to liquids with a bulk temperature higher than 212°F (100°C). At these fuel temperatures and above, foam forms an emulsion of steam, air, and fuel. This may produce a fourfold increase in volume when applied to a tank fire, with dangerous frothing or slipover of the burning liquid.
 - 44.5.9.1.1.1.3.** The liquid must not be unduly destructive to the foam used, or the foam must not be highly soluble in the liquid to be protected.
 - 44.5.9.1.1.1.4.** The liquid must not be water reactive.
 - 44.5.9.1.1.1.5.** The fire must be a horizontal surface fire. Three-dimensional (falling fuel) or pressure fires cannot be extinguished by foam unless the hazard has a relatively high flashpoint and can be cooled to extinguishment by the water in the foam.
- 44.5.10.** The **Table 9.44** depicts the basic design requirements for certain hazards to protect with Handhose, Monitors or Fixed outlets.



44.5.11. The **Table 9.45** Guidelines the basic design guidelines for Foam Water Sprinkler or Foam Water Spray Systems for certain hazards.

44.5.12. The hazards specifically not covered in these tables shall refer to **Table 9.7** Design Criteria for Sprinklers for the Hazard Classifications and Design Density requirements.

44.6. Piping and Installation

44.6.1. Refer to sections on Piping, Installation, Testing and Commissioning of Sprinkler Chapters along with Manufacturer's Manuals.



Table 9.44 DESIGN CRITERIA FOR FIXED FOAM OUTLETS, SURFACE AND SUBSURFACE APPLICATION

HAZARD	FOAM CONCENTRATE REQUIRED	WATER DEMAND / DESIGN DENSITY	DESIGN AREA (See 42.4.7 for details)	FOAM ADDITION FOR HYDRAULIC IMBALANCE	DISCHARGE DURATION (MINUTES)
OUTDOOR STORAGE					
FUELS WITH FLASH POINT 100 °F- 140 °F (37 °C- 37 °C)	AFFF, FFFP	0.10 gpm/ ft ²		10%	30
FUELS WITH FLASH POINTS BELOW 100°F (37 °C) OR LIQUIDS HEATED ABOVE THEIR FLASH POINT	AFFF, FFFP	0.10 gpm/ ft ²		10%	55
CRUDE PETROLEUM	AFFF, FFFP	0.10 gpm/ ft ²		10%	55
INDOOR HYDROCARBON STORAGE TANK (> 37.2 M² LIQUID SURFACE AREA)					
FUELS WITH FLASH POINT 100 °F- 140 °F (37 °C- 37 °C)	AFFF, FFFP	0.16 gpm/ ft ²		10%	30
FUELS WITH FLASH POINTS BELOW 100°F (37 °C) OR LIQUIDS HEATED ABOVE THEIR FLASH POINT	AFFF, FFFP	0.16 gpm/ ft ²		10%	55
CRUDE PETROLEUM	AFFF, FFFP	0.16 gpm/ ft ²		15%	55
AIRCRAFT HANGER	AFFF, FFFP	0.20 gpm/ft ²		15%	10
LOADING & UNLOADING SPILLAGE	AFFF, FFFP	0.10 gpm/ ft ²		10%	15
DIKED AREA	AFFF, FFFP	0.16 gpm/ ft ²		10%	20



Table 9. 45 DESIGN CRITERIA FOR FOAM WATER SPRINKLER & FOAM WATER SPRAY SYSTEMS

HAZARD	FOAM CONCENTRATE REQUIRED	WATER DEMAND / DESIGN DENSITY	DESIGN AREA (See 42.4.7 for details)	FOAM ADDITION FOR HYDRAULIC IMBALANCE	DISCHARGE DURATION (1)
RACK STORAGE IN METAL CONTAINERS < 5 GALLONS					
LIQUIDS- CLASS IB, IC, II, IIIA	AFFF, FFFP	0.30 gpm/ ft ²	2000 ft ²	10%	
RACK STORAGE IN METAL CONTAINERS > 5 TO < 60GALLONS					
LIQUIDS- CLASS IB, IC, II, IIIA	AFFF, FFFP	0.30 gpm/ ft ²	3000 ft ²	10%	
LIQUIDS- CLASS IIIB	AFFF, FFFP	0.30 gpm/ ft ²	2000 ft ²	10%	
	AFFF, FFFP				
PALLETIZED STORAGE IN METAL CONTAINERS < 5 GALLONS					
LIQUIDS- CLASS IB, IC, II, IIIA	AFFF, FFFP	0.30 gpm/ ft ²	3000 ft ²	10%	
SPRAY APPLICATION USING FLAMMABLE AND COMBUSTIBLE MATERIALS	AFFF, FFFP	0.40 gpm/ ft ²	5000 ft ²	10%	
POWDER COATING APPLICATIONS	AFFF, FFFP	0.20 gpm/ ft ²	5000 ft ²		
DIESEL GENERATOR	AFFF, FFFP	0.30 gpm/ ft ²	5000 ft ²	10%	10

45. Gas Suppression Systems

45.1. Introduction

45.1.1. This guideline describes the requirements for fire prevention and gas extinguishing systems. Generally it is possible to protect valuable goods in data centers, control rooms, server rooms, electrical rooms, BMS rooms, Telephone Rooms, archives and storages with fire prevention or fire suppression systems. The actual design of these gas suppression systems shall be based on Civil Defence approved Manufacturer's recommendations, guidelines and calculations through approved software.

45.2. Definitions

45.2.1. Clean Agent.

45.2.1.1. Electrically nonconducting, volatile, or gaseous fire extinguishing agent that does not leave a residue upon evaporation.

45.2.2. Design Factor

45.2.2.1. A fraction of the agent minimum design quantity (MDQ) added thereto deemed appropriate due to a specific feature of the protection application or design of the suppression system.

45.2.3. Final Design Quantity

45.2.3.1. The quantity of agent determined from the agent minimum design quantity as adjusted to account for design factors and pressure adjustment.

45.2.4. Local Application System.

45.2.4.1. A system consisting of a supply of extinguishing agent arranged to discharge directly on the burning material or equipment.

45.2.5. Pre-Engineered System.

45.2.5.1. A system having predetermined flow rates, nozzle pressures, and quantities of agent. These systems have the specific pipe size, maximum and minimum pipe lengths, flexible hose specifications, number of fittings, and number and types of nozzles prescribed by a testing laboratory. The hazards protected by these systems are specifically limited as to type and size by a testing laboratory based upon actual fire tests. Limitations on hazards that can be protected by these systems are contained in the manufacturer's installation manual, which is referenced as part of the listing.

45.2.6. Total Flooding System.

45.2.6.1. A system consisting of an agent supply and distribution network with discharge nozzles designed to achieve a total flooding condition in a hazard volume.



45.3. Gas Extinguishing Systems

- 45.3.1.** For a fire to start and continue to burn, flammable materials, oxygen and a heat source are all required. If one of these components is removed the fire will go out. Most extinguishing methods work by either removing the heat source or the oxygen.
- 45.3.2.** The goal of every fire-fighting system is to minimize damage to people and goods. On the one hand it is important to activate the specific fire extinguishing procedure as quickly as possible. On the other hand, the extinguishing technology itself should cause the least possible additional damage.
- 45.3.3.** Water is an excellent extinguishing agent with its capacity to absorb heat and stop fires from burning. However, using water in this way can damage buildings and goods. In areas where maintaining accessibility is a key or where valuable items are stored, water is therefore not always the ideal solution.
- 45.3.4.** Gas extinguishing agents provide the optimal solution for protecting important areas - use of such agents does not result in any additional damage.
- 45.3.5.** However, there are environmental considerations for certain Gas extinguishing agents. See CHAPTER 5. COMMITMENT TO BEST PRACTICES, Section 2. Environmental Management & Sustainability for upcoming issues regarding the acceptability of certain Clean Agents in the industry.
- 45.3.6.** Gas extinguishing technology is based mainly on the principle of removing oxygen. By introducing a gaseous extinguishing agent into the room's atmosphere the oxygen content is reduced to the point where the combustion process is halted. The gas extinguishing process uses either inert or chemical gases.

45.3.7. Advantages of gas extinguishing technology

- i. Protection of facility and fittings without water damage
- ii. Extinguishing gases are non-conducting
- iii. No danger to personnel using electrical plant or machinery
- iv. No danger of short circuits either during or after the extinguishing process

45.3.8. Ideal Applications

- i. Electrical Rooms
- ii. LV Rooms
- iii. Electronic Equipment Rooms
- iv. Telecommunication Rooms
- v. Server Rooms
- vi. BMS Rooms
- vii. IT Data Center
- viii. Museums
- ix. Galleries
- x. Mobile Switching Center



- xi. Storages
- xii. Archives
- xiii. Machinery
- xiv. Cabinets

45.3.9. The following picture shows the principle of gas extinguishing systems. Very important is the proper calculation of the pressure relief to protect the walls, doors and windows due to the overpressure during the extinguishing process.

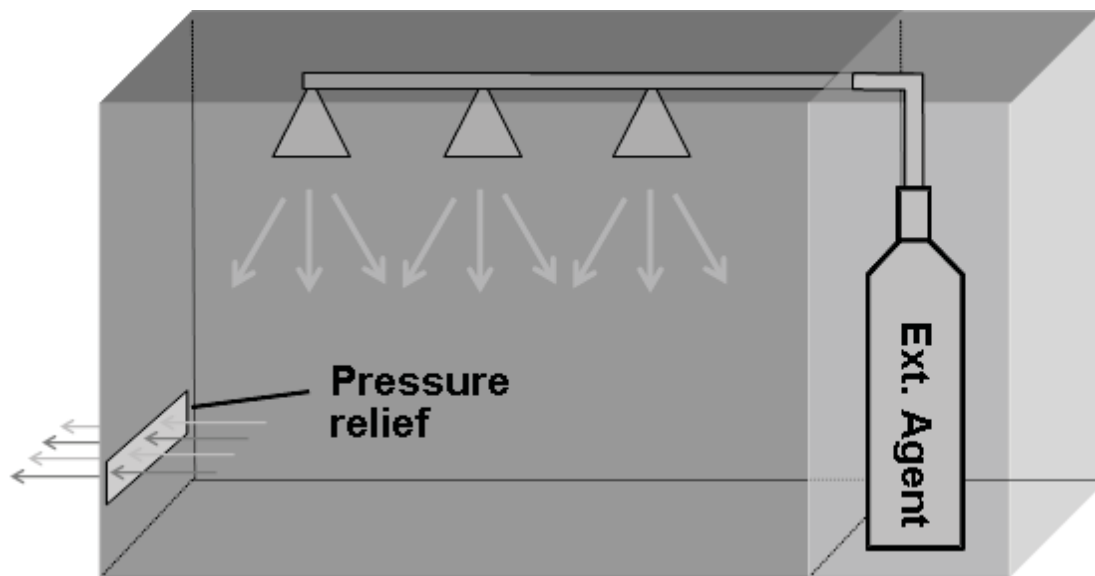


Figure 9.43: Typical Gas Extinguishing system with overpressure relief

45.4. Agent Storage Bank

- 45.4.1.** Clean Agent Bank and accessories shall be located and arranged so that inspection, testing, recharging, and other maintenance activities are facilitated and interruption of protection is held to a minimum.
- 45.4.2.** Storage containers shall be located as close as possible to or within the hazard or hazards they protect.
- 45.4.3.** Agent storage containers shall not be located where they can be rendered inoperable or unreliable due to mechanical damage or exposure to chemicals or harsh weather conditions or by any other foreseeable cause. Where container exposure to such conditions is unavoidable, then suitable enclosures and protective measures shall be employed.
- 45.4.4.** Storage containers shall be securely installed and secured according to the manufacturer's listed installation manual and in a manner that provides for convenient individual servicing or content weighing.



- 45.4.5.** The cylinders shall be installed so that each individual cylinder can be easily mounted and shall be fitted with a non-return valve (Check valve) to the manifold if there is more than one cylinder to prevent agent loss and to ensure personnel safety if the system is operated when any containers are removed for maintenance.
- 45.4.6.** The quantity of available extinguishing agent (if applicable, the reserve quantity as well) shall be monitored. Any loss in weight or pressure of more than 10% of the extinguishing agent in any cylinder shall be indicated automatically. The checking unit shall be easily manageable with no gas leaking from the bottles during functional testing.
- 45.4.7.** In a clean agent bank of multiple cylinders, only one cylinders size and one filling pressure shall be used.
- 45.4.8.** The filling tolerance per bottle shall be $+0/-2.5\%$ of the nominal filling pressure.
- 45.4.9.** Cylinders shall be supplementary marked with the name of the company responsible for the installation, type of gas, quantity of gas, filling density and degree of pressurization and specifications for the gas used as pressure cushion.

45.5. Cylinder valves

- 45.5.1.** Cylinder valves will be of a pressure seated, high flow rate design incorporating a stainless steel piston with seal, pressure releasing for valve operation, safety disc assembly, pressure actuation outlet port and pressure gauge.
- 45.5.2.** Cylinder valves will be provided with anti recoil plug fitted to the valve discharge outlet to prevent accidental rocketing or spinning of the cylinder in the event of discharge while the cylinder is not securely mounted

45.6. Nozzles

- 45.6.1.** Nozzles shall be arranged centrally and strategically so that a homogenous mixture of the required gas concentration will be achieved.
- 45.6.2.** The maximum protected area per nozzle shall not exceed the manufacturer's recommended range.
- 45.6.3.** Nozzles shall be sited so as not to disperse any combustible materials when gas is discharged. Nozzles shall be arranged so that the effects of discharge do not damage the components being protected.
- 45.6.4.** Nozzles shall be located in the upper area of a flooding zone.
- 45.6.5.** If the flooding zone is higher than 5 m, special care shall be taken to get an even distribution of gas by installing nozzles at intermediate levels.
- 45.6.6.** Suitable protective arrangements shall be made in environments where nozzles could be fouled. In rooms with electrical and electronic risks the nozzles shall be made of corrosion resistant materials.



45.7. Area valves

45.7.1. Area valves shall be located outside the flooding zone. No flammables shall be stored in the immediate vicinity of an area valve.

45.7.2. Area valves shall be arranged so that they will not open when subjected to:

- i. Operating environmental vibrations
- ii. Vibrations arising from the valve at the storage cylinder opening
- iii. From other selector valves openings

45.7.3. Automatic actuation of an area valve shall be powered by static weight and/or pneumatic and/or electrical means. The unit shall be designed in such a way that checking for proper functioning on site can be achieved without discharging gas.

45.7.4. If it is possible to release the extinguishing agent, even though the mechanism used to automatically open the area valve has failed, the emergency release mechanism shall not circumvent national codes for personnel safety nor the equipment required to prevent damage from excess pressure being exerted by the gas discharged into the flooding zone.

45.7.5. Area valves shall open automatically and simultaneously with the opening of a cylinder valve. Pressure relief devices shall discharge gas into the atmosphere away from windows, ventilation, openings, etc; in no case shall this constitute a hazard to personnel. Safety valves shall be assembled vertically.

45.8. Pipe and fittings

45.8.1. Pipes and pipe connections shall be made of metal (seamless welding) and be able to withstand the pressures as specified and calculated and any low temperature encountered.

45.8.2. The test pressure for the Inert Gas Systems' pipe between the cylinders and the area valve should have 1.5 times of the service pressure. (i.e. 200-300 bar cylinder – test pressure and pipe pressure resistance should be 300-450 bar respectively). The test pressure for the pipe between the area valve and the protected area should have 1.5 times of the service pressure (i.e. 60 bar pressure – 90 bar test pressure and pipe pressure resistance).

45.8.3. Fittings shall be calculated for the occurring service pressure. Fittings shall be suitable for deeper temperatures (approx. -50°C). In sections of pipe that are subjected to static head pressure (closed pipe work) the service pressure must not be exceeded, if need be a safety valve shall be fitted.

45.8.4. The pipe work between cylinder and area valve shall be marked by the manufacturer, so that identification according to the test certificates is possible after installation. Manifolds and distribution pipes may be marked as a kit by an authorized person. An unambiguous assignment to the test certificate shall be possible. Fittings shall be marked by a red spot and the letter D. Flexible pipes and hoses etc. shall only be used



where fixed pipes are unsuitable. Flexible pipes and hoses shall be as short as possible and approved.

- 45.8.5.** The inside and outside of pipes shall be effectively protected against corrosion if this is necessitated by environmental conditions. To protect sensitive machinery, e.g. computers, from corrosive particles in the pipe work, galvanized steel should be used as a minimum.
- 45.8.6.** Special-alloy steels and/or suitable surface protection coatings shall be used if the use of pipes and connections made of steel does not provide sufficient corrosion protection.
- 45.8.7.** The pipe work shall be arranged so that it cannot be damaged by its own weight, temperature fluctuations, vibration, release of gas or other installation inherent influences.
- 45.8.8.** All pipe work shall be accessible. The gas installation pipe work shall be earthed. If necessary, potential equalization conductors (i.e. regarding non-conductive pipe joints) between all pipes shall be provided or the installation shall be earthed at different points (auxiliary equipotent bonding).
- 45.8.9.** Dry air or Nitrogen will be blown inside the piping to remove any debris prior to installation of nozzles.
- 45.8.10.** Fastening of pipe will be secured especially near nozzles to prevent pipe movement due to the high pressure during discharge

45.9. Room Integrity and Air tightness Requirements

45.9.1. Airtight rooms

- 45.9.1.1.** Airtight rooms are the main requirement for the usage of fire prevention and gas extinguishing systems.

45.9.2. General Room tightness

- 45.9.2.1.** For fire prevention and gas extinguishing systems the protected areas have to be sealed to become defined air tightness.

45.9.3. Room tightness - Description n50 value

- 45.9.3.1.** The n50 value is the air change per hour (ACH) meaning the number of times each hour an amount of air equal to the volume of the area to be protected, leaks out at an overpressure of 50 Pa

45.9.4. Measurement of n50 value

- 45.9.4.1.** The Blower door measurement is a scientific approach to identifying and controlling Air Filtration. It is primarily used to check for any possible leakages in



a given area by applying two types of pressure: over pressure and under pressure.

45.9.4.2. Calculation is based on the Air Change per Hour (ACH), meaning the number of time each hour, an amount of air equal to the volume of the area to be protected, leaks out at a pressure of 50Pa.

45.9.4.3. The ventilator of the blower door measuring device creates a standard over/under pressure of 10 – 60 pa in the protected area. The air escapes over the leakage surfaces of the walls, doors and windows to the outside during overpressure measurement or enters from there during under pressure measurement.

45.9.4.4. The device measures the required flow volume so that the pressure difference of 50 Pa (as an example) needed for measuring can be maintained in the area. After input of all the relevant values the program calculates the n50 value, which regulates itself and relates to the created pressure value of 50Pa.

45.9.4.5. The following picture shows how the result of a blower door measurement looks like.

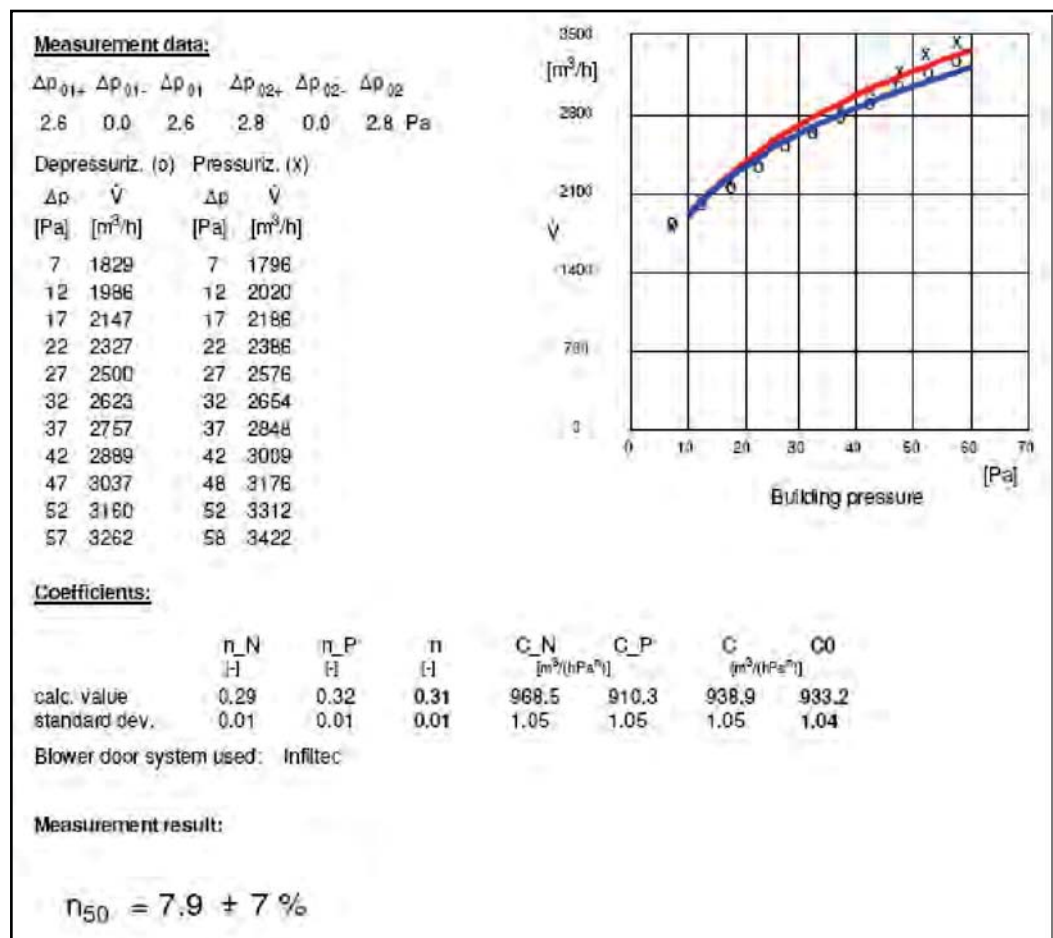


Figure 9.44:. Example for Blower door measurement report



45.9.5. Walls

- 45.9.5.1.** The walls as well as raised floor and ceiling of the protected areas should at least comply with the fire resistance class F30 or consist of non-flammable and non melting materials. The walls should also be plastered and if this is not sufficient enough painted with a reasonable tight coating.

45.9.6. Doors and Windows

- 45.9.6.1.** The doors and windows used for the protected areas should also comply with fire regulation and also be air tight to prevent leakage. The doors and windows need to have a mechanism for closing automatically in case of an emergency situation. For fire prevention systems the doors and windows have to be closed all times except for access.

45.9.7. Sealed Penetrations

- 45.9.7.1.** Sealing of penetrations for pipes and cables is also a very important issue otherwise it will have a major influence due to the holding time of the gas concentration within the protected area. Please be aware that normal fire stopping material will not seal the opening in an airtight matter. On the market are professional airtight breakthroughs available. Another solution is to seal with fire stopping material as first and add acrylic sealant followed by latex paint.

45.9.8. Pressure Relief

- 45.9.8.1.** For all gas extinguishing systems pressure relief have to be calculated and implemented to prevent the rooms from overpressure damages. Fire prevention systems do not require pressure relief.

45.9.9. Design Criteria for Applications

- 45.9.9.1.** All gas extinguishing designs have to be made in line with one of the following international approval bodies. Especially all calculation and design programs have to be approved by:

- i. AFNOR (Association Française de Normalization), France
- ii. FM (Factory Mutual), US
- iii. LPCB (Loss Prevention Certification Board), UK
- iv. NTC (National Test Center), China
- v. SSL (Scientific Services Laboratory), Australia
- vi. UL (Underwriters Laboratory Inc), US
- vii. ULC (Underwriters Laboratory Canada), Canada
- viii. VdS (Verband der Sachversicherer e.V.), Germany

45.9.10 Room tightness

- 45.9.9.2.** The air tightness of the protected areas has to be designed according to the following **Table 9.46**:



Table 9.46: n50 Values based on volumes

Volume in m ³	1	100	1,000	10,000	50,000	500,000
N50 – Value in 1/h	5.0	1.5	1.0	0.1	0.05	0.01

45.9.9.3. To all intermediate volumes linear interpolation should be applied.

45.9.10. Special requirements for closed cabinets

45.9.10.1. For closed cabinets (enclosed and airtight vaults, IT-cabinets, etc.) inside the protected area a separate fire detection and fire protection have to be implemented (i.e. inside fire detection and extinguishing, inside fire detection and automatic door opening in case of fire prevention).

45.9.10.2. The following picture shows possible solutions for enclosed cabinets by using internal fire detection with integrated extinguishing agent.

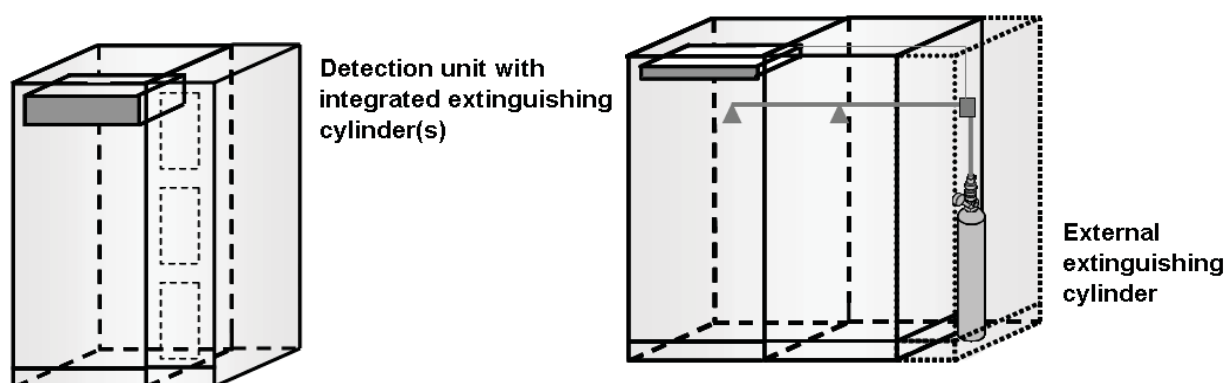


Figure 9.45: Fire Detection and extinguishing in closed cabinets (air tight).

45.10. Inert Gases

45.10.1. By introducing an inert gas, the oxygen content in the room is reduced - until the point where the oxygen concentration lies below the level at which combustion is possible. Inert gases do not generate any chemical reactions and also leave no residue.

45.10.2. An inert gas is any gas that does not react with elements. Like the noble gases an inert gas is not necessarily elemental and is often compound gases. Like the noble gases the tendency for non-reactivity is due to the valence, the outermost electron shell, being complete in all the inert gases. This is a



tendency, not a rule, as noble gases and other "inert" gases can react to form compounds.

- 45.10.3.** Inert gases used for fire protection are Nitrogen, Argon, Carbon Dioxide and mixtures of these three gases.
- 45.10.4.** Carbon dioxide is not applicable to usually occupied facilities due to the toxic property. But it can be used in industrial applications.
- 45.10.5.** Maximum discharge time for all Inert Gases shall not exceed 60 seconds.
- 45.10.6.** The following diagram shows the principle structure of an inert gas extinguishing system.

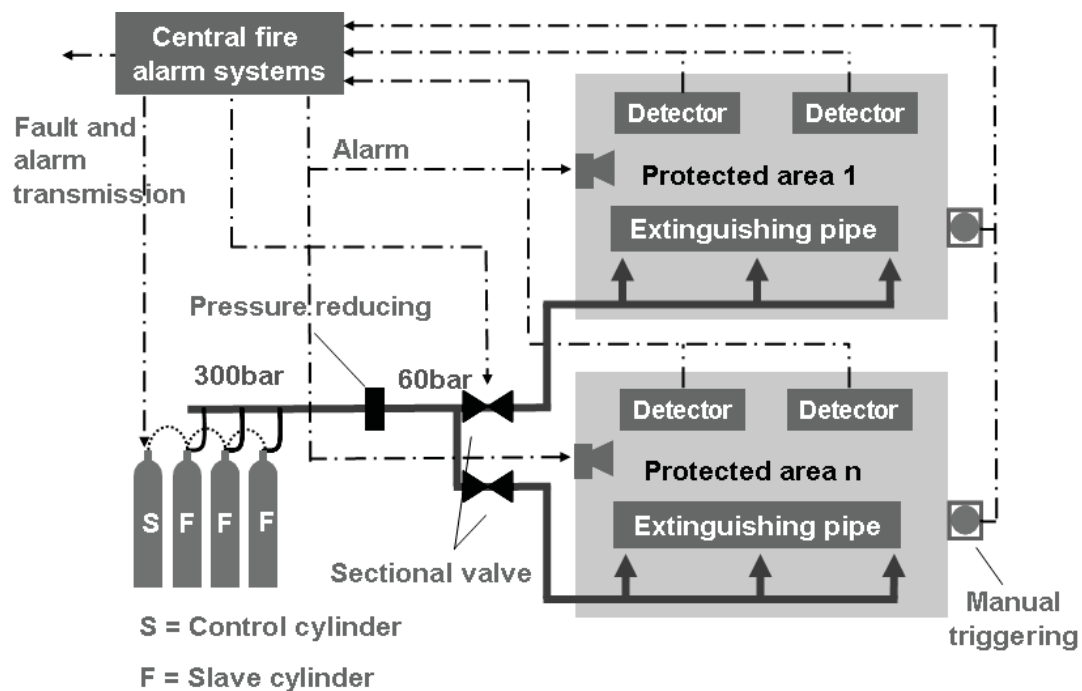


Figure 9.46: Block Diagram for inert gas extinguishing systems

- 45.10.7.** Nitrogen, Argon, Inergen, Argonite and Carbon Dioxide are all inert extinguishing agents. [Table 9.47](#) below briefs out the comparison between the inert gases.



Table 9.47 INERT GAS COMPARISONS

Table 9.47 INERT GAS COMPARISONS				
TRADE NAMES	NITROGEN IG 100, NN 100	ARGON Argon	INERGEN IG 541	ARGONITE IG 55
POSITIVES	• Non Toxic • Environmentally friendly • Electrically Non-conductive • Normal venting after flooding • Forms harmless compound when mixed with air	• Non Toxic • Environmentally friendly • Electrically Non-conductive • Normal venting after flooding • Forms harmless compound when mixed with air	• Contains only natural gases • Non Toxic • Environmentally friendly • Electrically Non-conductive • Normal venting after flooding • Feasible to be used in occupied spaces	CARBON DIOXIDE • CO2 is a natural element making up 0.03% of the air • Most effective extinguishing properties of all inert gases • Has been used as an extinguishing agent for approximately 80 years • Ideal to extinguish open or un-enclosed sections • Electrically Non-conductive
NEGATIVES	• Due to lighter density than air, not suitable for unenclosed objects	• Due to heavier density than air, counter acts the hyper-ventilation effect • Not suitable for unenclosed objects	• Due to heavier density than air, counter acts the hyper-ventilation effect • Not suitable for unenclosed objects	• Life endangering • Pressure relief via adjacent areas only permitted in certain circumstances • Due to it's density, (CO2 is 1.5 times heavier than air) lower lying areas could become contaminated through leakage • Distance between reservoir / gas bottles and area to be flooded is limited. • Not applicable for office buildings
EXTINGUISHING CHARACTERS	• Does not cause misting • Negligible temperature reduction • Extinguishing Concentration of 40-41% • Nominal Discharge time is 60 seconds	• Does not cause misting • Negligible temperature reduction • Extinguishing Concentration of 35-45% • Nominal Discharge time is 60 seconds	• Does not Cause misting • Negligible temperature reduction • Removal from flooded area through normal ventilation • Extinguishing Concentration of 33-35% • Nominal Discharge time is 60 seconds	• Causes misting • Considerable temperature reduction during flooding • Danger to neighboring areas through leakage • Release of room pressure during extinguishing by feeding directly into the open only.

				60 seconds	
TECHNICAL INFORMATION	• Density- 1.165 kg/m³ • Does not mix in reservoirs • Low friction loss • Stored in Gas form at 200-300 bar pressure	• Density- 1.662 kg/m³ • Does not mix in reservoirs • Low friction loss • Stored in Gas form at 200-300 bar pressure	• Density- 1.418 kg/m³ • Does not mix in reservoirs • Low friction loss • Stored in Gas form at 200-300 bar pressure	• Density- 1.412 kg/m³ • Does not mix in reservoirs • Low friction loss • Stored in Gas form at 200-300 bar pressure	• Removal from area after flooding must be controlled. Usually carried out by the fire services. • Does not mix in the reservoirs • Low friction loss • Stored in liquid form, usually requires less space for the reservoir/ bottles • Storage in cylinders in liquid form at 60 bar pressure
APPLICATION	• Electrical Equipment • Equipment Rooms • Industrial Applications • Warehouse • Cable cellars • Telecommunication rooms (i.e. Mobile Switching Center) • Storages • Archives	• Partial flooding in floor voids in IT Data Centers & Communication Rooms	• Electrical Rooms • Equipment Rooms • Museums • Galleries • IT Data Center • Telecommunication rooms (i.e. Mobile Switching Center) • Storages • Archives	• Partial flooding in floor voids in IT Data Centers & Communication Rooms	• Electrical Switchgear Rooms • Open apparatus such as cabinets and machinery • In particular, unmanned areas.



45.10.8. Carbon Dioxide in detail

45.10.8.1 Location

45.10.8.1.1 The CO₂ storage area shall be located outside the area put at risk in the case of a fire, but it should be located as close as possible to the protected zone.

45.10.8.1.2 The CO₂ storage area shall be a separate enclosure which is easily accessible even in the event of a fire, and protected against access by unauthorized persons. No other combustible material and no stored goods shall be available in this area.

45.10.8.1.3 The CO₂ storage area shall be separated from adjacent rooms and/or areas such that the components of the CO₂ system installed in this area are protected from mechanical, chemical and atmospheric exposure.

45.10.8.2 Equipment

45.10.8.2.1 The CO₂ storage area shall have sufficient electrical illumination.

45.10.8.2.2 The room temperature in the CO₂ storage area for high pressure systems shall not fall below 0° or exceed 35°C. Any heating, if necessary, shall be fixed. The components of the CO₂ system in the CO₂ storage area shall be protected against heating above ambient temperature caused by sunlight or other sources.

45.10.8.2.3 If in the case of high pressure systems room temperatures below 0°C in the CO₂ storage area cannot be ruled out, the distribution pipe work shall be calculated and dimensioned as for low pressure systems.

45.10.8.2.4 The CO₂ storage area shall allow easy access for maintenance and inspection of components of the CO₂ system on the spot.

45.10.8.2.5 In the CO₂ storage area the following shall be permanently affixed in a highly visible position resp. be available:

- name of the installer and, if available, the company responsible for maintenance of the system, the year of installation of the CO₂ system;
- operation instructions with pipe work and control layout of the CO₂ system; if applicable, number of weights required for actuating the containers;
- layout of the zone protected by the CO₂ system



45.10.8.3 CO2 supply containers and selector valves

- 45.10.8.3.1** Any legal and official requirements for pressure containers shall be fulfilled.
- 45.10.8.3.2** Valves and equipment for CO2 supply containers to be assembled in a CO2 system shall be approved by a competent authority.
- 45.10.8.3.3** Any valves and slide valves, even those according to DIN 3352, shall be approved.
- 45.10.8.3.4** In high pressure systems all CO2 supply containers shall contain the same quantity of CO2. The highest allowable fill level of these CO2 supply containers is 0,75kg per liter of container volume. The container volume per container shall not exceed 67,5l.
- 45.10.8.3.5** The CO2 supply quantity shall be permanently monitored by an automatic device approved by the authority.
- 45.10.8.3.6** This leakage monitoring shall respond at the latest when only 90% of the required CO2 quantity are left. If the CO2 supply quantity is stored in several supply containers, all containers shall be monitored.
- 45.10.8.3.7** In high pressure systems each CO2 supply container shall be connected to the main supply pipe via a check valve, such that it may be decommissioned and replaced at all times without interfering with the other containers.
- 45.10.8.3.8** The automatic opening of the container valves shall be carried out by a device approved by the authority. The functional reliability of this device shall be easy to inspect on the spot without causing any discharge of CO2.
- 45.10.8.3.9** If an emergency triggering device is provided, this shall be approved by the authority.
- 45.10.8.3.10** In low pressure systems the response pressure of the required safety valve shall not exceed 23 bar.
- 45.10.8.3.11** The CO2 shall be kept at a temperature between 252K (-21°C) and 254K (-19°C) by an automatic cooling aggregate, corresponding to an absolute pressure between 19 bar and 21 bar. If the pressure in the CO2 supply container exceeds 22 bar, a fault warning shall be released. The heat insulation of the CO2 supply container shall be at least such that during a failure of the cooling aggregate, assuming an ambient temperature of 303K (30°C), not more than 0,05% of the



required CO₂ supply quantity per hour are discharged via the safety valve.

- 45.10.8.3.12** Containers without dip tube (e.g. alarm containers) shall be permanently marked as “containers without immersion tube”. For this purpose, a flange may be inserted when screwing in the container valve.

45.10.8.4 Pipes

- 45.10.8.4.1** All pipes of CO₂ low pressure systems and the nozzle pipe work of CO₂ high pressure systems require a certificate according to EN 10 204. This certificate shall state that the pipes are designed according to the required operating pressure.
- 45.10.8.4.2** Manifolds require a factory test certificate according to EN 10 204 stating that they were designed for the required operating pressure. Additionally, all materials and components used shall be specified in the certificate.
- 45.10.8.4.3** After the installation the pipes between container and selector valve shall be subjected to a 60-minute water pressure test.
- 45.10.8.4.4** Where flange connections are used, this water pressure test may be replaced by a water pressure test of the individual components or of pipe. In these cases a gas leakage test (pabs = 3 bar) shall be carried out after installation.
- 45.10.8.4.5** If existing manifolds of low pressure systems are extended, no water pressure test will be required, provided that:
- the extension is subjected to a water pressure test with 40 bar;
 - the connecting welding seam (old and new part) is done
 - a leakage test with CO₂ is carried out for the entire manifold, using the existing container pressure of the low pressure system.
- 45.10.8.4.6** Welding works at the pipe work shall be carried out only by welders holding a certificate of qualification according to local standards.
- 45.10.8.4.7** Fittings shall be designed according to the anticipated operating pressure and for use at low temperatures (approx. –50°C).
- 45.10.8.4.8** All pipe sections of CO₂ high pressure systems between container and selector valve shall bear the manufacturer’s mark, so that they can be identified according to the factory



test certificates even after installation. Manifolds, being a physical unit, may be marked by an expert. A clear assignment of the physical unit to the factory test certificate submitted shall be possible.

45.10.8.4.9 The welder shall mark each welding seam with an individual mark, so that the seam may be clearly identified as done by this particular welder.

45.10.8.4.10 If required by the application, the outer and inner surfaces shall be sufficiently protected against corrosion.

45.10.8.4.11 Hoses used for the installation of CO₂ extinguishing systems shall be approved by the authority. Hoses shall not be longer than necessary and used only where fixed pipes are unsuitable

45.10.8.5 Nozzles:

- a. Nozzles shall be approved by the authority for the installation into CO₂ systems.
- b. Nozzle openings smaller than 7mm² in diameters are not permitted.
- c. Each nozzle shall be marked clearly and permanently, e.g. with the equivalent nozzle diameter.
- d. Unless specified otherwise for particular applications, the nozzles of CO₂ systems, without extended discharge and in consideration of the CO₂ storage pressure and the respective pipe work, shall be dimensioned such that the required CO₂ design quantity can be discharged into the flooding zone within the discharge time.

45.10.8.5.1 Evidence shall be given via a procedure approved by the authority, that these requirements are fulfilled. The nozzle dimensioning of systems with extended discharge shall be agreed with the authority.



Table 9.48: KB factor for solid materials and facilities

MATERIAL	KB - factor	WITHIN 4 MIN		WITHIN 1 MIN	
		CO2 vol%	O2 vol%	CO2 vol%	O2 vol%
Paper	2.00	57.00	9.10	34.00	13.80
Plastic	2.25	61.00	8.20	34.00	13.80
Polystyrene	1.00			34.00	13.80
Polyurethane	1.00			34.00	13.80
Cellulose	2.25	61.00	8.20	34.00	13.80
Electrical switch and distribution rooms	1.20	40.00	12.60	34.00	13.80
Data processing systems	2.25	61.00	8.20	34.00	13.80
Control room of high rack storage	1.50	47.00	11.20	34.00	13.80
Paint shop and drying system	1.50	47.00	11.20	34.00	13.80
Generators incl. Cooling systems	2.00	57.00	9.10	34.00	13.80
Cable rooms, cable floors and cable ducts	1.50	47.00	11.20	34.00	13.80
Oil filled transformers	2.00	57.00	9.10	34.00	13.80
Textile machines	2.00	57.00	9.10	34.00	13.80

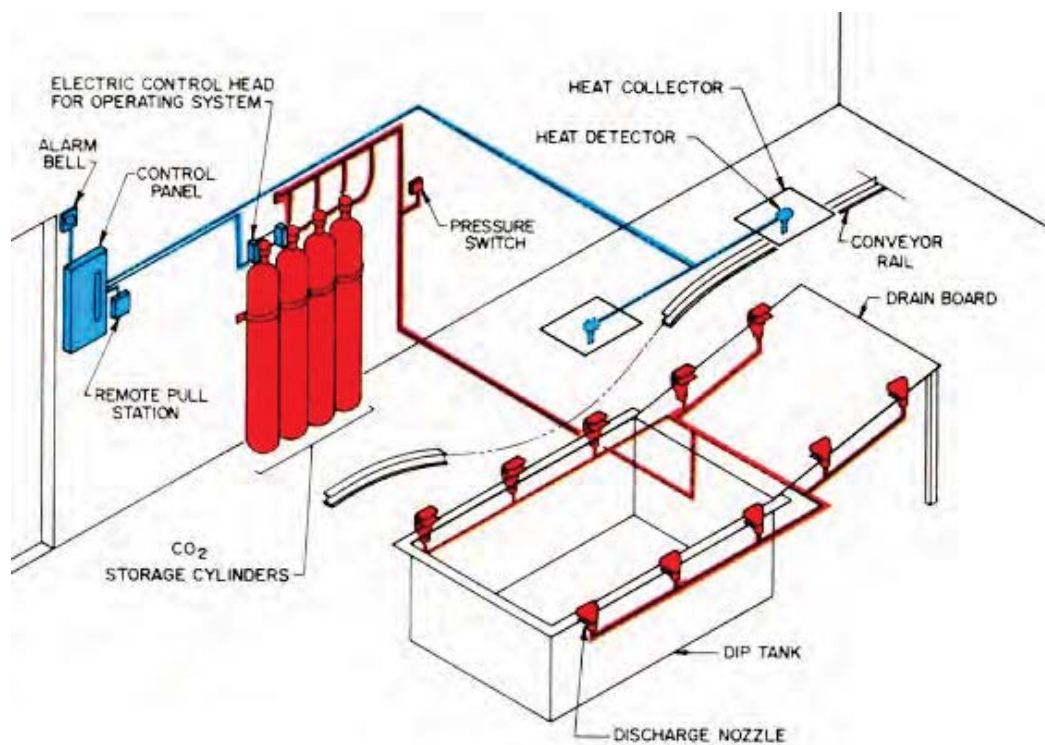


Figure 9.47: Typical Carbon Dioxide Suppression System



45.11. Chemical Gases

- 45.11.1.** The extinguishing ability of chemical gases is based on both physical and chemical processes. In addition to the suppression of oxygen - as in the use of inert gases – chemical gases absorb heat and chemically disrupt the burning process.
- 45.11.2.** Several chemical extinguishing agents are available on the market. The most important and common agents are HFC227 (FM200) and C6 F12 O (NOVEC 1230). **Table 9.49** briefs out the comparison between Chemical Gases.
- 45.11.3.** Maximum discharge time for all Chemical Gases shall not exceed 10 seconds.
- 45.11.4.** **All chemical gas extinguish systems should strictly adhere to manufacturer's MSDS recommendations and design parameters. Careful considerations should be exercised as some of the chemical gases produce hazardous byproducts during extinguishing process when they come in contact with burning or hot surfaces**
- 45.11.5.** **Powdered Aerosol agents shall be strictly applied to Unoccupied areas only.**



Table 9.49 CHEMICAL GAS COMPARISONS

Table 9.49 CHEMICAL GAS COMPARISONS			
	HFC 227	HFC 125	C6 F12 O
TRADE NAMES	FM-200, FE-227, MH227, Solkaflam 227	NAFS 125, ECARO-25, FE-25TM	Novac 1230
POSITIVES	• Low concentration of gas required • Does not cause Ozone depletion • Feasible for use in occupied spaces	• Low concentration of gas required • Does not cause Ozone depletion	• No Flooding damage to facility and equipment • Low concentration of gas required • Does not cause Ozone depletion
NEGATIVES	• Global warming potential is very high with around 31-42 years of agent lifetime • At high temperature, agent will decompose to hydrogen fluoride which leaves pungent odor along with other decomposition products such as Carbon monoxide and carbon dioxide	• Generates hazardous reaction during fire and intense heat • Contact will cause frostbite • After flooding, atmosphere should be tested before re-entry	• High temperature fires produce split products of Novac which are toxic. Refer to MSDS, TDP of the product.
EXTINGUISHING CHARACTERS	• Effective Fire suppression at concentrations between 6.25% and 9% • Maximum discharge duration is 10 seconds	• Effective Fire suppression at concentrations between 8% and 10% • Extinguishes fire by absorbing heat at molecular level faster than heat is generated, so fire cannot sustain itself • Maximum discharge duration is 10 seconds	• Liquid at room temperature, gasifies immediately after discharge • Maximum discharge duration is 10 seconds
TECHNICAL INFORMATION	• Consists of Carbon, Fluorine and Hydrogen • Super-pressurized with Nitrogen to 2482 Kpa • Colorless, Odorless and Electrically Non-conductive • Operating temperature is -12.2 °C to 65.6 °C • Stored in liquid form at 24-42 bar	• Super-pressurized with Nitrogen to 2482 Kpa • Colorless, Odorless and Electrically Non-conductive • Operating temperature is -12.2 °C to 65.6 °C • Stored in liquid form at 24 bar	• Low toxicity • Boiling point of 49 °C • Stored in liquid form, Super-pressurized with Nitrogen to 25 bar
APPLICATION	• Electrical Rooms • Telecommunication Rooms • Data centers • Server Rooms • BMS rooms • High value areas • Clean rooms • Archives and record storage	• Transportation and Infrastructure • Marine Applications • Storages • Industrial applications • Laboratories • Petrochemical industries	• Pump applications • EDP Equipment enclosures • Telecommunication equipment enclosures • Storages • Marine Applications • Industrial Applications

45.12. Fire Prevention System

45.12.1. Under normal circumstances a fire can start at any time. According to the value of the goods requiring protection, measures should be in place to minimize damage for such a scenario. Measures stretch from simple hand-held extinguishers to automatic early fire detection and extinguishing systems. All these methods have one thing in common: they can only react once a fire has already started.

45.12.2. Fire prevention offers a system that can actively prevent a fire from starting and can therefore offer one hundred percent fire protection.

45.12.3. The advantages of a fire prevention system are:

- i. Certainty of avoiding outbreak and spread of fire
- ii. Permanent and preventative fire protection to secure business Processes and valuable goods
- iii. Avoidance of further damage from smoke, spread of fire or from extinguishing agents
- iv. Problem-free adaptability to changes in fire risk
- v. Wide-ranging design freedom
- vi. Cost savings at the construction stage of fire detection measures
- vii. Personnel retain access to protected areas

45.12.4. Fire prevention through extraction of oxygen

45.12.4.1. In order for a fire to start, heat, combustible substance and oxygen from the atmosphere are needed. If the oxygen is reduced, the flammability levels also decline. Below a certain level of oxygen concentration, fires can no longer burn. This is the principle of fire prevention through extraction of oxygen.

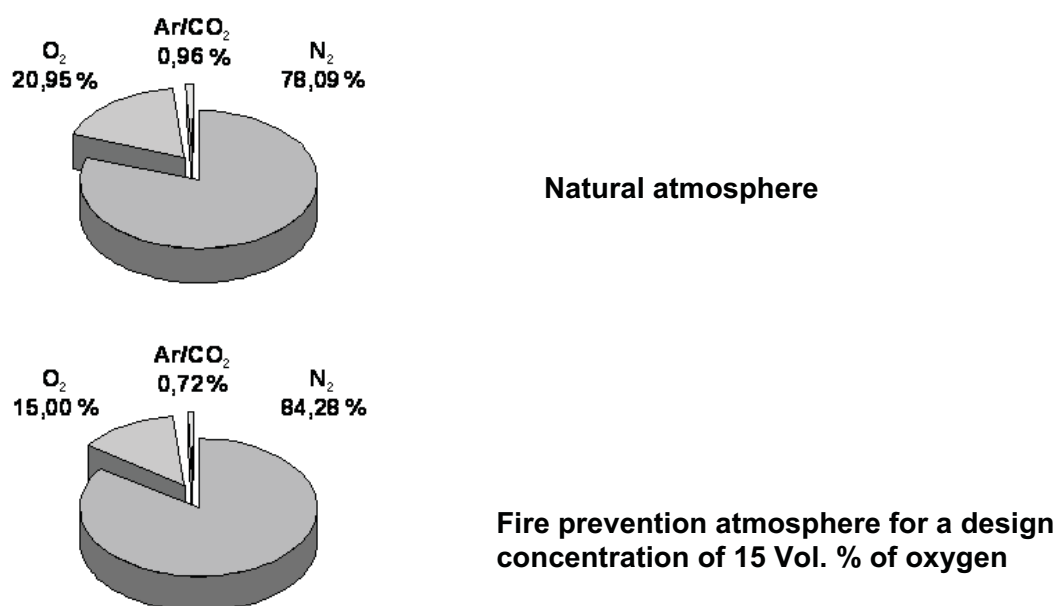


Figure 9.48: Comparison Natural and fire prevention atmosphere



45.12.4.2. Oxygen reduction facilitates a controlled reduction of oxygen levels in enclosed areas. By introducing nitrogen the oxygen content is reduced by dilution and held at a precise level. In such an atmosphere, outbreak of fire can be eliminated.

45.12.5. Accessibility of protected area

45.12.5.1. Rooms protected by fire prevention systems remain accessible to personnel, so that there is no reduction in functionality of the space.

45.12.6. Production of nitrogen on-site

45.12.6.1. The nitrogen required to reduce the oxygen concentration can be generated in a cost-effective manner on-site using an air processing system.

45.12.7. Advantages of using nitrogen to reduce oxygen content

- i. In combination with air it forms the most tolerant mixture to breathe
- ii. Is present at 78% of normal atmospheric air
- iii. Is simple to generate on-site
- iv. Is non-toxic
- v. Distributes quickly and evenly

45.12.7.1. Fire prevention systems are able to protect single and multi zone applications. The protected area is defined on base of the air condition system and the room areas that are connected by this air conditioning.

45.12.7.2. The following pictures show the system diagram for single zone and multi zone systems:

single zone system

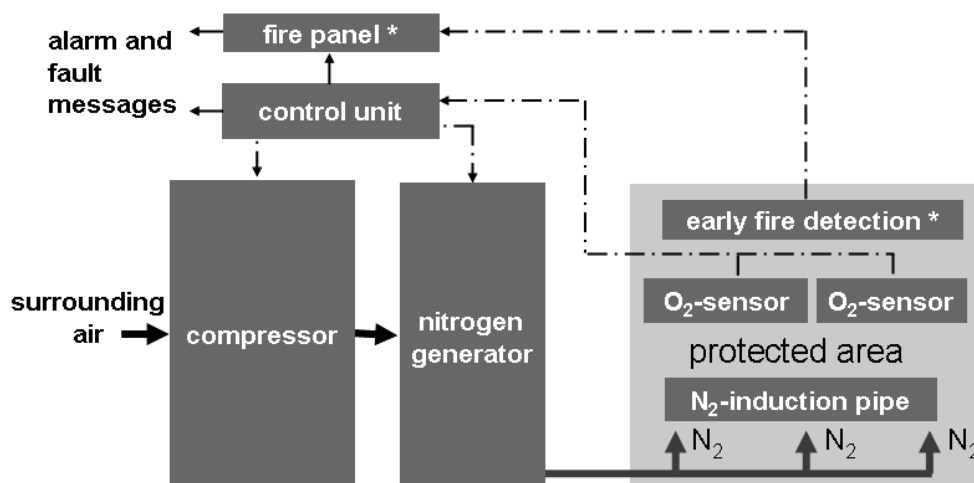


Figure 9.49:- Single Zone Oxygen Reduction System Diagram



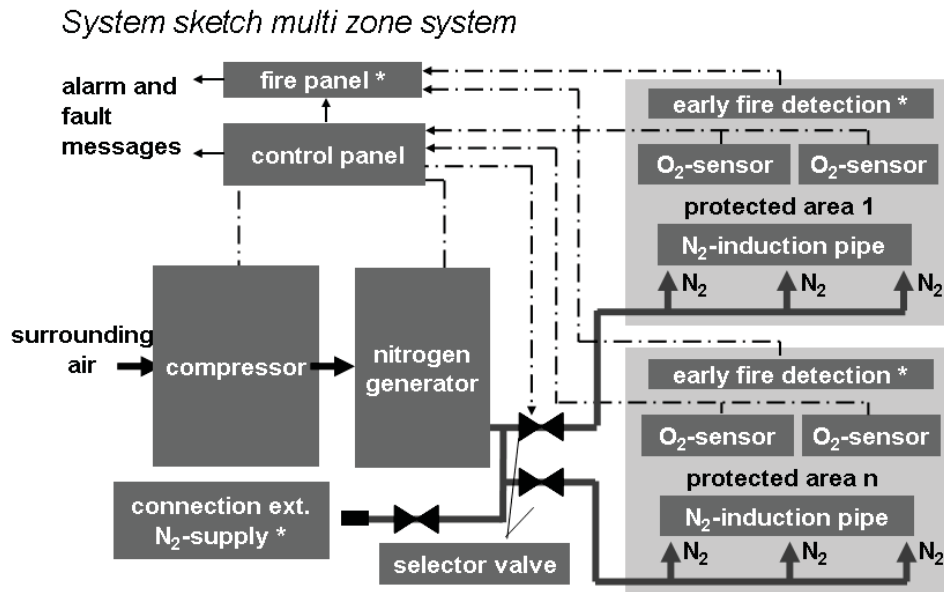


Figure 9.50: Multi Zone Oxygen Reduction System Diagram

45.12.8. Ideal Applications

45.12.8.1. Access controlled, enclosed airtight environments like:

- i. IT and data centers
- ii. Server rooms
- iii. Telecommunication rooms (i.e. Base Transmitter Station cylinders, base transmitter station controller rooms, mobile switching centers)
- iv. Electrical rooms (i.e. Low voltage rooms, UPS rooms, Battery rooms, etc)
- v. Archives
- vi. Hazard warehouses
- vii. Cold and cool warehouses
- viii. Small loading carrier warehouses
- ix. Automatic car parks
- x. Storage rooms of Museums and Galleries

45.12.9. Fire prevention with fast oxygen reduction

45.12.9.1. Fire prevention systems with fast oxygen reduction may be used under the following conditions:

- i. The Oxygen design concentration is higher as the ignition point of the material inside the protected area.
- ii. The risk of fire will be solved by using a fast oxygen reduction system
- iii. The fast oxygen reduction system will take care, that in case of a starting ignition the oxygen level will reduced to the designed concentration according to the materials inside the protected area.



- iv. The Fire prevention system is able to hold this level for an endless period of time.
- v. Shut down of the air condition system and the power is not necessary.
- vi. The business process can run without any interruption

System sketch single zone system with N_2 -storage

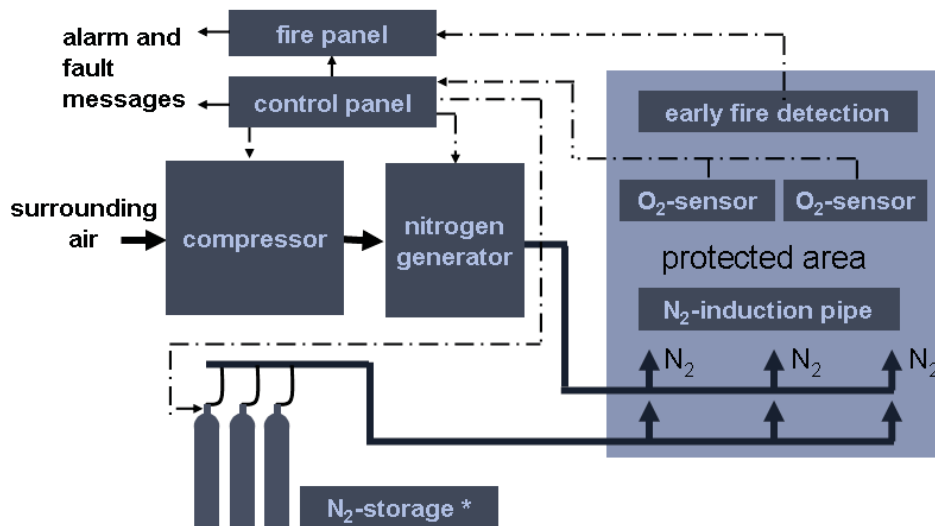


Figure 9.51: Single Zone System Diagram with fast oxygen reduction

45.12.10. Special requirements for fire prevention systems

- 45.12.10.1. The fire prevention system should have a dedicated and separate Air Handling Unit (AHU) system per protected area; no fresh air entry is allowed.
- 45.12.10.2. The objectives of having an AHU system complying with the norms of the fire prevention system will:
 - i. Eliminate fresh Air entry to the protected areas,
 - ii. Eliminate Nitrogen leakage from the protected areas to the outside
 - iii. Reduce the cost of power consumption
- 45.12.10.3. In case the AHU is located outside the protected area, you should make sure that all outside ducting are air tight to prevent fresh air entry or Nitrogen leakage.
- 45.12.10.4. The Air handling systems of the building should be designed in the way that no pressure differences will accrues between protected areas and neighbor areas. Pressure differences force a much higher air exchange rate so that the fire prevention system will not work efficiently. Another effect will be an uncontrolled introduction of nitrogen into unprotected areas.



45.13. Health & Safety Aspects of Gas Extinguishing Systems and Fire Prevention Systems

45.13.1. Safety for Gas Extinguishing Systems

- i. For the warning of persons, hazard areas shall be provided with audible and visual alarm systems in order to alert people present in the flooding zone.
- ii. The signal of the audible alarm devices shall be distinctly different from the operational noises and be at least by 5 dB (A) above the environment sound level.
- iii. Visual alarm devices shall be available in addition to the audible ones. Visual alarm devices shall provide a conspicuous signal by way of flashing.
- iv. As far as extinguishing systems with gaseous extinguishing agent are concerned, the extinguishing alarm shall be switched off only after it has been ensured that no unauthorized people can enter the hazard areas any more.
- v. The energy supply for the alarm must in any case be sufficient for a duration of 30 minutes.
- vi. Extinguishing systems that can cause harm to persons due to flooding shall be provided with delay devices. Delay devices shall ensure that flooding will be performed only after the alarm devices have been activated and the set pre-warning time has elapsed.
- vii. For total flooding systems, a pre-warning time shall be effective for each automatic or manual release of the extinguishing system.
- viii. There shall be a provision to disable the release of extinguishing system. The blocking shall be performed mechanically such that an extinguishing agent discharge is safely prevented.
- ix. Piping must be electrically grounded.
- x. Rooms that are protected with extinguishing systems shall be arranged such that extinguishing agents cannot unintentionally escape in such quantities that people in adjacent rooms or areas will be affected.
- xi. Escape routes shall be available for all extinguishing and hazard areas.
- xii. Rooms, whose single escape and rescue route runs through the extinguishing area, have to be treated as 'extinguishing area' as far as alarm and delay are concerned.
- xiii. Doors shall be of self-closing construction, swing open in the escape direction and be easily openable from inside at any time and without any other tools.
- xiv. If, for operational reasons, self-closing doors have to be kept open, these shall be fitted with hold-open systems that are designed such that automatic closing on activation of the extinguishing system.
- xv. The owner shall develop an operating procedure based on the operating instructions provided by the manufacturer and installer, which covers, in particular, all necessary safety information.
- xvi. The owner shall instruct all persons who have access to the hazard areas before they take up their activities and at least annually regarding any possible hazards of the extinguishing agent and any necessary protection measures on the basis of the operating procedures.
- xvii. The instruction shall be documented.
- xviii. The owner shall have rectified any faults of the extinguishing system which impair personnel protection without delay. If this is not possible, he shall shut down the system. During this time fire protection shall be ensured by other means.
- xix. Flooded rooms may only be re-entered when a instruction to do so has been issued by the person authorized by the owner or by the Civil Defence after



thorough investigation. If required, concentration measurements of the extinguishing gases and of the oxygen concentration need to be performed.

- xx. Flooded rooms shall be ventilated prior to re-entry. In doing so, it shall be ensured that people in adjacent rooms and in the vicinity will not be jeopardized.
- xxi. The venting of the flooded rooms shall only be performed by people who have been instructed accordingly.
- xxii. In case the rooms have to be entered for venting, this is permissible only when using a breathing apparatus that is independent from the surrounding atmosphere.

45.13.2. Safety for Fire Prevention Systems

45.13.2.1. Fire Prevention systems function with an oxygen reduced atmosphere to prevent a fire from breaking out. The design concentration is depending on the materials stored inside the protected area. For standard application the design concentration will be between 17 Vol. % and 13.0 Vol. % oxygen. The human body works well with an oxygen concentration between 12 Vol. % and 20.95 Vol. % of Oxygen. Employers should provide preliminary medical examinations to all employees having access to rooms provided with Fire Prevention System with reduced oxygen levels. The medical examination should consist of the following questionnaire at minimum:

- i. Is there a family history of benign blood disease, inherited blood disease, anemia or sickle-cell anemia?
- ii. Did you, while in the mountains or flying, ever get pains (excluding headaches) such as stomach pains, chest or joint pains?
- iii. Did you, while in the mountains or flying, get headaches, nausea, have breathing difficulties, tiredness such that you felt ill?
- iv. Do you have any known heart disease?
- v. Do you have any known disease of the lungs or breathing tracts?
- vi. Do you have anemia of any kind?
- vii. Do you have sickle-cell anemia?
- viii. Have you had a stroke, a transient ischemic attack or do you know if you have a narrowing of the carotid artery?
- ix. Have you been treated for irregular heartbeat?
- x. Have you felt dizziness in the last 3 months which interfered with your daily activities?
- xi. Have you fainted in the past year?
- xii. Do you have to pause in your private or professional activities because of shortness of breath on exertion?
- xiii. While climbing stairs do you have to stop to catch your breath?
- xiv. Has your physical fitness deteriorated noticeably in the past 3 months?
- xv. Under physical or mental stress, have you experienced pains or pressure in your chest?
- xvi. Have you in the past month had pains in your chest even while at rest?
- xvii. Have you in the last 3 months woken up because you couldn't breathe properly?

45.13.2.2. If all questions will be answered with no, the person could access oxygen reduced areas safely. In all other cases the person should be checked by a



doctor. The working time inside a oxygen reduced atmosphere should be limited to 4 hours. After 4 hours the people should have a break of 30 minutes with fresh air before re-entering this area.

46. Dry Chemical Suppression Systems

46.11. Introduction

- 46.11.1.** Dry chemical is a powder mixture that is used as a fire-extinguishing agent. It is intended for application by means of portable extinguishers, hand hose line systems, or fixed systems.
- 46.11.2.** The principal base chemicals used in the production of currently available dry chemical extinguishing agents are sodium bicarbonate, potassium bicarbonate, potassium chloride, urea-potassium bicarbonate, and monoammonium phosphate. Various additives are mixed with these base materials to improve their storage, flow, and water repellency characteristics. The most commonly used additives are metallic stearates, tricalcium phosphate, or silicones, which coat the particles of dry chemical to make them free-flowing and resistant to the caking effects of moisture and vibration.
- 46.11.3.** Multipurpose dry chemical can be used on fires in flammable liquids, fires involving energized electrical equipment, and fires in ordinary combustible materials.

46.12. Application

- i. Flammable liquids
- ii. Existing Kitchen hoods and ducts which are provided with pre-engineered dry chemical system. (Dry Chemical for new Kitchen hoods is not allowed. See next section on WET CHEMICAL SYSTEM)
- iii. Deep fryers
- iv. Oil filled transformers
- v. Oil filled circuit breakers
- vi. Textile Machinery
- vii. Cotton Mills

- 46.12.1.** Regular dry chemical has certain limited applications in extinguishment of flash surface fires with ordinary combustibles, but the chemical requires water to put out deep-seated smoldering fires.

46.13. Limitations

- i. Regular dry chemical provided for use on surface-type Class A fires, it should be supplemented by water spray for extinguishing smoldering embers or in case the fire gets beneath the surface.



- ii. Multipurpose dry chemical becomes sticky when heated, where removal of the residue from fine machine parts may be difficult.
- iii. Dry chemical should not be used in installations where relays and delicate electrical contacts are located (e.g., in telephone exchanges and computer equipment rooms), as the insulating properties of dry chemical might render such equipment inoperative.
- iv. Total flooding systems are applicable only when the hazard is totally enclosed or when all openings surrounding a hazard can be closed automatically.

46.14. Design criteria

- 46.14.1.** Dry Chemical Systems can be Total flooding, Local application type, Hand hose type or combinations. Any Dry Chemical System shall be Engineered or Pre-engineered. All the system, cylinders, containers, Dry Chemical, expellant gas, piping, valves and nozzles shall be as per Manufacturer's instructions with approval and listing for particular applications.
- 46.14.2.** Dry chemical system's application, system size, flowrate, quantity, selection of nozzles, piping arrangement etc shall be as per Manufacturer's recommendation.
- 46.14.3.** See CHAPTER 8. FIRE DETECTION AND ALARM SYSTEM for Automatic fire detection for system actuation.
- 46.14.4.** At least one manual actuator shall be provided for the system.
- 46.14.5.** Chemical agents are stored in pressure containers, usually of welded steel construction, either under atmospheric pressure until the system is actuated or under the pressure of the internally stored expellant gas.
- 46.14.6.** Containers in which dry chemical is stored separately under atmospheric pressure are equipped with an expellant gas inlet, a moisture-sealed fill opening, and a dry chemical outlet. The gas inlet leads to an internal gas tube arrangement constructed so that, when it flows into the tank, it agitates and permeates the powder, making it fluidlike. The dry chemical outlet is provided with a rupture disc or valve to permit buildup of proper operating pressure in the tank before the dry chemical can start to flow.
- 46.14.7.** The expellant gas assembly consists of a pressure storage vessel together with necessary valves, pressure regulators, and piping to deliver the expellant gas to the dry chemical storage tank at the correct pressure and rate of flow.
- 46.14.8.** The expellant gas is usually dry nitrogen. However, dry air or other gases may be used.
- 46.14.9.** Chemical expellant gas assemblies shall be located as near as practicable to the hazard to be protected. An area in which temperatures stay between -



40 to +120°F (- 40 to +49°C) is desirable to maintain the quality of the dry chemical.

46.14.10. Shutdown of Ventilation, fans, openings, doors and windows, shutdown of fuel, gas, electrical power to the protected equipment etc shall be achieved at the time of system discharge for the successful extinguishing of fire.

46.14.11. A total flooding type of system shall be used only where there is a permanent enclosure surrounding the hazard that adequately enables the required concentration to be built up.

46.14.12. The total area of unclosable openings shall not exceed 15 percent of the total area of the sides, top, and bottom of the enclosure. Where unclosable openings exceed 15 percent of the total enclosure surface area, a local application system shall be used to protect the entire hazard

46.14.13. In Existing kitchen hood and common exhaust duct protection, each protected cooking appliance(s), individual hood(s), and branch exhaust duct(s) directly connected to the hood or common exhaust duct shall be protected by a single system or by systems designed for simultaneous operation. At least one fusible link or heat detector shall be installed within each exhaust duct opening in accordance with the manufacturer's listing. A fusible link or heat detector shall be provided above each protected cooking appliance and in accordance with the system manufacturer's listing.

47. Wet Chemical Suppression Systems

47.11. Introduction

47.11.1. Wet Chemical Agent consists of organic or inorganic salts mixed with water to form an alkaline solution that is capable of being discharged through piping or tubing when under expellant gas pressure. It can be used as a fire-extinguishing agent. It is intended for application by means of portable extinguishers, hand hose line systems, or fixed systems.

47.11.2. Wet chemical extinguishing agents are typically a proprietary mixture consisting of potassium carbonate, potassium acetate, potassium citrate, or a combination, mixed in water and other additives such as phenolphthalein, phosphoric acid, and/or dyes. As they are already liquid in character, wet chemical agents do not require additives to enhance flow.

47.11.3. When wet chemicals extinguishing agents are sprayed on a grease fire, they interact immediately with the grease and saponify, forming a blanket of foam over the surface on which they are sprayed.

47.12. Application

- i. Kitchen hoods



47.13. Limitation

- 47.13.1.** Wet chemical extinguishing agents are not acceptable for use in areas where fires involve energized electrical equipment.

47.14. Design criteria

- 47.14.1.** Wet Chemical Systems can be Total flooding, Local application type, Hand hose type or combinations. Any Wet Chemical System shall be Engineered or Pre-engineered. All the system, cylinders, containers, Wet Chemical, expellant gas, piping, valves and nozzles shall be as per Manufacturer's instructions with approval and listing for particular applications.
- 47.14.2.** Wet chemical system's application, system size, flowrate, quantity, selection of nozzles, piping arrangement etc shall be as per Manufacturer's recommendation.
- 47.14.3.** See CHAPTER 8. FIRE DETECTION AND ALARM SYSTEM for Automatic fire detection for system actuation.
- 47.14.4.** At least one manual actuator shall be provided for the system.
- 47.14.5.** Wet chemical extinguishing agents are typically stored in plastic containers up to 5 gal (19 L) in capacity. Attention should be given to the freeze point of the particular agent. The agent storage life is approximately 12 years. System tanks containing wet chemical range in size between 1.5 gal (5.7 L) and 3 gal (11.4 L), depending on the manufacturer's design.
- 47.14.6.** To expel the agent, most systems use pressurized cartridges of nitrogen or carbon dioxide. To ensure proper operation, the temperature ranges for wet chemical systems are between 32°F (0°C) and 130°F (54°C).
- 47.14.7.** Shutdown of fuel, gas, electrical power to the protected equipment etc shall be achieved at the time of system discharge.
- 47.14.8.** Piping and fittings must be of noncombustible materials and compatible with the characteristics of wet chemical. Distribution piping should be either Schedule 40 black iron, chromeplated or stainless steel.
- 47.14.9.** Nozzles should be provided with 'blow off cap' to prevent the clogging due to grease, dust etc.
- 47.14.10.** In kitchen hood and common exhaust duct protection, each protected cooking appliance(s), individual hood(s), and branch exhaust duct(s) directly connected to the hood or common exhaust duct shall be protected by a single system or by systems designed for simultaneous operation. At least one fusible link or heat detector shall be installed within each exhaust duct opening in accordance with the manufacturer's listing. A fusible link or heat detector shall be provided above each protected cooking appliance and in accordance with the system manufacturer's listing.



- 47.14.11.** A typical kitchen hood protection with wet chemical system is shown in **Figure 9.52** below.

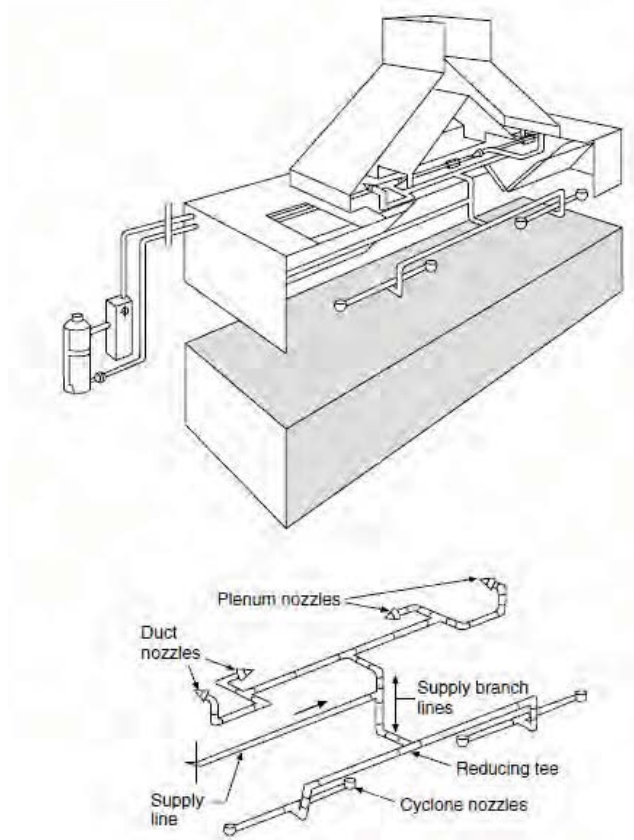


Figure 9.52: typical Kitchen hood wet chemical system

47.15. Inspection and Maintenance

- 47.15.1.** Owners of chemical extinguishing systems should conduct monthly inspections to determine whether the system is in proper operating condition. This inspection is not intended to be a detailed, but is rather a visual check of the system to ensure the following items:
- Clogging of nozzles, fusible links because of grease, paint or dust is cleaned
 - The extinguishing system is in its proper location.
 - The manual actuators are unobstructed.
 - The tamper indicators and seals are intact.
 - The maintenance tag or certificate is in place.
 - There is no obvious physical damage or condition exists that might prevent operation.
 - There is no damage to, or obstruction of, fusible links or actuating devices.
 - The pressure gauge(s), if provided, is in operable range.
 - The nozzle blow-off caps are intact and undamaged.
 - The hood, duct, and protected cooking appliances have not been replaced, modified, or relocated.



48. Material Approval

- 48.11.** All the Materials, Systems, Assemblies, equipment, Products and Accessories, referred to in this chapter with respect to Life Safety, Fire Safety and Emergency Services shall be Listed, Approved and Registered by the Civil Defence Material Approval Department.
- 48.12.** The above requirement applies to all the products with or without international listing, registration or approval.

49. Further References

- 49.1.** The following International Codes and Standards were referred, studied and consulted for this chapter. Further details where applicable can be referred to in these Codes and Standards. Also see **XV. ACKNOWLEDGEMENT OF INTERNATIONAL CODES AND STANDARDS.**

- NFPA 11: Standard for Low-, Medium-, and High-Expansion Foam
- NFPA 12: Standard on Carbon Dioxide Extinguishing Systems
- NFPA 13: Standard for the Installation of Sprinkler Systems
- NFPA 13D: Standard for the Installation of Sprinkler Systems in One- and Two- Family Dwellings and Manufactured Homes
- NFPA 13R: Standard for the Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height
- NFPA 14: Standard for the Installation of Standpipes and Hose Systems
- NFPA 15: Standard for Water Spray Fixed Systems for Fire Protection
- NFPA 16: Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems
- NFPA 17: Standard for Dry Chemical Extinguishing Systems
- NFPA 17A: Standard for Wet Chemical Extinguishing Systems
- NFPA 20: Standard for the Installation of Stationary Pumps for Fire Protection
- NFPA 22: Standard for Water Tanks for Private Fire Protection
- NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems
- NFPA 2010: Standard for Fixed Aerosol Fire-Extinguishing Systems
- NFPA 750: Standard on Water Mist Fire Protection Systems.



CHAPTER 10

MECHANICAL VENTILATION AND SMOKE CONTROL SYSTEMS

1. Definitions

1.1 Air Connector.

A conduit for transferring air between an air duct or plenum and an air terminal unit or an air inlet or air outlet.

1.2 Air Duct.

A conduit or passageway for conveying air to or from heating, cooling, air conditioning, or ventilating equipment, but not including the plenum.

1.3 Air-Handling Unit Room Plenum.

An individual room containing an air-handling unit(s) used to gather air from various sources and combine the air within the room for returning to the air-handling unit.

1.4 Atrium.

A large-volume space created by a floor opening or series of floor openings connecting two or more stories that is covered at the top of the series of openings and is used for purposes other than an enclosed stairway; an elevator hoist way; an escalator opening; or as a utility shaft used for plumbing, electrical, air-conditioning, or communications facilities.

1.5 Fire Damper.

A device, installed in an air distribution system, designed to close automatically upon detection of heat, to interrupt migratory airflow, and to restrict the passage of flame, smoke and heat.

1.6 Fire Wall.

A wall separating buildings or subdividing a building to prevent the spread of fire and having a fire resistance rating and structural stability.

1.7 Legitimate Stage.

A stage with a height greater than 15 m measured from the lowest point on the stage floor to the highest point of the roof or floor deck above.



1.8 Mall.

A roofed or covered common pedestrian area within a mall building that serves as access for two or more tenants and does not exceed three levels that are open to each other.

1.9 Plenum.

A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.

1.10 Regular Stage.

A stage with a height of 15 m or less measured from the lowest point on the stage floor to the highest point of the roof or floor deck above.

1.11 Smoke.

The airborne solid and liquid particulates and gases evolved when a material undergoes pyrolysis or combustion, together with the quantity of air that is entrained or otherwise mixed into the mass.

1.12 Smoke Control.

A system that utilizes fans to produce pressure differences so as to manage smoke movement.

1.13 Smoke Damper.

A device within an air-distribution system to control the movement of smoke, i.e. to stay close to prevent the spread of flame, smoke & heat into other compartments or to open to extract smoke outside from the fire zone.

2. Air-Conditioning and Ventilation Systems**2.1 General Requirements for Equipment**

- 2.1.1** Equipment shall be arranged to provide minimum 600 mm horizontal access with minimum 2030 mm headroom for inspection, maintenance, and repair.
- 2.1.2** Equipment shall be guarded for personnel protection and against the intake of foreign matter into the system.
- 2.1.3** Each air distribution system shall be provided with at least one manually operable means for stopping the operation of the supply, return, and exhaust fan(s) in an emergency.



- 2.2** The means of manual operation shall be located in the emergency command centre or a dedicated protected room.

3. Air-Handling Unit Rooms

3.1 Air-Handling Unit Rooms Used as Plenum Space

- 3.1.1** Air-handling unit rooms, used as plenum space, shall not be used for storage or occupancy other than during equipment servicing.
- 3.1.2** Materials used in the construction of an air-handling unit room plenum shall be noncombustible or shall be limited combustible having maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84 and shall be suitable for continuous exposure to the temperature and humidity conditions of the environmental air in the plenum.
- 3.1.3** Electrical wires and cables and optical fiber cables shall be listed as having a maximum peak optical density of 0.50 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m or less, or shall be installed in metal raceways, metal sheathed cable, or totally enclosed non-ventilated bus way.

3.2 Air-Handling Unit Rooms That Have Air Ducts That Open Directly into a Shaft.

- 3.2.1** Air-handling Unit rooms, including the protection of openings, shall be separated from shafts by construction having a fire resistance rating not less than that required for the shaft.
- 3.2.2** Fire-resistant separation shall not be required for air-handling Unit rooms that are enclosed by construction having a fire resistance rating not less than that required for the shaft.

4. Outside Air Intakes

- 4.1** Outside air intakes shall be protected by screens of corrosion-resistant material not larger than 12.7 mm mesh.
- 4.2** Outside air intakes shall be located so that these shall not introduce fire or smoke into the building.



5. Air Cleaners and Air Filters

- 5.1 Electrostatic air cleaners shall be listed in accordance with ANSI/UL 867.
- 5.2 Air filters shall be rated either as Class 1 or Class 2 in accordance with ANSI/UL 900.

6. Fans

- 6.1 Exposed fan inlets shall be protected with metal screens to prevent the entry of paper, trash, and foreign materials.
- 6.2 Smoke Exhaust fans shall be capable of operating effectively at 400°C for 2 hours.

7. Air Ducts

- 7.1 Air ducts shall be constructed of iron, steel, aluminum, copper, concrete, masonry. See [Figure 10.1](#) for illustrations.
- 7.2 Class 0 or Class 1 rigid or flexible air ducts tested in accordance with ANSI/UL 181 listing shall be permitted to be used for ducts when air temperature in the ducts does not exceed 250°C or when used as vertical ducts serving not more than two adjacent stories in height.
- 7.3 Pipe and duct insulation and coverings, duct linings, vapor retarder facings, adhesives, fasteners, tapes, and supplementary materials added to air ducts, plenums, panels, and duct silencers used in duct systems, shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84.
- 7.4 Pipe and duct insulation and coverings, duct linings and their adhesives, and tapes shall use the specimen preparation and mounting procedures of ASTM E 2231. See [Figure 10.1](#), [10.2](#), [10.3](#) and [10.4](#) for illustrations.
- 7.5 Air connectors shall not pass through any wall, partition, or enclosure of a vertical shaft that is required to have a fire resistance rating of 1 hour or more. Air connectors shall not pass through floors.
- 7.6 A service opening shall be provided in air ducts adjacent to each fire damper, smoke damper, and any smoke detectors that need access for installation, cleaning, maintenance, inspection, and testing.
- 7.7 Service openings shall be identified with letters having a minimum height of 1.27 cm to indicate the location of the fire protection device(s) within.
- 7.8 Where proprietary fire rated materials are used to construct the fire rated duct, the fire rating of the fire rated duct shall have the same period of fire resistance as the wall or floor it penetrates. See [Figure 10.1](#) for illustrations.



- 7.9** Openings for the intakes of outdoor air to all air handling systems, mechanical ventilation systems, pressurization systems of exit staircases and internal corridors, and smoke control systems shall be no less than 5m from any exhaust discharge openings.

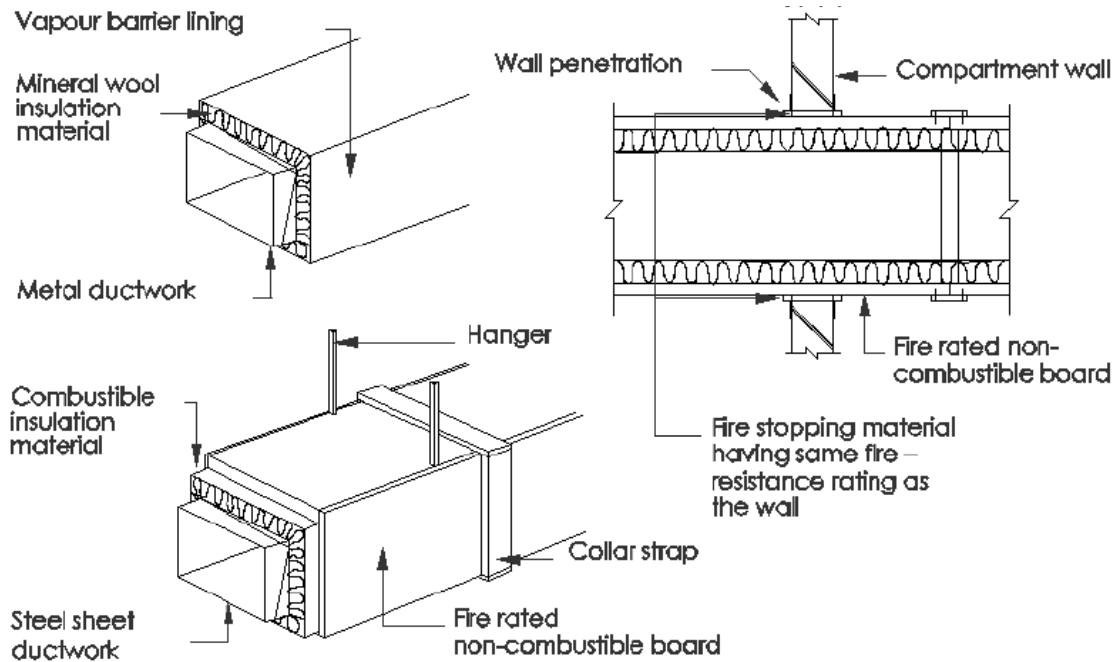


Figure 10.1: Duct Construction and Duct Penetration through walls

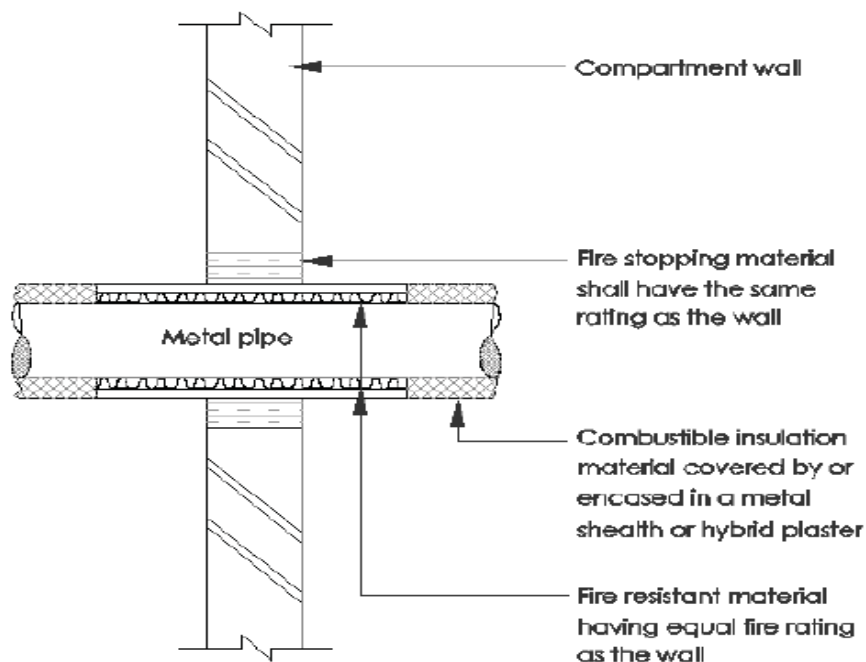


Figure 10.2: Metal pipes with combustible insulation

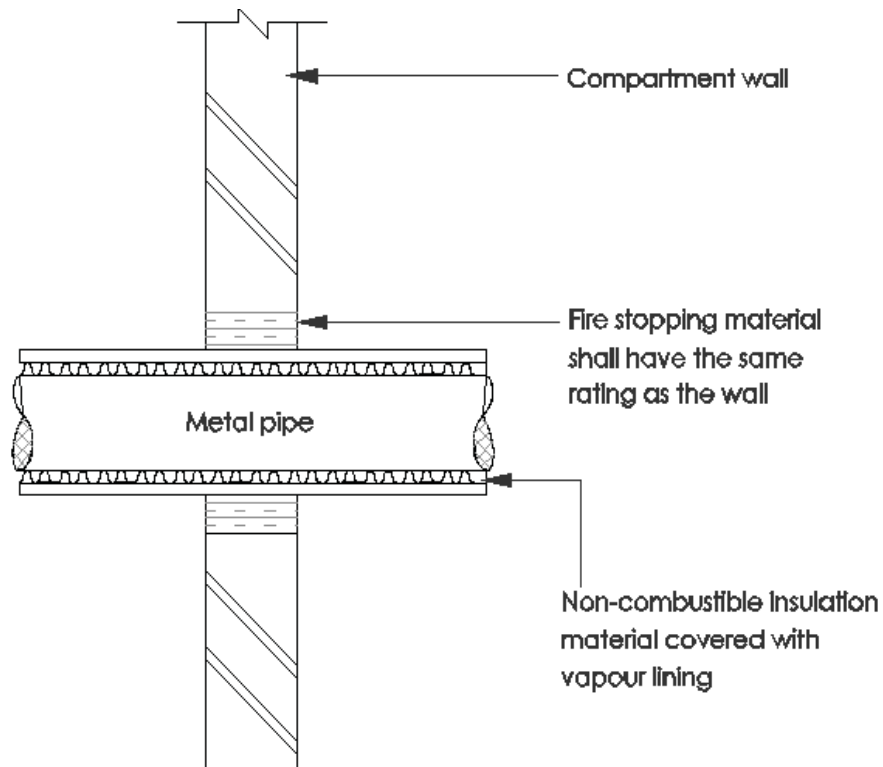


Figure 10.3: Metal pipes with non-combustible insulation

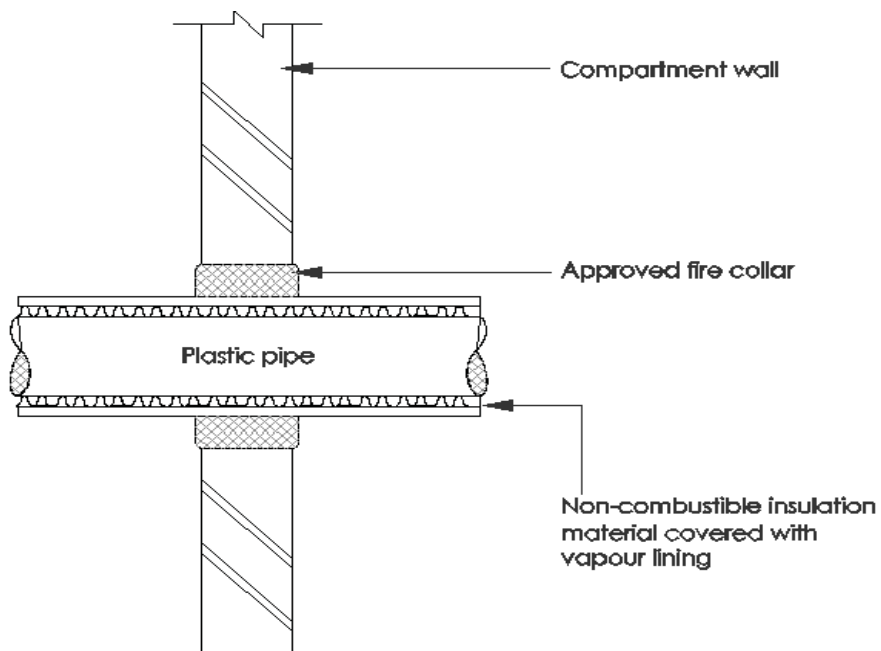


Figure 10.4: Metal pipes with non-combustible insulation

8. Ventilation Ducts

- 8.1** Ventilation ducts should not pass through smoke-stop or fire fighting lobby.
- 8.2** Where unavoidable, the part of the ventilation duct within the lobby shall be enclosed in construction with fire resistance rating at least equal to that of the elements of structure. See [Figure 10.5](#), [10.6](#) and [10.7](#) for illustrations.
- 8.3** Such construction shall be in masonry. If other form of fire resisting construction is used, fire damper shall be fitted where the duct penetrates the lobby enclosure. No air conditioning or ventilation ducts shall penetrate separating walls.

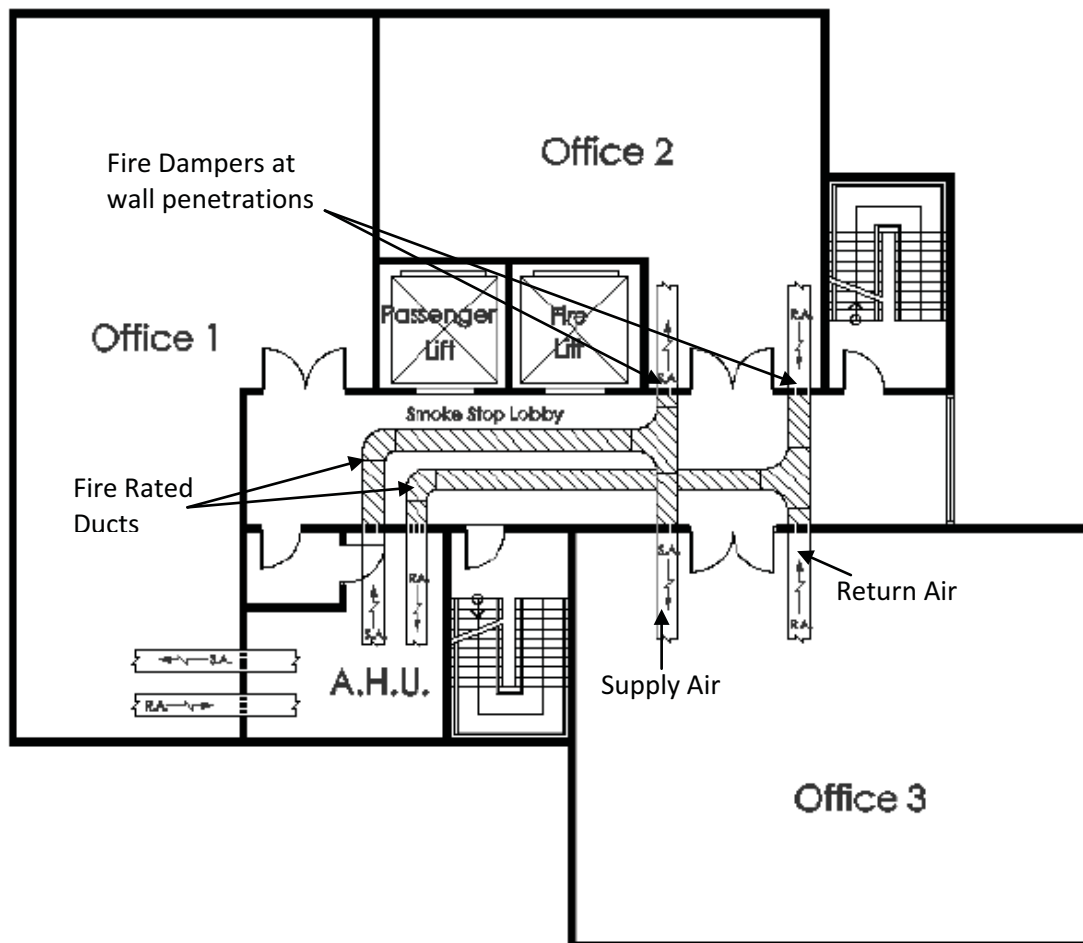


Figure 10.5: Ventilation Duct through protected lobby

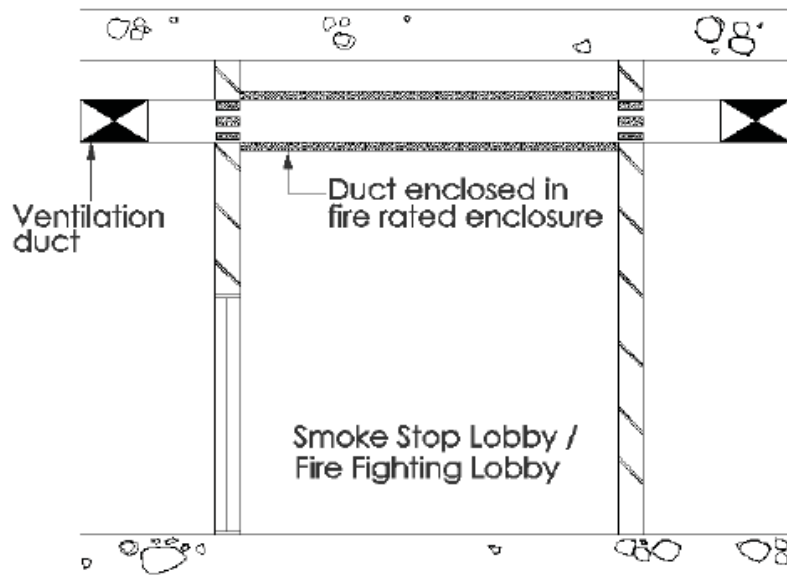


Figure 10.6: Ventilation Duct in fire rated enclosure through protected lobby

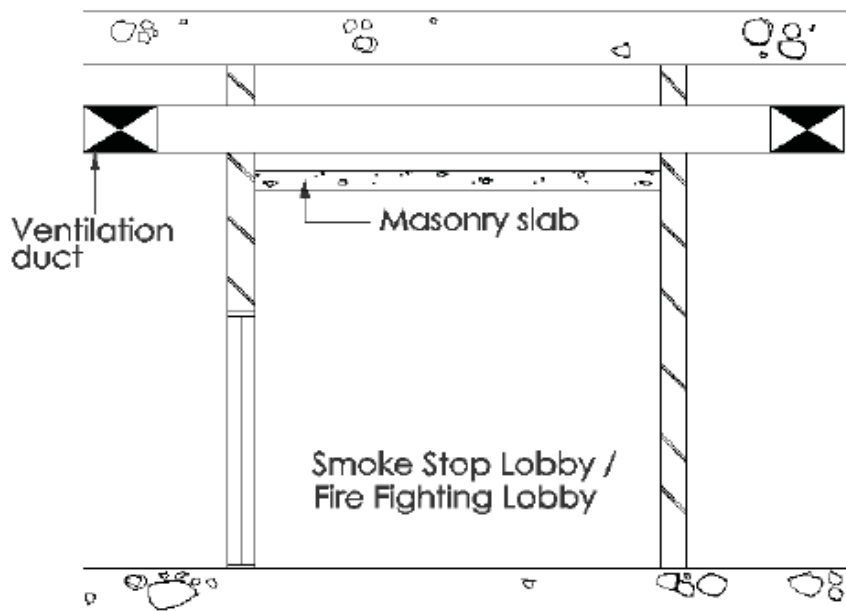


Figure 10.7: Ventilation Duct within masonry slab through protected lobby

9. Plenum

9.1 A concealed space between the ceiling and floor above it, ceiling and roof, or raised floor and structural floor of a building may be used as a plenum provided that the concealed space contains only:

- i. Mineral-insulated metal-sheathed cable,
- ii. Aluminum-sheathed cable,
- iii. Copper-sheathed cable,
- iv. Rigid metal conduit,
- v. Enclosed metal trunking,
- vi. Flexible metal conduit,
- vii. Liquid-tight flexible metal conduit in lengths not more than 2 m, or metal-clad cables;
- viii. Communication cables for computers, television, telephone and inter-communication system;
- ix. Fire protection installations;
- x. Pipes of non-combustible material conveying non-flammable liquids

9.2 The supports for the ceiling membrane shall be of non-combustible material. See **Figure 10.8** and **10.9** for illustrations.

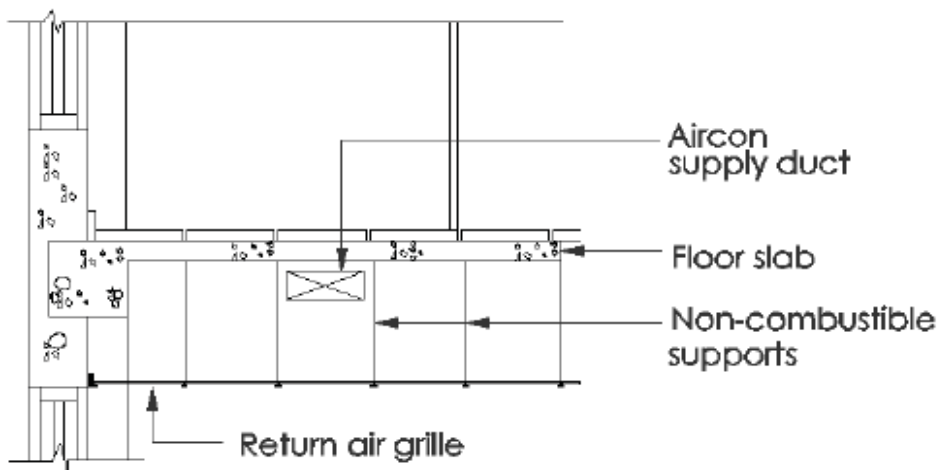


Figure 10.8: Return Air Plenum in ceiling space



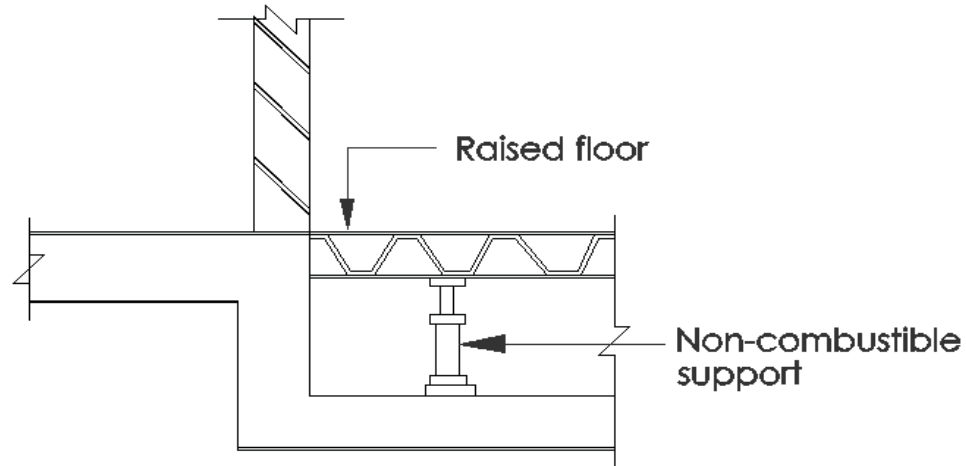


Figure 10.9: Return Air Plenum under raised floor.

10. Fire Dampers

- 10.1** Duct penetrations of fire walls should be avoided. Approved fire dampers shall be provided where air ducts penetrate or terminate at openings in walls or partitions required to have a fire resistance rating of 1 hour or more.
- 10.2** Where air ducts extend through only one floor and serve only two adjacent stories, the air ducts shall be enclosed, or fire dampers shall be installed at each point where the floor is penetrated. See [Figure 10.10](#) for illustrations.

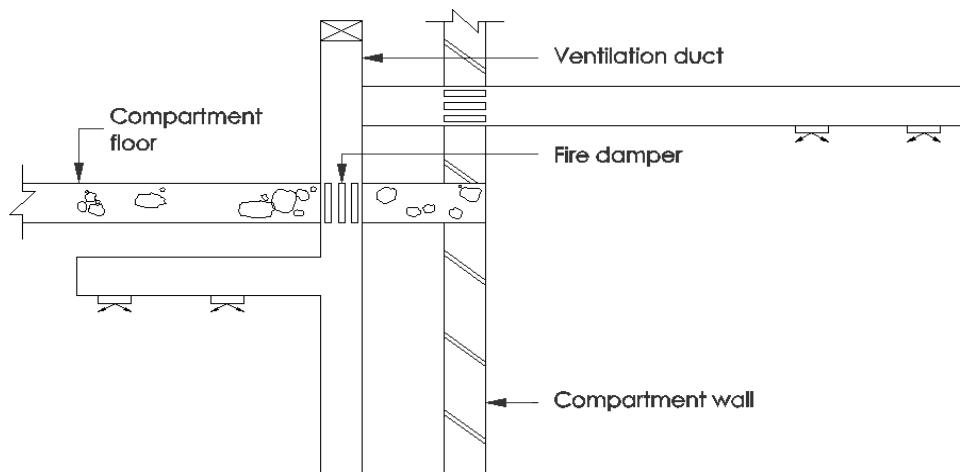


Figure 10.10: Fire dampers provided in ducts penetration through fire compartments.



10.3 A fire damper shall not be required for the following:

- i. Clothes Dryer Exhaust Ducts
- ii. Hazardous Fume Exhaust Duct
- iii. Stairwell Pressurization Ducts
- iv. Smoke Extraction Ducts
- v. Laundry and Trash Chutes

10.4 Fire dampers used for the protection of openings in walls, partitions, or floors with fire resistance ratings of less than 3 hours shall have a 1½-hour fire protection rating in accordance with ANSI/UL 555 Standard for Safety Fire Dampers or EN 1366-2.

10.5 Fire dampers used for the protection of openings in walls, partitions, or floors having a fire resistance rating of 3 hours or more shall have a 3-hour fire protection rating in accordance with ANSI/UL 555 Standard for Safety Fire Dampers or EN 1366-2.

10.6 Fire dampers used in any sensitive buildings as healthcare facilities, hotels (occupancy with sleeping risk), education buildings, and any buildings where habitable height exceeds 23m shall be controlled by an automatic alarm-initiated device, and shall ensure no smoke leakage and no heat transfer.

10.7 Fire dampers and ceiling dampers shall be installed and maintained in accordance with NFPA 80, Standard for Fire Doors and Other Opening Protectives or EN 12101-4.

Note: A combination fire and smoke damper is a fire damper and cannot be used as a smoke damper.

11. Smoke Dampers

11.1 Smoke dampers shall be installed at or adjacent to the point where air ducts pass through required smoke barriers, but in no case shall a smoke damper be installed more than 0.6 m from the barrier, or after the first air duct inlet or outlet, whichever is closer to the smoke barrier.

11.2 Smoke dampers shall not be required on air systems other than where necessary for the proper function of that system where the system is designed specifically to accomplish the following:

- i. Function as an engineered smoke-control system, including the provision of continuous air movement with the air-handling system
- ii. Provide pressure differentials during a fire emergency

11.3 If the air-handling equipment is serving more than one floor then smoke dampers shall be installed in systems with a capacity greater than 7080 L/s (15,000 ft³/min) to isolate the air-handling equipment, including filters, from the remainder of the system on both the building supply and return sides, in order to restrict the circulation of smoke.



- 11.4 Smoke dampers used for the protection of openings in smoke barriers or in engineered smoke-control systems shall be classified in accordance with ANSI/UL 555S, Standard for Safety Smoke Dampers and with a minimum Class II leakage rating, and elevated temperature rating shall not be less than 250°C or EN 1366-10.
- 11.5 Smoke dampers shall be installed and maintained in accordance with NFPA 105, Standard for the Installation of Smoke Door Assemblies and Other Opening Protectives or EN 12101-4.
- 11.6 Smoke dampers shall be controlled by an automatic alarm-initiated device.

12. Smoke Detection for Automatic Control

- 12.1 Smoke detectors provided as required by this clause shall automatically stop their respective fan(s) on detecting the presence of smoke.
- 12.2 Where the return air fan is functioning as part of an engineered smoke-control system and a different mode is required, the smoke detectors shall not be required to automatically stop their respective fans.
- 12.3 Smoke detectors listed for use in air distribution systems shall be located as follows:
 - i. Downstream of the air filters and ahead of any branch connections in air supply systems having a capacity greater than 944 L/s (2000 ft³/min)
 - ii. At each story prior to the connection to a common return and prior to any recirculation or fresh air inlet connection in air return systems having a capacity greater than 7080 L/s (15,000 ft³/min) and serving more than one story
 - iii. Return system smoke detectors shall not be required where the entire space served by the air distribution system is protected by a system of area smoke detectors
 - iv. Smoke detectors shall not be required for fan units whose sole function is to remove air from the inside of the building to the outside of the building.
 - v. Smoke detectors shall be installed, tested, and maintained in accordance with NFPA 72, National Fire Alarm Code
 - vi. Smoke detectors used solely for closing dampers or for heating, ventilating, and air-conditioning system shutdown shall not be required to activate the building evacuation alarm.



13. Plenum Material

- 13.1** Plenums shall not be used for occupancy or storage. The temperature of air delivered to these plenums shall not exceed 121°C.
- 13.2** Materials used in the construction of a ceiling plenum shall be noncombustible or shall be limited combustible having a flame spread index of not more than 25 a maximum smoke developed index of 50.
- 13.3** Electrical wires and cables and optical fiber cables shall be listed as having a maximum peak optical density of 0.50 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less, or shall be installed in metal raceways, metal sheathed cable, or totally enclosed non-ventilated bus way.
- 13.4** Wall or ceiling finish in plenums shall be noncombustible or shall exhibit a flame spread index of 25 or less and a smoke developed index of 50 or less, when tested in accordance with ASTM E 84.

14. Corridor Air Systems

- 14.1** Egress corridors in health care, detention and correctional, and residential occupancies shall not be used as a portion of a supply, return, or exhaust air system serving adjoining areas.
- 14.2** An air transfer opening(s) shall not be permitted in walls or in doors separating egress corridors from adjoining areas.
- 14.3** Use of egress corridors shall be permitted as part of an engineered smoke-control system.

15. Exits

- 15.1** Exit passageways, stairs, ramps, and other exits shall not be used as a part of a supply, return, or exhaust air system serving other areas of the building.
- 15.2** Mechanical ventilation system for each exit staircase and internal exit passageway, if provided, shall be an independent system of supply mode only exclusive to the particular staircase, and it shall comply with the following requirements:
- Supply air for the system shall be drawn directly from the external, with intake point not less than 5m from any exhaust discharge openings.
 - For exit staircase serving more than 4 stories, supply air shall be conveyed via a vertical duct extending throughout the staircase height and discharging from outlets distributed at alternate floor.



- iii. Where the supply air duct serving the exit staircase has to penetrate the staircase enclosure, the portion of the duct where it traverses outside the staircase shall be enclosed in masonry construction or drywall of at least the same fire resistance as the elements of structure and it shall not be fitted with fire dampers.
- iv. The ventilation system shall be of supply mode only of not less than 4 air changes per hour.

15.3 The mechanical ventilation system shall be automatically activated by the building fire alarm system. In addition, a remote manual start-stop switch shall be made available to firemen at the emergency command centre, or at the fire indicating board where there is no emergency command centre.

15.4 Visual indication of the operation status of the mechanical ventilation system shall be provided.

15.5 Air-conditioning and fan coil units are not allowed to be in exit staircases.

15.6 All fire exit staircases that serve the basement floors shall also be pressurized if the same staircase shafts serving the upper floors are pressurized.

15.7 Fire exit staircases that only serve the basement which have more than 2 levels or more than 7m below the level of discharge (high depth underground buildings and structures) shall be pressurized.

15.8 Fire exit staircases that only serve the basement which have less than 2 or levels or less than 7m below the level of discharge (low depth underground buildings and structures) shall be provided with mechanical ventilation.

16. Smoke free enclosure and fire fighting lobbies

16.1 Mechanical ventilation system for smoke-stop lobbies and fire fighting lobbies shall be a system exclusive to these lobbies, and it shall comply with the following requirements:

- i. The ventilation system shall be of supply mode only of not less than 10 air changes per hour. See **Figures 10.12** and **10.25c** for illustrations.
- ii. Supply air shall be drawn directly from the external with intake point not less than 5m from any exhaust discharge or openings for natural ventilation.
- iii. Any part of the supply duct running outside the smoke-stop or fire fighting lobby which it serves shall either be enclosed or constructed to give a fire resistance rating of at least 1 hr.



- iv. The mechanical ventilation system shall be automatically activated by the building fire alarm system. In addition, a remote manual start-stop switch shall be made available to firemen at the emergency command centre, or at the fire indicating board where there is no emergency command centre. Visual indication of the operation status of the mechanical ventilation system shall be provided. See [Figure 10.11](#) for illustrations.

17. Engine driven fire pump and generator room and emergency command centre

17.1 Independent mechanical ventilation (if required) shall be provided for fire pump and generator rooms and shall comply with the following:

- i. Supply air shall be drawn directly from the external and its intake point shall not be less than 5 m from any exhaust discharge openings. Exhaust discharge shall also be direct to the external and shall not be less than 5 m from any air intake openings.
- ii. Where the corresponding ducts run outside the room they shall either be enclosed in a structure or be constructed to give at least the same fire rating as the room which they serve or that of the room through which they traverse, whichever is higher. The rating shall apply to fire exposure from both internal and external of the duct or structure.
- iii. Where the duct risers are required to be enclosed in a protected shaft constructed of masonry or drywall, they shall be compartmented from the rest of the shaft space containing other ducts or services installations.
- iv. No fire damper shall be fitted in either supply or exhaust duct required under this clause.
- v. Duct serving areas other than rooms housing equipment stated in this clause shall not pass through such rooms. See [Figure 10.13](#) and [10.14](#).



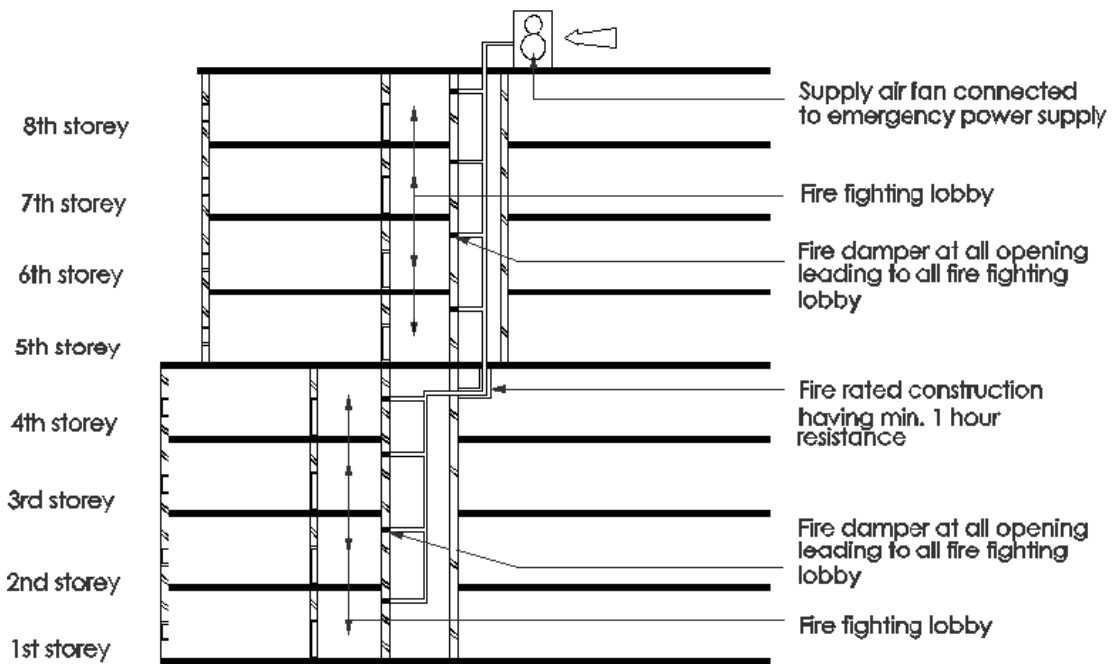


Figure 10.11: Mechanical ventilation for smoke-proof (smoke stop) and fire fighting lobby

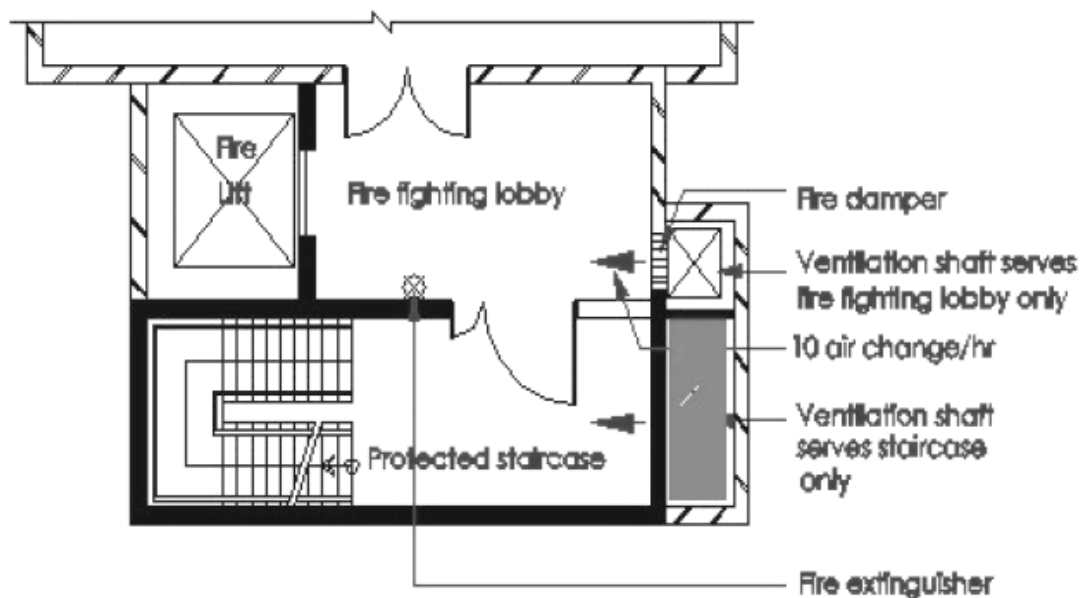


Figure 10.12: Layout of fire fighting lobby, fire lift and exit staircase.

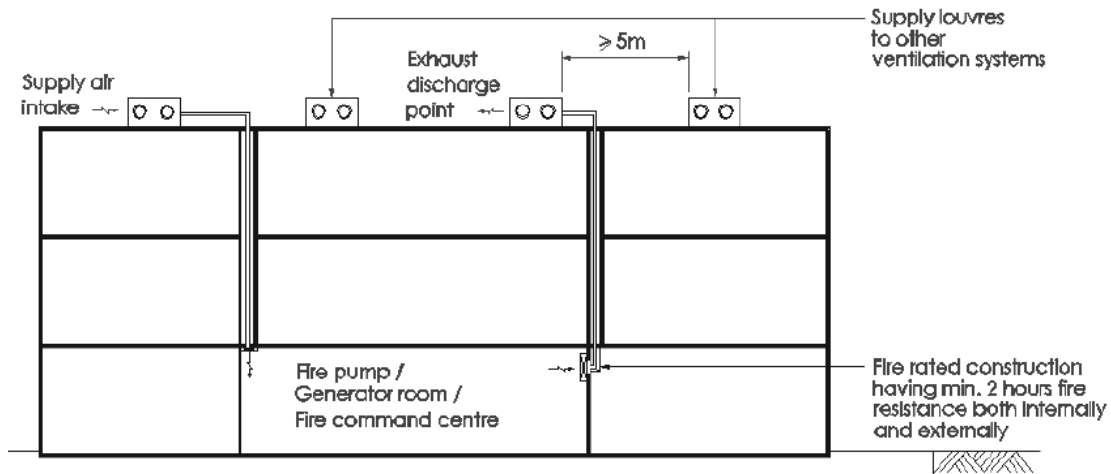


Figure 10.13: Mechanical ventilation for fire pump room, generator room and emergency command centre (fire command centre)

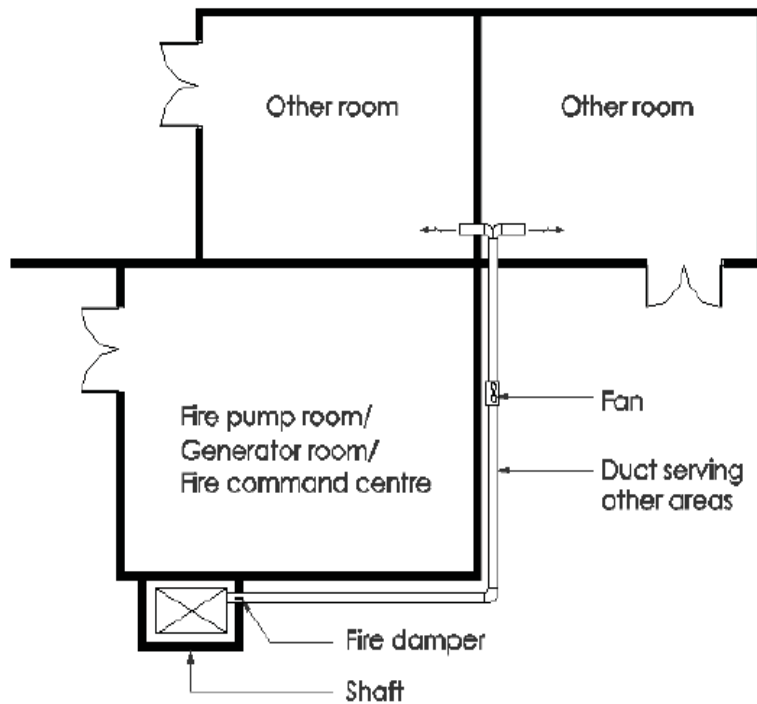


Figure 10.14: Ducting serving other areas avoiding fire pump room, generator room or emergency command centre

18. Rooms involving use of Flammable and Explosive Substances

- 18.1** Mechanical ventilation system where required for rooms which involve the use of flammable and explosive substances shall be independent from those serving other parts of the building. It shall comply with the following requirements:
- Ventilation system shall consist of exhaust and supply part with a rate of 20 air-changes per hour.
 - The exhaust shall be direct to the external and shall not be less than 5 m from any air intake openings;
 - Where such ducts run outside the room they shall either be enclosed in a structure or be constructed to give at least the same fire rating as the room which they serve or that of the room through which they traverse, whichever is higher. The rating shall apply to fire exposure from both internal and external of the duct or structure.
 - Where the duct risers are required to be enclosed in a protected shaft constructed of masonry or drywall complying, they shall be compartmented from the rest of the shaft space containing other ducts or services installations;
 - No fire damper shall be fitted in either supply or exhaust duct required under this Clause; and
 - Ducts serving other areas shall not pass through rooms involving use of flammable and explosive substances. See [Figure 10.15](#).

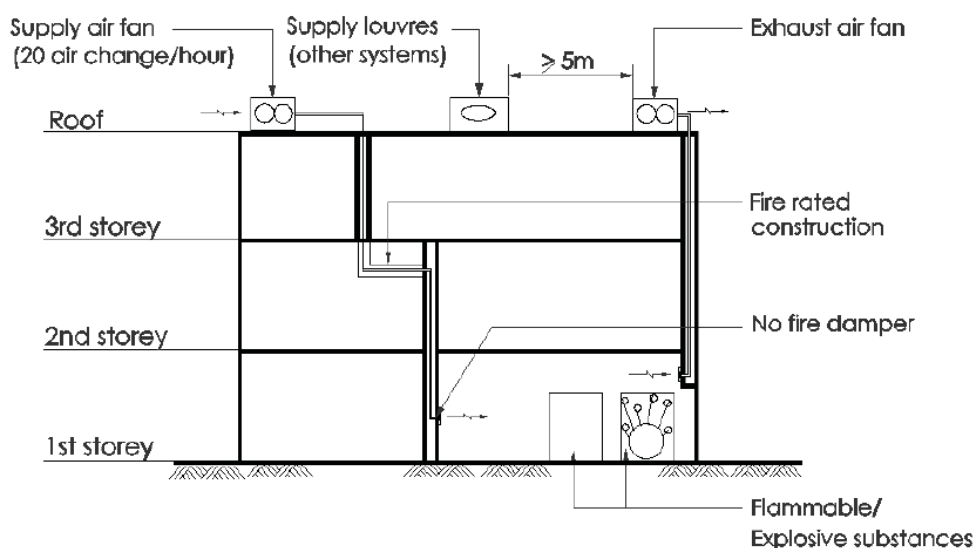


Figure 10.15: Mechanical ventilation for rooms involving flammable or explosive substances.



19. Acceptance testing

- 19.1** All fire dampers, smoke dampers, and ceiling dampers shall be operated prior to the occupancy of a building to determine that they function in accordance with the requirements of this standard.
- 19.2** Acceptance tests of fire protection devices in air-conditioning and ventilating systems shall, as far as practicable, be performed under normal operating conditions.
- 19.3** The tests shall be performed to determine that the system operates under the standby power or emergency operation mode conditions as well as under normal conditions.
- 19.4** To avoid any openings in case of a power failure and to ensure energy savings, smoke damper should be operated through an 'electric signal emission', not through 'power cut-off'.

20. Building Smoke Ventilation System**20.1 Smoke Ventilation Of Commercial Cooking Operations**

- 20.1.1** Cooking equipment used in processes producing smoke or grease-laden vapors shall be equipped with an exhaust system that complies with all the equipment and performance requirements of this standard.
- 20.1.2** A fire-actuated damper shall be installed in the supply air plenum at each point where a supply air duct inlet or a supply air outlet penetrates the continuously welded shell of the exhaust hood assembly.
- 20.1.3** The fire damper shall be listed for such use or be part of a listed exhaust hood with or without exhaust damper.
- 20.1.4** The actuation device shall have a maximum temperature rating of 141°C.
- 20.1.5** Listed grease filters, listed baffles, or other listed grease removal devices for use with commercial cooking equipment shall be provided. Listed grease filters shall be tested in accordance with UL 1046. Mesh filters shall not be used.
- 20.1.6** Exhaust ducts shall not pass through fire walls. All exhaust ducts shall lead directly to the exterior of the building, so as not to unduly increase any fire hazard. Exhaust duct systems shall not be interconnected with any other building ventilation or exhaust system.
- 20.1.7** Exhaust ducts shall be constructed of and supported by carbon steel not less than 1.37 mm (No. 16 MSG) in thickness or stainless steel not less than 1.09 mm (No. 18 MSG) in thickness.



20.1.8 Smoke Exhaust fans shall be capable of operating effectively at 400°C for 2 hours.

20.2 In kitchens where vertical fire barriers are penetrated, the ducts shall be enclosed in a continuous enclosure extending from the first penetrated fire barrier and any subsequent fire barriers or concealed spaces to or through the exterior, to maintain the fire resistance rating of the highest fire barrier penetrated. [See Figure 10.16, 10.17, 10.18 and 10.19](#) for illustrations.

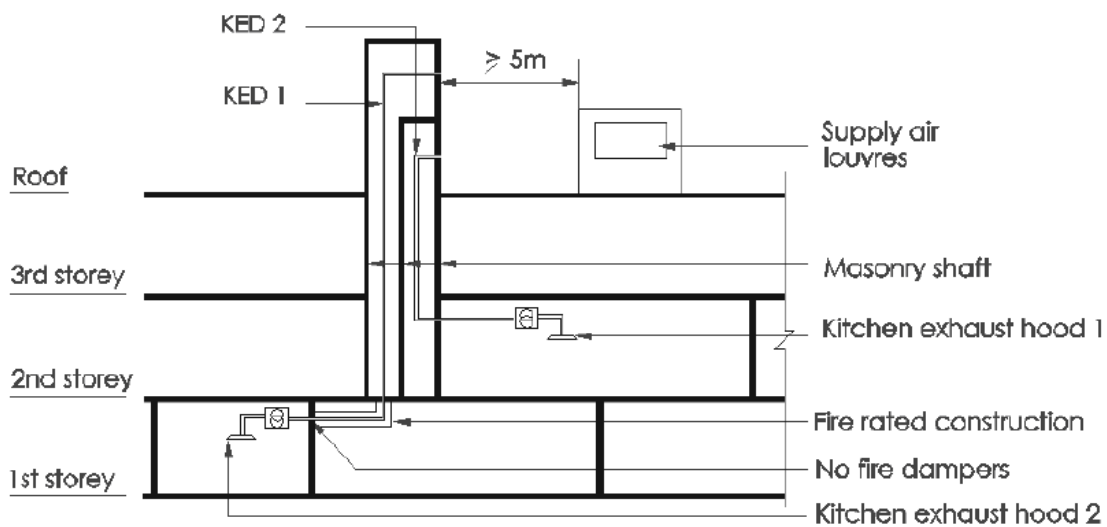


Figure 10.16: Ducting for individual kitchen

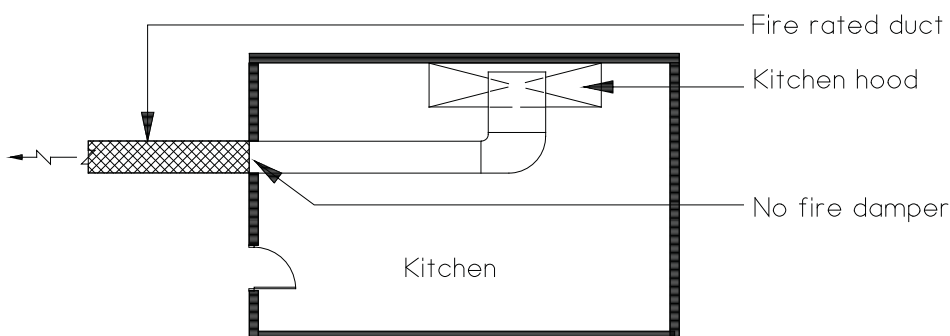


Figure 10.17: protection for duct penetration from kitchen



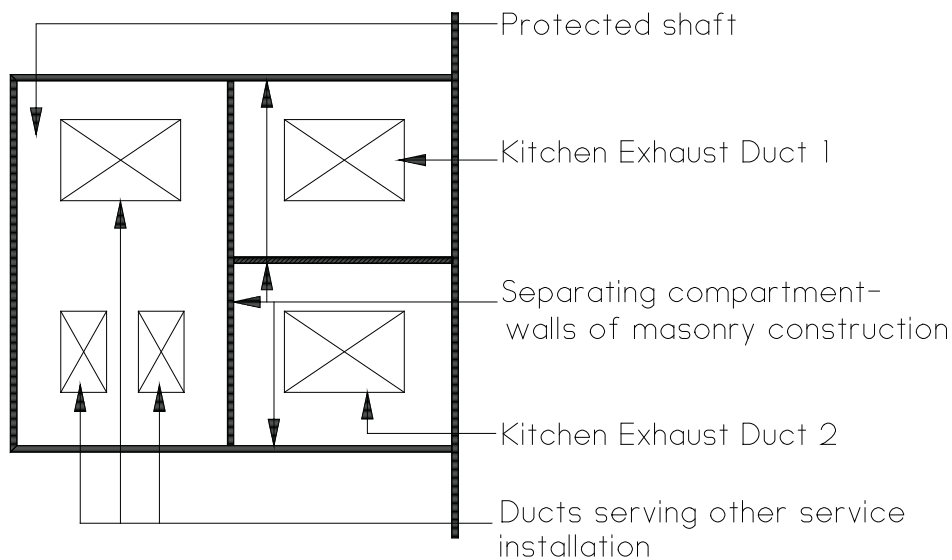


Figure 10.18: Separated vertical shaft for kitchen exhaust duct

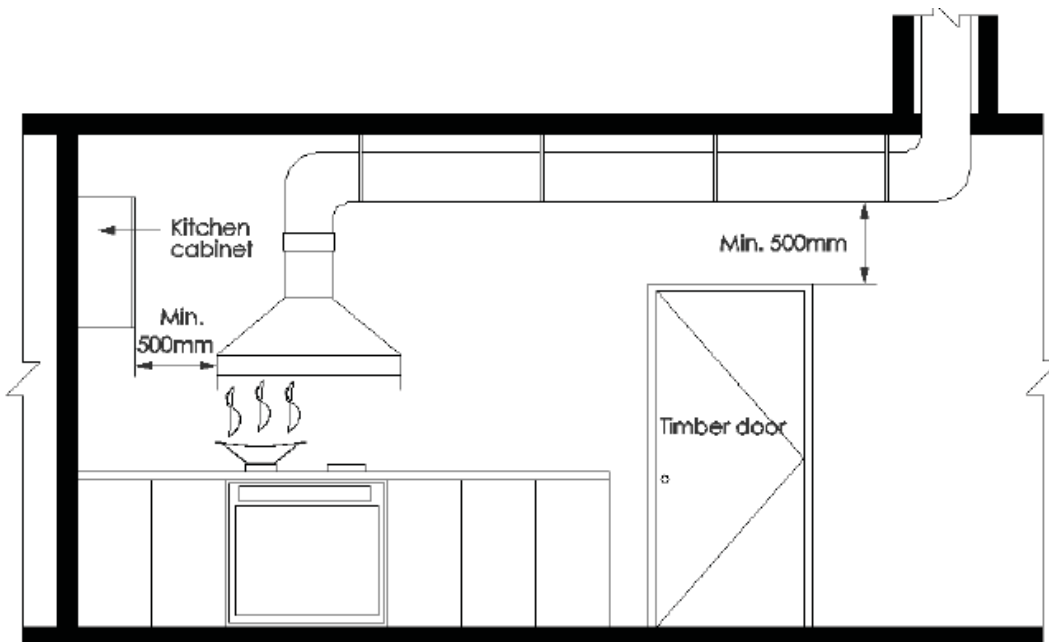


Figure 10.19: Minimum distance between heat source and combustibles.



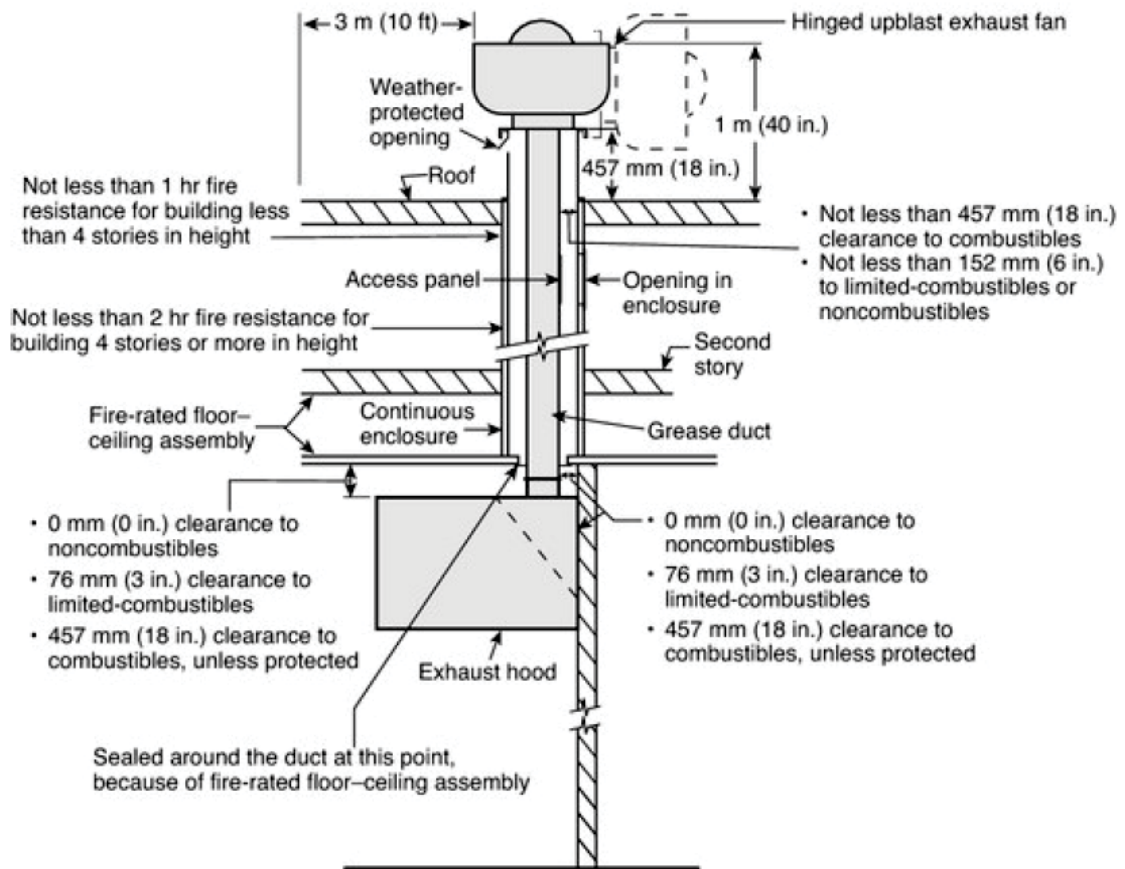


Figure 10.20 - Typical Cooking Exhaust System

- 20.3** The continuous enclosure provisions shall not be required where a field-applied grease duct enclosure or a factory-built grease duct enclosure is protected with a listed duct-through-penetration protection system equivalent to the fire resistance rating of the assembly being penetrated, and where the materials are installed in accordance with the conditions of the listing and the manufacturer's instructions.

21. Industrial Building & Storage Smoke Ventilation

21.1 Sprinklered Buildings

- 21.1.1** Automatic roof vents and draft curtains shall not be provided in the sprinklered buildings. Manually operated smoke vents and draft curtains should be provided in the sprinklered buildings.

21.2 Nonsprinklered Buildings

- 21.2.1** Automatic roof vents and draft curtains shall be provided in the nonsprinklered buildings. Vent systems shall be designed in accordance with this standard by



calculating the vent area required to achieve a mass rate of flow through the vents that equal the mass rate of smoke production.

- 21.3** Draft curtains shall be constructed of noncombustible or limited-combustible materials in buildings of Type I or Type II construction as defined by NFPA 220, Standard on Types of Building Construction, and shall be designed and constructed to resist the passage of smoke.

22. Assembly Occupancy Building Smoke Ventilation

- 22.1** Regular stages greater than 93 m² and legitimate stages shall be provided with emergency ventilation to provide a means of removing smoke and combustion gases directly to the outside in the event of a fire.
- 22.2** A means shall be provided to maintain the smoke level at not less than 1830 mm above the highest level of assembly seating or above the top of the proscenium opening where a proscenium wall and opening protection are provided. The smoke control system shall be activated independently by each of the following:
- i. Activation of the sprinkler system in the stage area
 - ii. Activation of smoke detectors over the stage area
 - iii. Operation of a manual switch at an approved location
- 22.3** The emergency ventilation system shall be supplied by both normal and standby power. The fan power wiring and ducts shall be located and properly protected to ensure a minimum of 20 minutes of operation in the event of activation.
- 22.4** Smoke Exhaust fans shall be capable of operating effectively at 400°C for 2 hours.

23. Smoke Control System

23.1 Exit Stair Enclosures

- 23.1.1** In any building of which the habitable height exceeds 23 m, any internal exit staircases without adequate provision for natural ventilation shall be pressurized to comply with the requirements in this Code.
- 23.1.2** Where a smoke-proof enclosure is also pressurized, the pressure at the exit staircase shall always be higher. See **Figure 10.21** for illustrations.

23.2 Flow velocity

- 23.2.1** When in operation, the pressurization system shall maintain airflow of sufficient velocity through open doors to prevent smoke from entering into the pressurized area.



- 23.2.2** The flow velocity shall be attained when a combination of two doors from any two successive stories and the main discharge door are fully open. Magnitude of the velocity averaged over the full area of each door opening shall not be less than 1.0 m/s. See [Figure 10.22](#) for illustrations.

23.3 Leakage and relief

- 23.3.1** The rate of supply of pressurized air to the pressurized areas shall be sufficient to make up for the loss through leakages into the unpressurised surroundings.
- 23.3.2** Adequate relief of leaked air out of the occupied area shall be provided to avoid a pressure build-up in this area. The relief may be in the form of perimeter leakages or purpose-built extraction systems.

23.4 Pressure Distribution

- 23.4.1** The number and distribution of injection points for supply of pressurizing air to the exit staircase should ensure an even pressure profile.
- 23.4.2** The arrangement of the injection points and the control of the pressurization system shall be design to restore variation in pressure difference as soon as practicable.
- 23.4.3** Supply air for pressurization system shall be drawn directly from the external and its intake shall not be less than 5 m from any exhaust discharge openings.
- 23.4.4** The pressurization system shall be automatically activated by the building fire alarm system. In addition, a remote manual start-stop switch shall be made available to firemen at the fire command centre, or at the fire indicating board where there is no fire command centre. Visual indication of the operation status of the pressurization system shall be provided.
- 23.5** Smokeproof enclosures using pressurization shall use an approved engineered system with a design pressure difference across the barrier of not less than 12.5 Pa in sprinklered buildings, or 25 Pa in nonsprinklered buildings, and shall be capable of maintaining these pressure differences under likely conditions of stack effect or wind. The pressure difference across doors shall not exceed that which allows the door to begin to be opened by a force of 133 N. See [Figure 10.23](#) for illustrations.
- 23.6** Equipment and ductwork for pressurization shall be located in accordance with one of the following specifications:
- Exterior to the building and directly connected to the enclosure by ductwork enclosed in noncombustible construction
 - Within the enclosure with intake and exhaust air vented directly to the outside or through ductwork enclosed by a 2-hour fire-resistive rating
 - Within the building under the following conditions:



- a. Where the equipment and ductwork are separated from the remainder of the building, including other mechanical equipment, by a 2-hour fire-resistive rating
 - b. Where the building, including the enclosure, is protected throughout by an approved, supervised automatic sprinkler system, and the equipment and ductwork are separated from the remainder of the building, including other mechanical equipment, by not less than a 1-hour fire-resistive rating
- 23.7** For pressurized enclosure systems, the activation of the systems shall be initiated by a smoke detector installed in an approved location within 3050 mm of each entrance to the smoke proof enclosure.
- 23.8** Manual activation and deactivation control of the stairwell pressurization systems shall be provided at the Emergency Command Centre.
- 23.9** A single-point injection system shall not be used where the stairwell height is more than eight stories. Stairwells more than 3 storeys above grade or 15m in height, whichever lower shall be provided with multiple-injection systems. See [Figure 10.24](#) for illustrations.
- 23.10** Staircase pressurization can be either bottom fed or top fed. See [Figures 10.24a](#) and [10.24b](#) for illustrations.
- 23.11** Pressurization of staircase shaft, lift shaft, lobbies and corridors for various occupancies shall be as per [Table 10.1](#). Examples of pressurization configuration for staircase shaft, lift shaft, lobbies and corridor can be seen in [Figure 10.25a](#) to [10.25i](#).

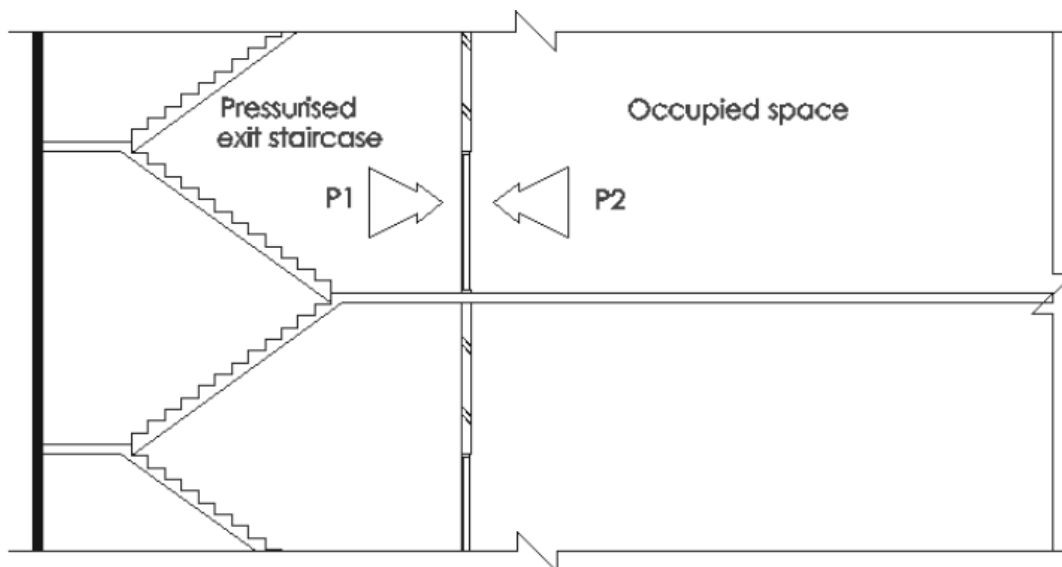


Figure 10.21: Pressure difference between staircase shaft and occupied area ($P_1 > P_2$)



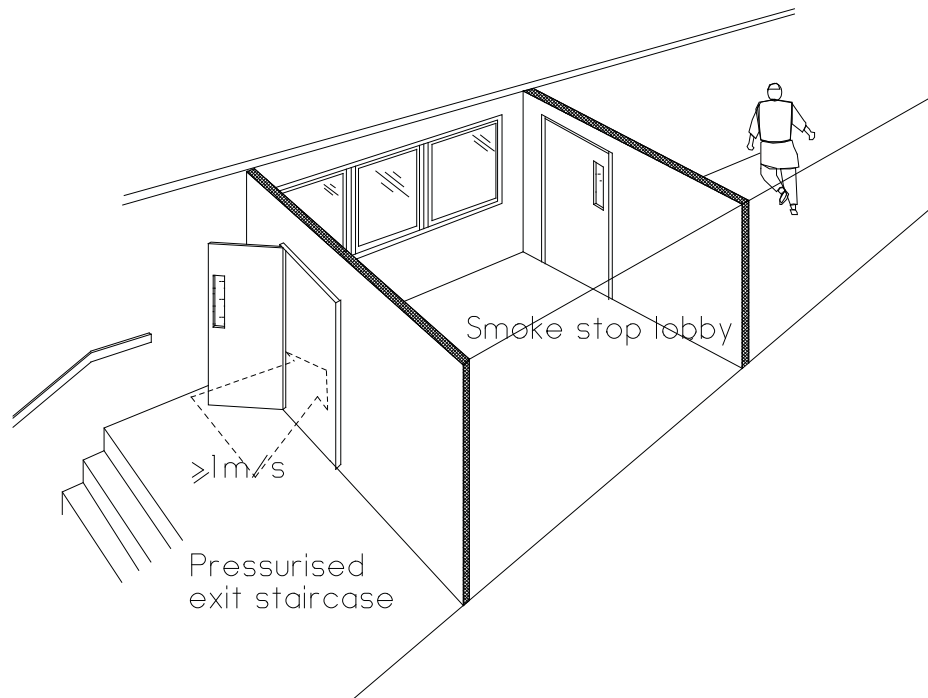


Figure 10.22: Air flow velocity across door opening

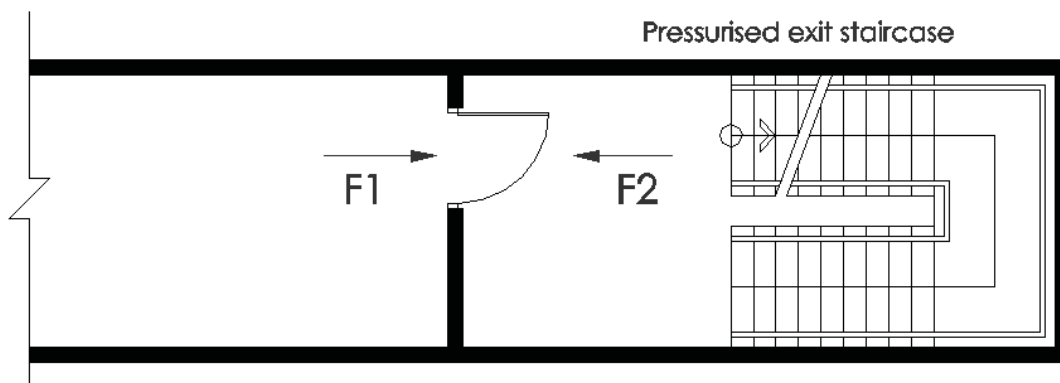


Figure 10.23: Force direction from staircase shaft and occupied space (Force to open the door, F1 shall not exceed 133Newtons)



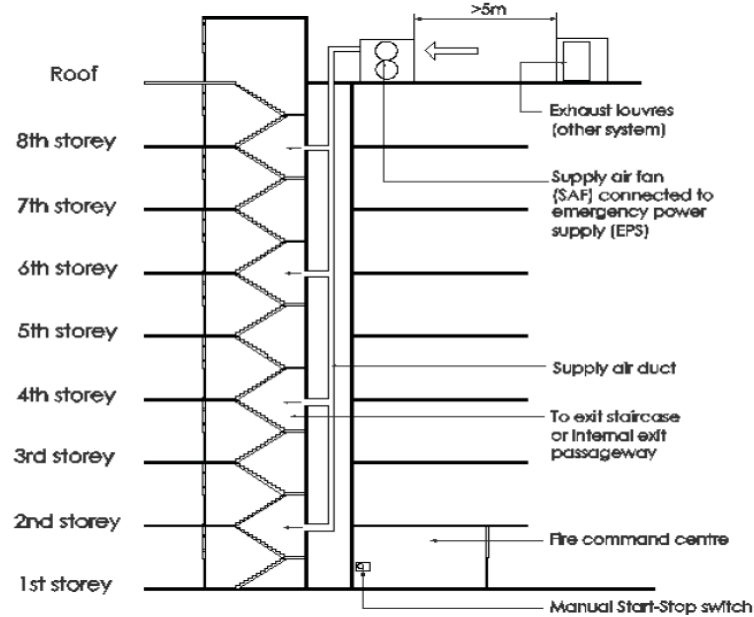


Figure 10.24: Multi level staircase pressurization inlet

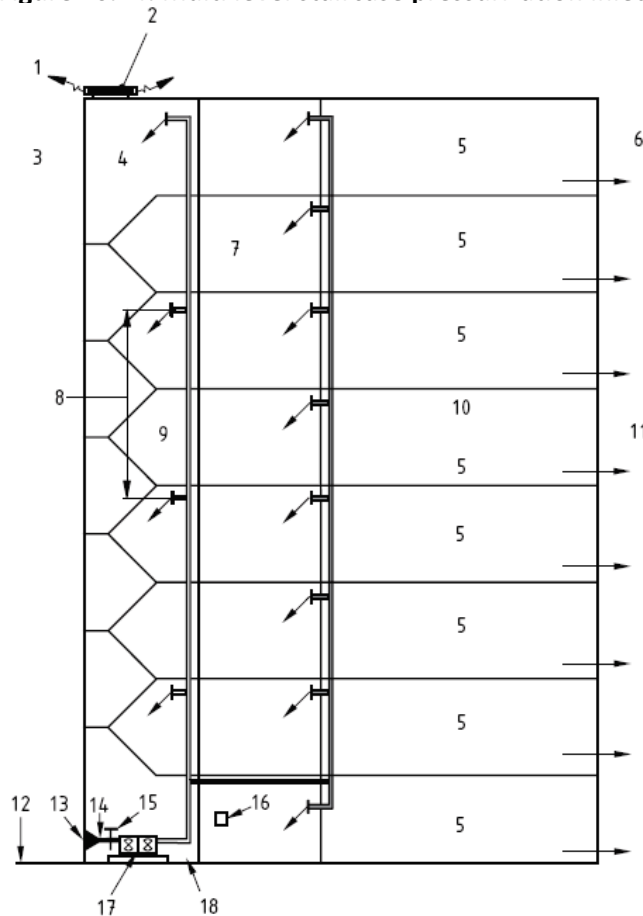


Figure 10.24a: Typical features of bottom fed staircase pressurization (See Notes on next page for descriptions of features)

Notes: for Figure 10.24a

1. An alternative option is to control the fan to ensure overpressure does not exceed 60 Pa max.
2. Pressure relief dampers set to operate at 60Pa (max) within the stairwell enclosure.
3. Pressurizing are discharged evenly throughout the stair height for building greater than 15m or 3 storeys above grade (Mid-rise buildings). A single discharge normally at the top of the stair is acceptable for buildings less than 15m.
4. Fire fighting stairs.
5. Accommodation.
6. External leakage.
7. Pressurizing air discharged at every lobby level.
8. Distance between air discharge to be no greater than three floor levels.
9. Firefighting lobby access.
10. Fire zone.
11. Air release vents.
12. Fire service access level.
13. Single air intake.
14. Smoke detector.
15. Motorized smoke damper.
16. Fire officers override switch.
17. Primary and back-up pressurizing air units.
18. Plant room that is protected by two-hour fire rated compartments and housing smoke pressurization fans.



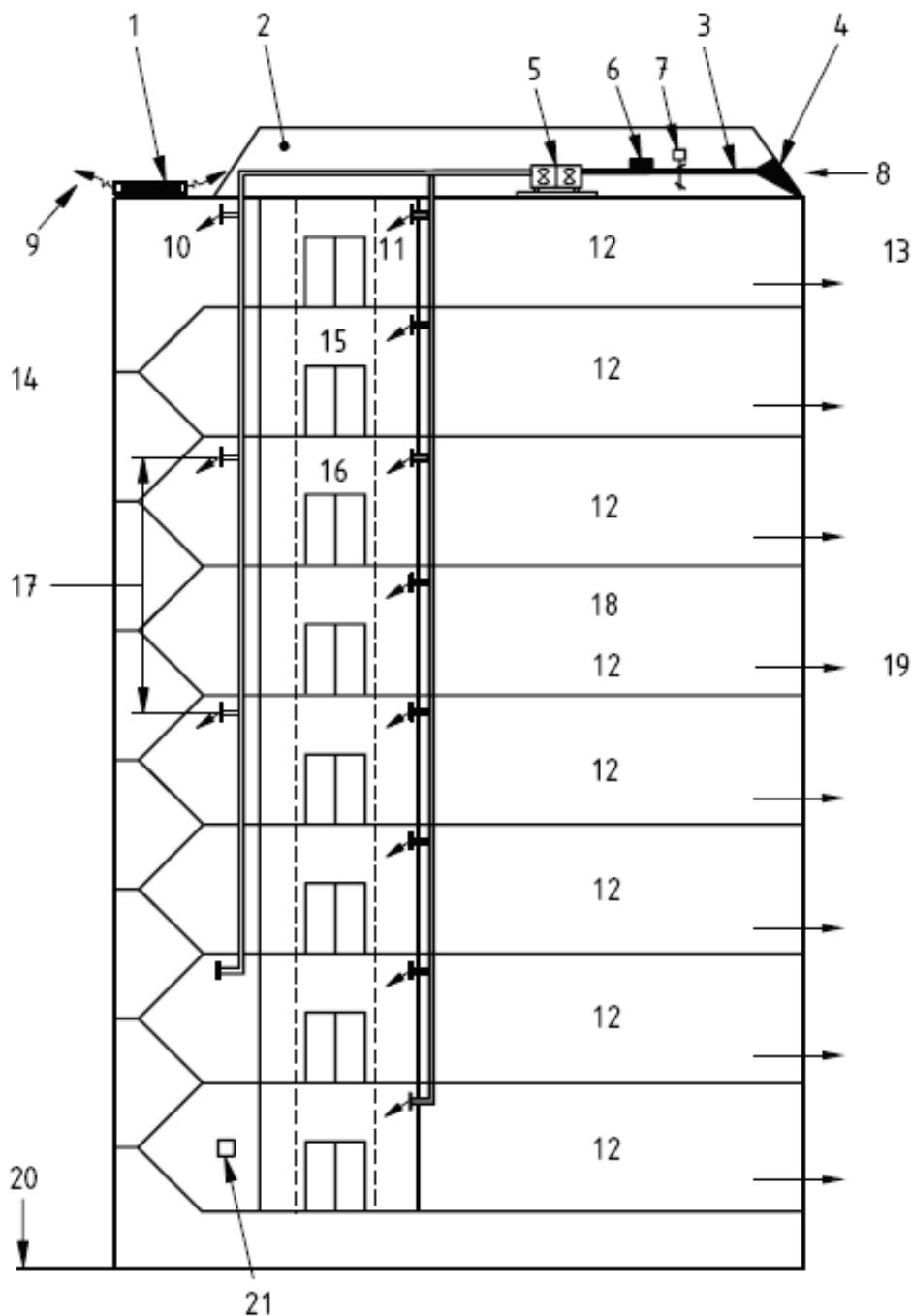


Figure 10.24b: Typical features of top fed staircase pressurization (See Notes on next page for descriptions of features)



Notes: for Figure 10.24b

1. Pressure relief dampers set to operate at 60 Pa (max) within the stairwell.
2. Plant room that is protected by two-hour fire rated compartments and housing smoke pressurization fans.
3. Smoke detector.
4. Twin air intakes to alternative facades of the building complete with smoke detector and motorised smoke damper.
5. Primary and back-up pressurizing air units.
6. Alternative air intake.
7. Motorised smoke damper.
8. Air intake.
9. An alternative option is to control the fan to ensure over-pressure does not exceed 60 Pa max.
10. Firefighting stairs.
11. Firefighting lift well.
12. Accommodation.
13. External leakage.
14. Pressurizing air discharged evenly throughout the stair height for building greater than 15m or 3 storeys above grade (Mid-rise buildings). A single discharge normally at the top of the stair is acceptable for buildings less than 15m.
15. Firefighting lobby.
16. Pressurizing air discharged at every lobby level.
17. Distance between air discharge to be no greater than three floor levels.
18. Fire zone.
19. Air release vent.
20. Fire service access level.
21. Fire officers override switch.



Note:

- 1 = Staircase
- 2 = Lobby
- 3 = Accommodation
- 4 = Supply Air
- 5 = Leakage path through doors
- 6 = Air release path through building
- P = Pressurized space

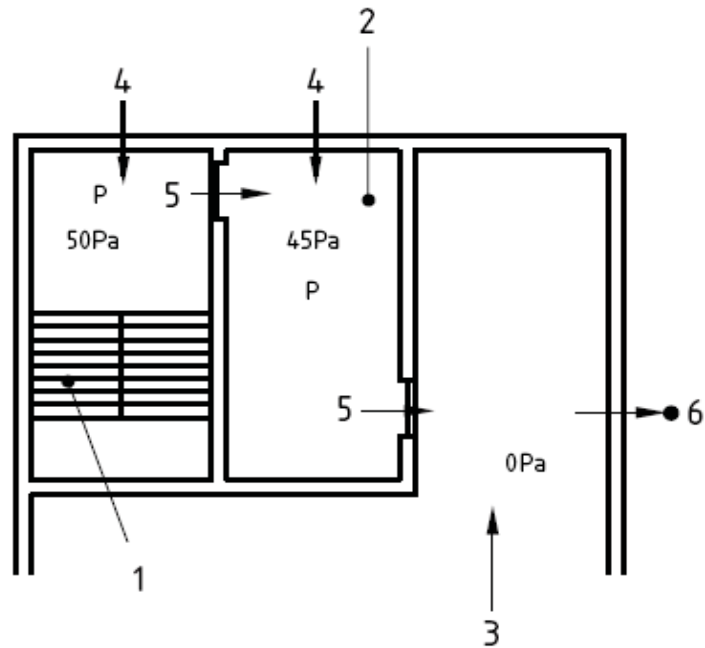


Figure 10.25a: Pressurization to Staircase shaft with lobby

Note:

- 1 = Staircase
- 3 = Accommodation
- 4 = Supply Air
- 5 = Leakage path through doors
- 6 = Air release path through building
- P = Pressurized space

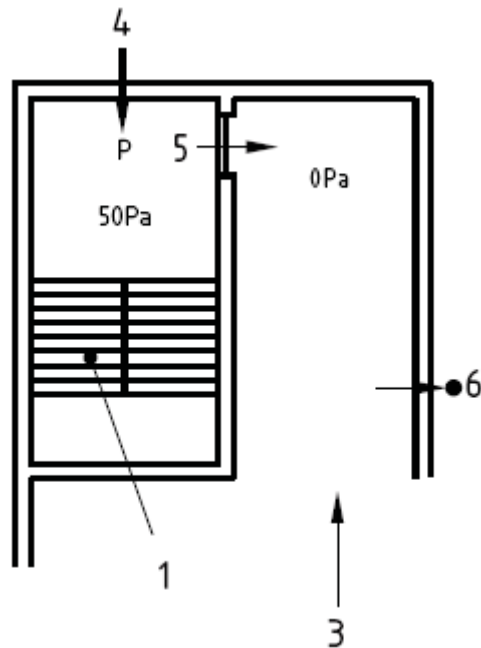


Figure 10.25b: Pressurization to staircase shaft without lobby

Note:

- 1 = Staircase
- 2 = Lobby
- 3 = Accommodation
- 4 = Supply Air
- 5 = Leakage path through doors
- 6 = Air release path through building
- 8 = Lift
- P = Pressurized space

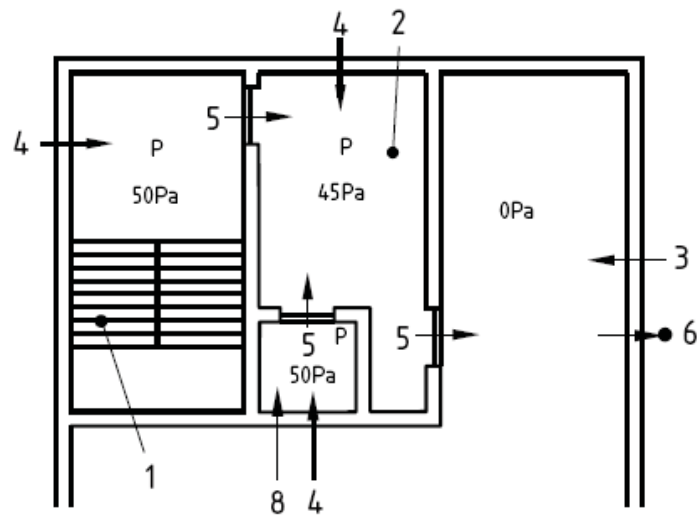


Figure 10.25c: Pressurization to staircase lobbies and lift shaft (these arrangements are provisions for fire fighting staircase, fighting lift and fire fighting lobby)

Note:

- 1 = Staircase
- 3 = Accommodation
- 4 = Supply Air
- 5 = Leakage path through doors
- 6 = Air release path through building
- 7 = Corridor
- 8 = Lift

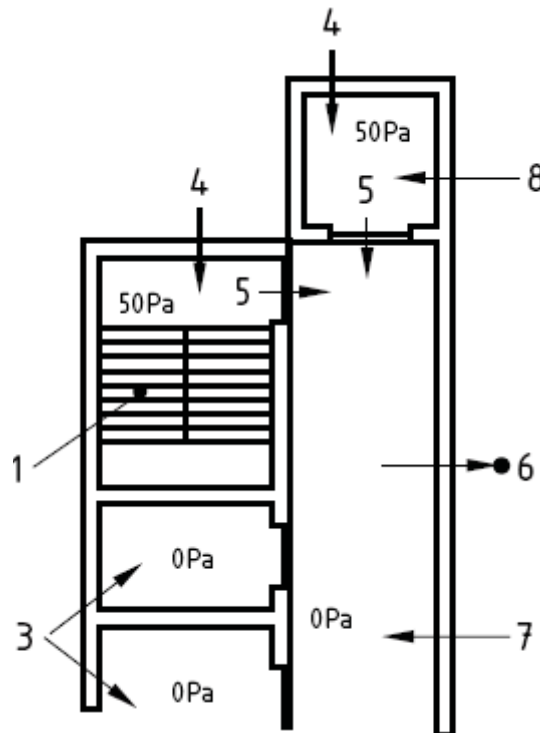


Figure 10.25d: Pressurization to staircase shaft and lift shaft

Note:

- 1 = Staircase
- 3 = Accommodation
- 4 = Supply Air
- 5 = Leakage path through doors
- 6 = Air release path through building
- 7 = Corridor
- 8 = Lift
- P = Pressurized space

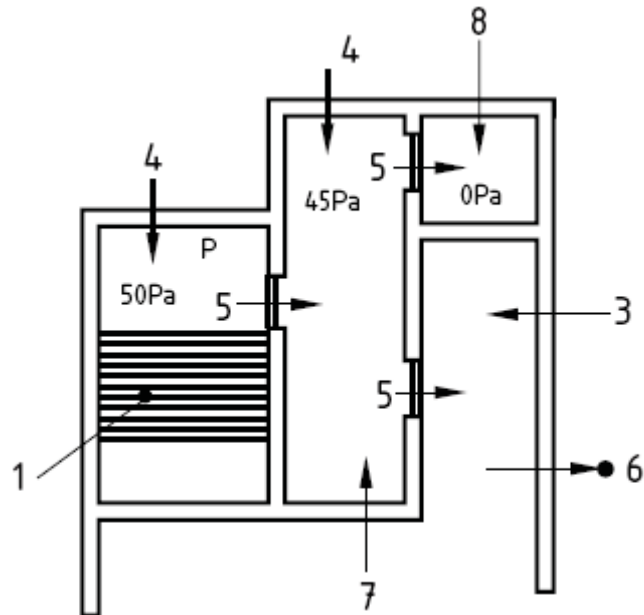


Figure 10.25e: Pressurization to stairs and corridors

Note:

- 1 = Staircase
- 3 = Accommodation
- 4 = Supply Air
- 5 = Leakage path through doors
- 6 = Air release path through building
- 7 = Corridor
- 8 = Lift
- P = Pressurized space

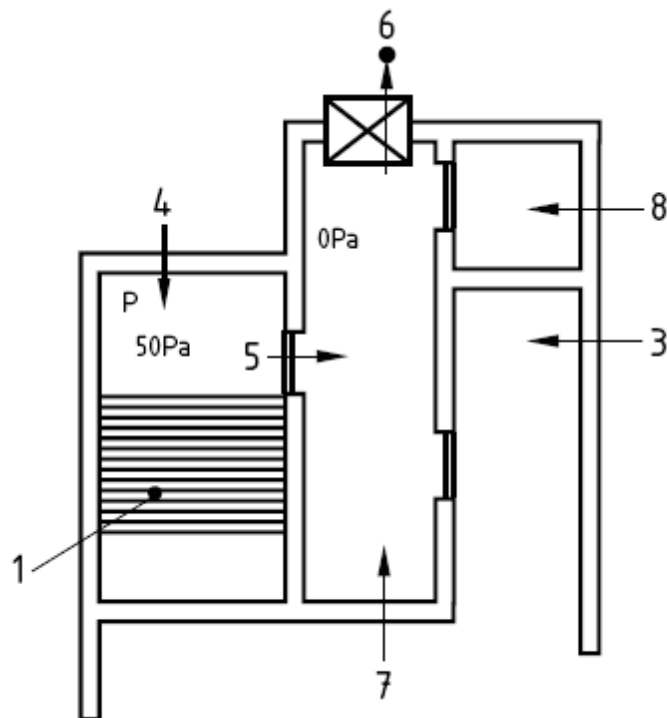


Figure 10.25f : Pressurization to staircase shaft and air release in corridors

Note:

- 1 = Staircase**
- 2 = Lobby**
- 3 = Accommodation**
- 4 = Supply Air**
- 5 = Leakage path through doors**
- 6 = Air release path through building**
- 7 = Corridor**
- 8 = Lift**
- P = Pressurized space**

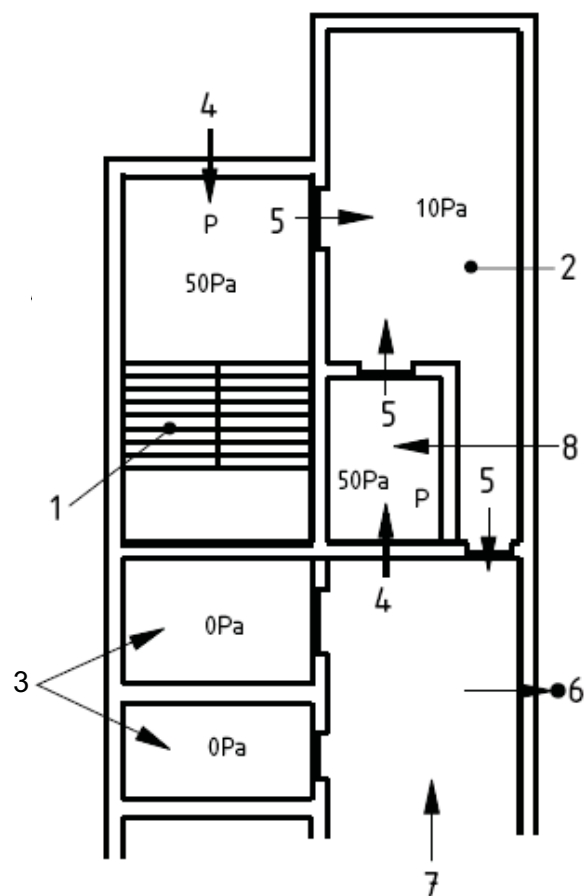


Figure 10.25g : Pressurization to staircase shaft and lift shaft



Note:

- 1 = Staircase
- 2 = Lobby
- 3 = Accommodation
- 4 = Supply Air
- 5 = Leakage path through doors
- 6 = Air release path through building
- 7 = Corridor
- P = Pressurized space

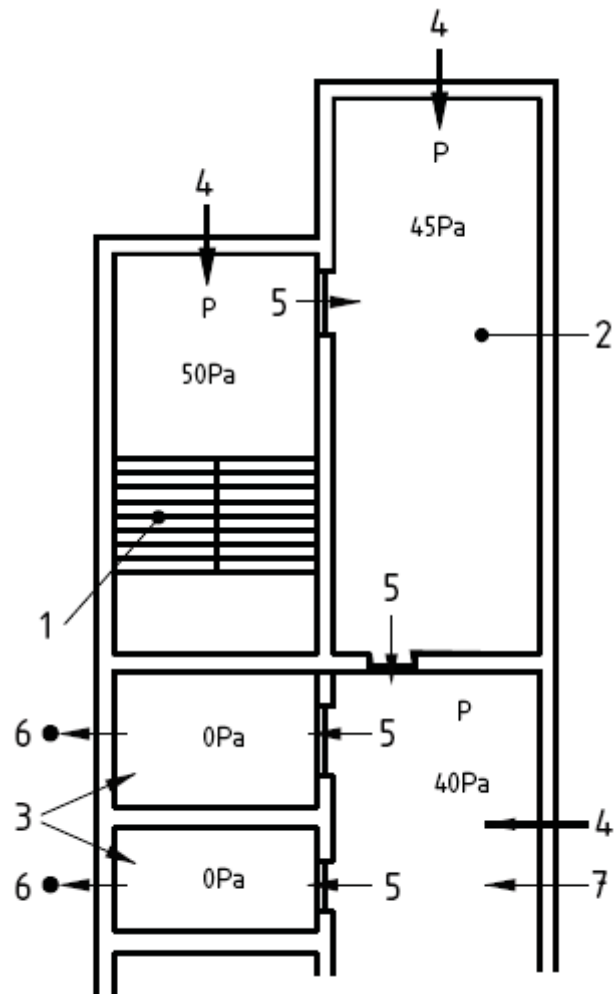


Figure 10.25h: Pressurization to staircase shaft associated lobbies and corridors



Note:

- 1 = Staircase
- 2 = Lobby
- 3 = Accommodation
- 4 = Supply Air
- 5 = Leakage path through doors
- 6 = Air release path through building
- 7 = Corridor
- P = Pressurized space

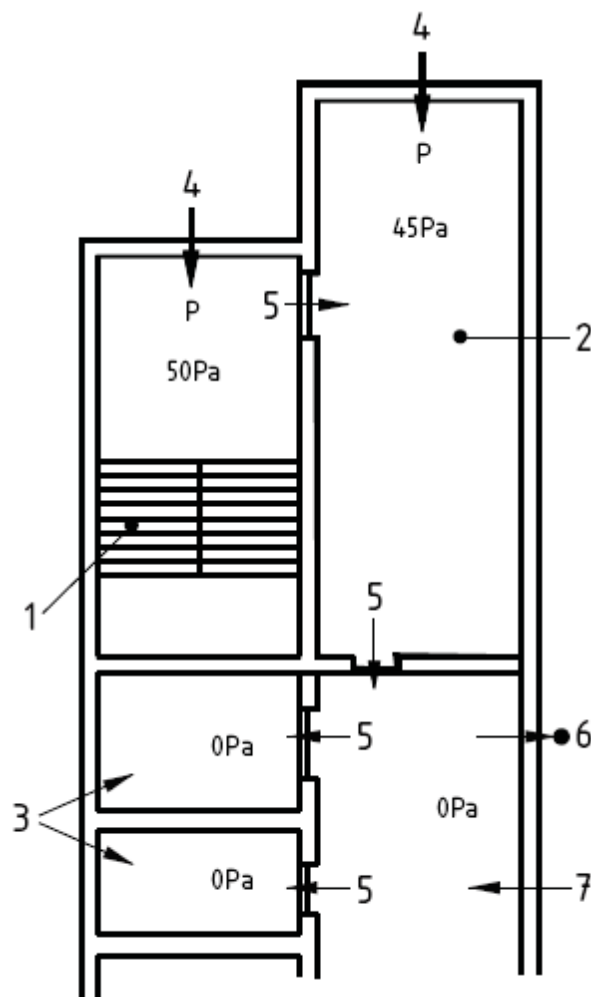


Figure 10.25i: Pressurization to stairs and associated release from corridors



24. Elevators.

- 24.1** Elevator machine rooms that contain solid-state equipment for elevators, having a travel distance exceeding 15 m above the level of exit discharge, or exceeding 9150 mm below the level of exit discharge, shall be provided with independent ventilation or air-conditioning systems to maintain temperature during fire fighters' emergency operations for elevator operation. The operating temperature shall be established by the elevator equipment manufacturer's specifications.
- 24.2** When standby power is connected to the elevator, the elevator equipment, elevator communications, elevator machine room cooling, and elevator controller cooling shall be supplied by both normal and standby power.
- 24.3** Wiring for power and control shall be located and properly protected to ensure a minimum 1 hour of operation in the event of a fire.
- 24.4** Conveyors, elevators, dumbwaiters, and pneumatic conveyors serving various stories of a building shall not open to an exit enclosure.
- 24.5** Every floor served by the elevator shall have an elevator lobby. Barriers forming the elevator lobby shall have a minimum 1-hour fire resistance rating and shall be arranged as a smoke barrier.
- 24.6** Elevator lobby door assemblies shall have a minimum 1-hour fire protection rating. The transmitted temperature end point shall not exceed 250°C above ambient at the end of 30 minutes of the fire exposure. Elevator lobby door leaves shall be self-closing or automatic-closing.
- 24.7** The elevator lobby door leaves shall close in response to a signal from a smoke detector located directly outside the elevator lobby adjacent to or on each door opening. Elevator lobby door leaves shall be permitted to close in response to a signal from the building fire alarm system.
- 24.8** Where one elevator lobby door leaf closes by means of a smoke detector or a signal from the building fire alarm system, all elevator lobby door leaves serving that elevator evacuation system shall close.
- 24.9** Two-way communication systems shall be provided between elevator lobbies and a central control point and between elevator cars and a central control point. Communications wiring shall be protected to ensure a minimum 1 hour of operation in the event of fire.



25. Ventilation Requirements for Internal Corridors and Exit Staircases.

- 25.1** High-rise hotels corridors shall be provided with zone smoke control system (pressure sandwich system). The pressure within such corridors shall be higher than that in the guest rooms and the pressure within the internal exit staircases higher than that of the corridors.
- 25.2** The smoke zone exhaust shall discharge to the outside of the building. Design of the smoke zone exhaust system shall include an engineering analysis of the stack and wind effects.
- 25.3** Floor- or zone-dependent smoke control systems shall be automatically activated by sprinkler water flow or smoke detection systems (whichever initiated first). Means for manual operation of smoke control systems shall be provided at an approved location.
- 25.4** The mode of ventilation based on types of occupancies for the internal corridors and staircases shall be in accordance with [Table 10.1](#) below. See [Figures 10.26 to 10.31](#) for illustrations and examples.
- 25.5** Smoke removal system for firefighting operation shall be provided where there are no natural ventilation openings or where there no operable panels or windows.
- 25.6** Naturally ventilated internal corridor shall be by fixed ventilation openings in an external wall and such ventilation openings being not less than 15 % of the floor area of the internal corridor.
- 25.7** Natural ventilation opening shall not be more than 9m from any part of the internal corridor.
- 25.8** Mechanically ventilated internal corridor shall have a purging rate of at least 6 air changes per hour.
- 25.9** Smoke extract fans shall be capable of operating effectively at 400°C for 2 hours. See [Figures 10.32 and 10.33](#) for illustrations on smoke extract configuration.



Table 10.1: Smoke Control System requirements criteria for various types of Buildings.

OCCUPANCY WITH SLEEPING RISK	MORE THAN 23M BUILDING HEIGHT (HIGH RISE)	15M TO 23M BUILDING HEIGHT (MID RISE)	LESS THAN 15M BUILDING HEIGHT (LOW RISE)	LESS THAN 2 BASEMENT OR LESS THAN 7M DEEP (LOW DEPTH)	MORE THAN 2000M ² PER BASEMENT AREA OR MORE THAN 2 BASEMENT OR MORE THAN 7M DEEP (HIGH DEPTH)
Hotels	CSC and SP	SP and CMV	CMV or CNV and SMV or SNV	SMV and CMV	SP and CSC
Residential Apartment	CSC and SP	SMV and CMV	CMV or CNV and SMV or SNV	SMV and CMV	SP and CSC
Staff Accommodation	CSC and SP	SMV and CMV	CMV or CNV and SMV or SNV	SMV and CMV	SP and CSC
Labor Accommodation	CSC and SP	SMV and CMV	CMV or CNV and SMV or SNV	SMV and CMV	SP and CSC
Health Care	CSC and SP	SP and CMV	CMV or CNV and SMV or SNV	SMV and CMV	SP and CSC
Detention and Correctional	CSC and SP	SMV and CMV	CMV or CNV and SMV or SNV	SMV and CMV	SP and CSC
Animal Housing	CSC and SP	CMV or CNV and SMV or SNV	CMV or CNV and SMV or SNV	SMV and CMV	SP and CSC
Commercial Group Villas	CSC and SP	CMV or CNV and SMV or SNV	CMV or CNV and SMV or SNV	SMV and CMV	SP and CSC
Private Villas	CSC and SP	CMV or CNV and SMV or SNV	CMV or CNV and SMV or SNV	SNV or SMV and CNV or CMV	SMV and CMV
Occupancy Without Sleeping Risk	MORE THAN 23M BUILDING HEIGHT (HIGH RISE)	15M TO 23M BUILDING HEIGHT (MID RISE)	LESS THAN 15M BUILDING HEIGHT (LOW RISE)	LESS THAN 2 BASEMENT OR LESS THAN 7M DEEP (LOW DEPTH)	MORE THAN 2000M ² PER BASEMENT AREA OR MORE THAN 2 BASEMENT OR MORE THAN 7M DEEP (HIGH DEPTH)
Business Offices	CSC and SP	CMV and SMV	CMV or CNV and SMV or SNV	SMV and CMV	SP and CSC
Assembly	CSC and SP	CSC and SP	CMV or CNV and SMV or SNV	SMV and CMV	SP and CSC
Malls	CSC and SP	CSC and SP	CMV or CNV and SMV or SNV	SMV and CMV	SP and CSC
Educational (Schools)	CSC and SP	CMV and SMV	CMV or CNV and SMV or SNV	SMV and CMV	SP and CSC
Day Care	CSC and SP	CMV and SMV	CMV or CNV and SMV or SNV	SMV and CMV	SP and CSC
Mercantile	CSC and SP	CMV and SMV	CMV or CNV and SMV or SNV	SMV and CMV	SP and CSC
Mixed Occupancies	Based on the most stringent requirement				

Legend:
concept.

Corridor Smoke Control (Smoke Extraction or Pressurization) based on engineer's design and fire safety

- CSC
- CMV
- CNV
- SP
- SMV
- SNV
- Corridor Mechanical Ventilation
- Corridor Natural Ventilation
- Staircase Pressurization
- Staircase Mechanical Ventilation
- Staircase Natural Ventilation

Smoke removal system for firefighting operation shall be provided where there are no natural ventilation openings or where there are no operable panels or windows.

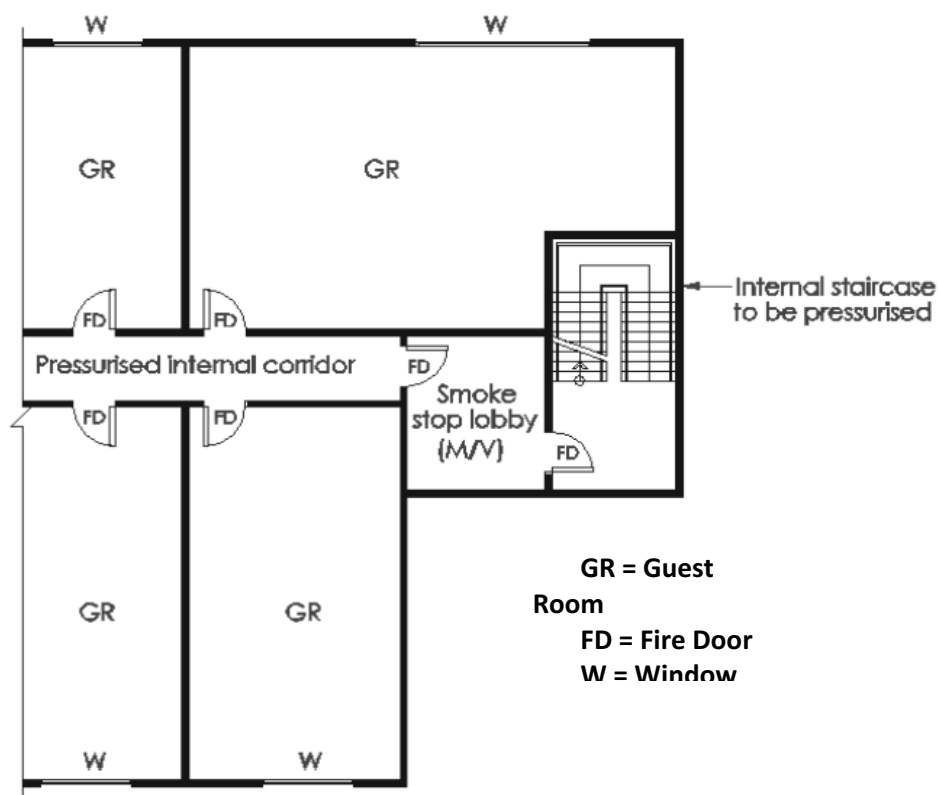


Figure 10.26: Pressurization of hotel internal corridor with mechanically ventilated lobby and pressurized staircase shaft (can be applied to high rise buildings)

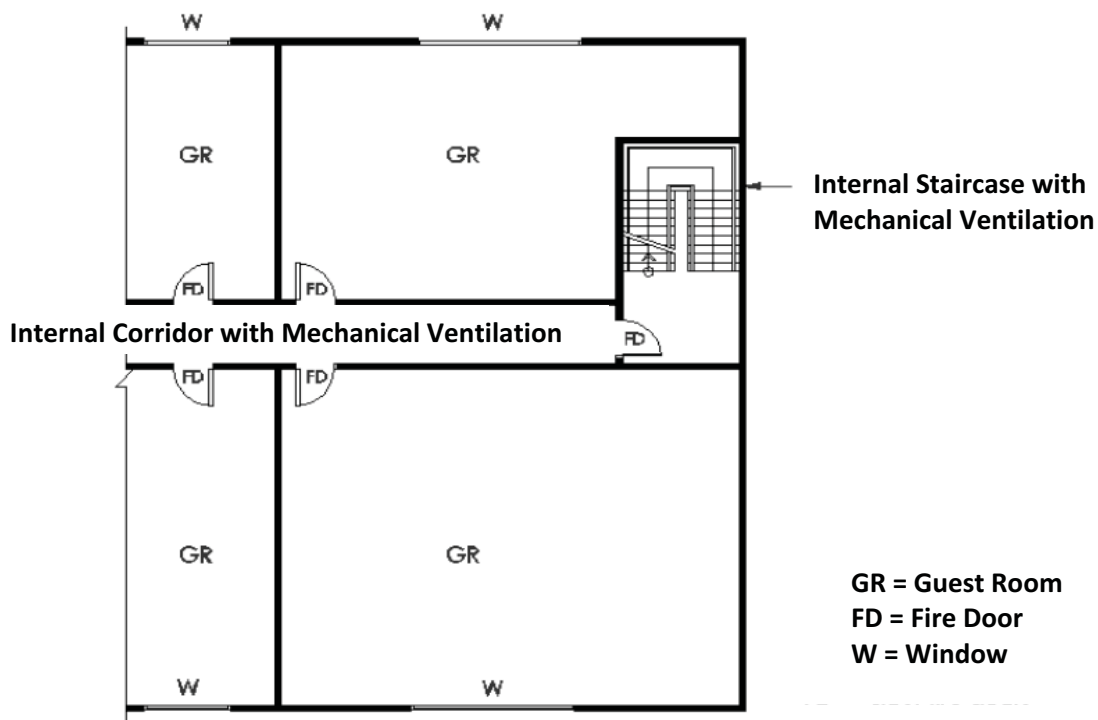


Figure 10.27: Hotel corridor and staircase with mechanical ventilation (can be applied to low rise buildings)

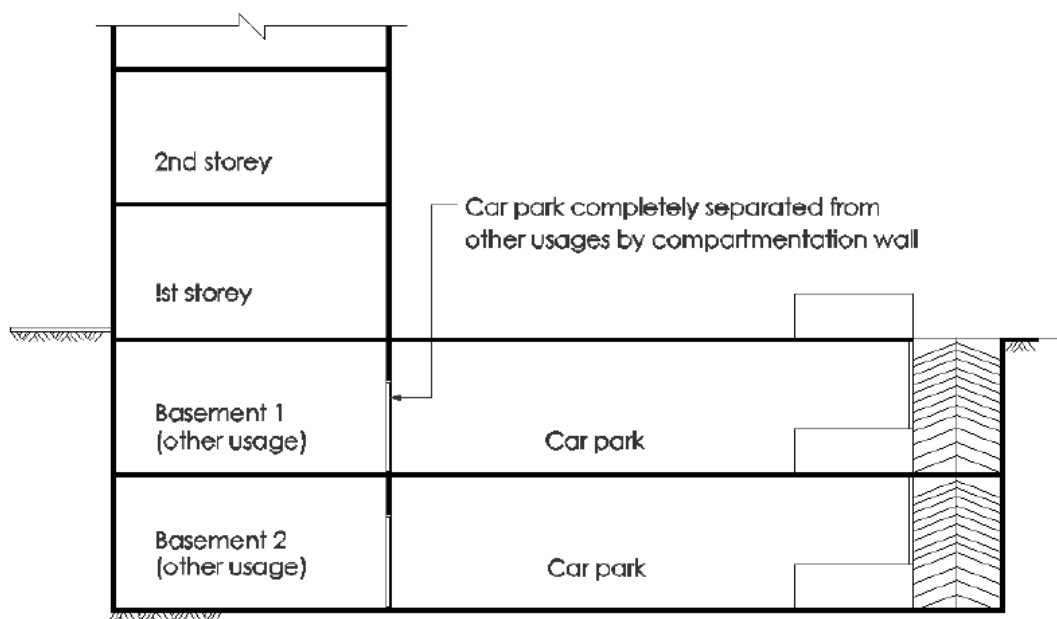


Figure 10.28: Low Depth hotel building which requires mechanically ventilated staircase and corridors

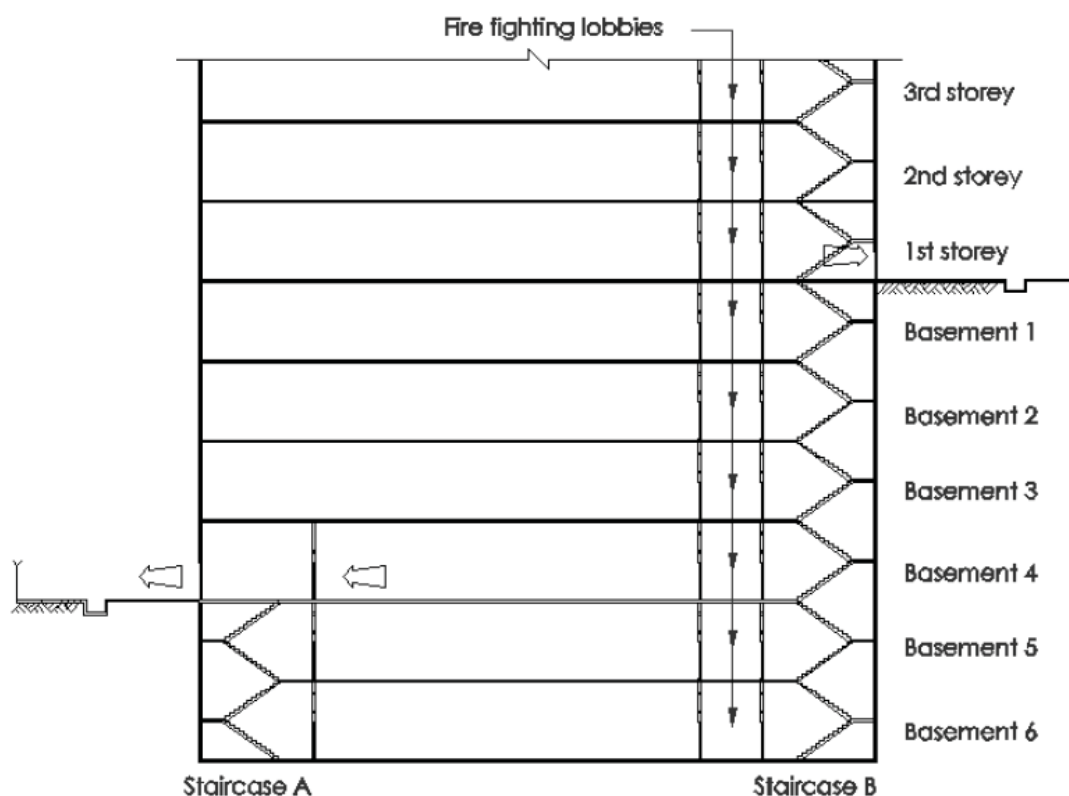


Figure 10.29: Low Depth requirements for Staircase A and High Depth requirements for Staircase B





This detailed floor plan illustrates the back-of-house areas of a restaurant. The layout includes a large **CAMPUS LOT** on the left, a **DRIVEWAY** at the top, and a **BOILER ROOM** with an adjacent **UFT LOBBY** and **FAN RM.** The central section features a **KITCHEN** with a **SERVERY** and **DISH-WASHING** area, along with **UFT** and **AMU** rooms. To the right is the **EMPLOYEE'S RECREATION AREA** and a **BACK OF HOUSE CORRIDOR** leading to **HOUSEKEEPING DEPT.**, **LAUNDRY**, **TRAINING ROOM**, and **TRAINERS OFFICE**. The bottom section contains a **PLANT ROOM**, **PUMP RM.**, **EMPLOYEE'S DINING**, and another **BACK OF HOUSE CORRIDOR** that provides access to restrooms (**FEMALE**, **MALE**), an **ADV. GEN. OFFICE**, **CASHIER**, **PANTRY**, **HEAD CONT.**, **SECURITY**, **UFT LOBBY**, **STORE**, **INTERVIEW RM.**, **PERSONNEL DEPT.**, **VIDEO RM.**, **OPERATOR**, **SYSTEMS MANAGER**, and a **COMPUTER SUITE**. The plan also shows a **STAFF ENTRANCE** and various utility rooms like **UFT** and **AMU**.



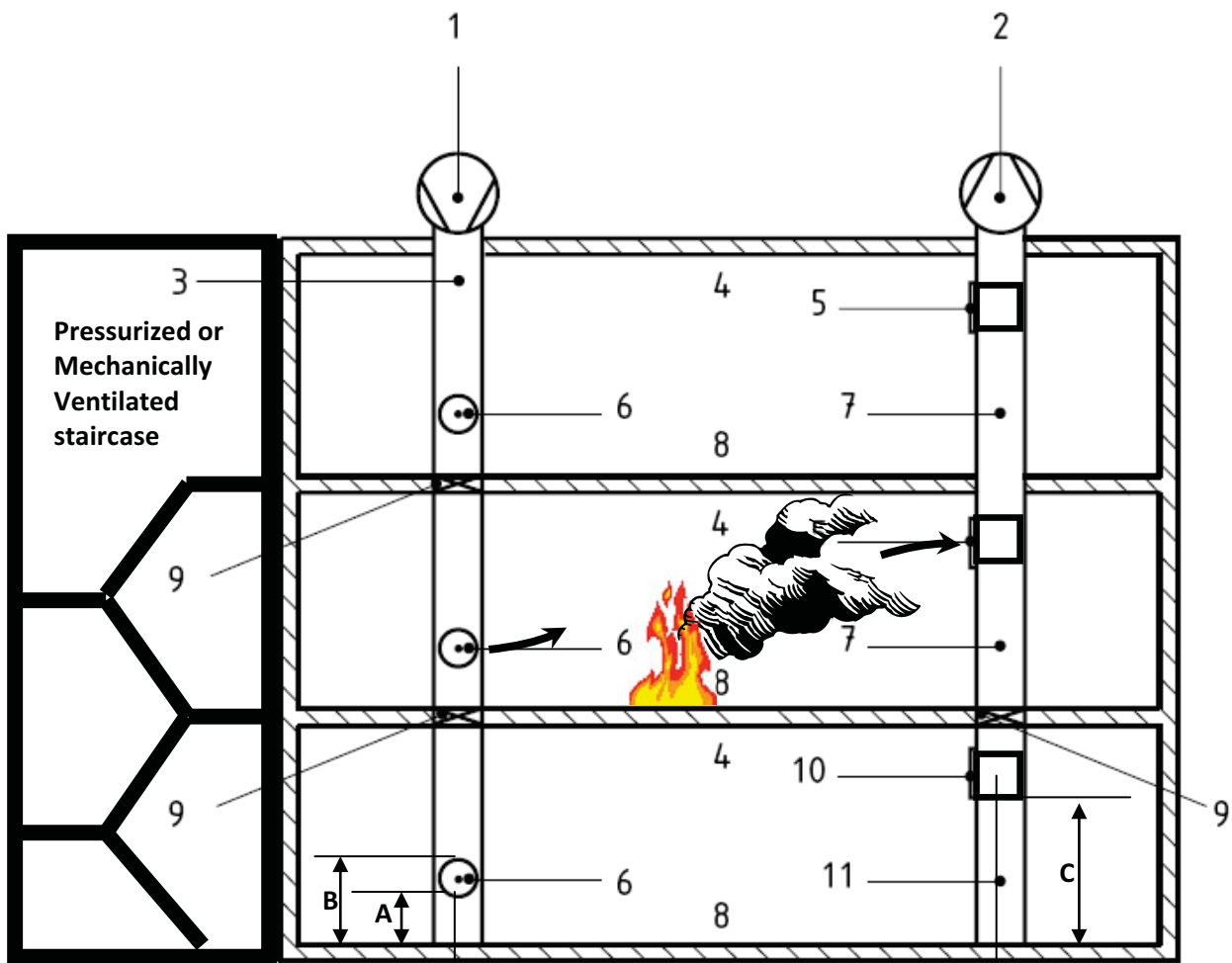


Figure 10.32: Typical Smoke extraction for internal corridor of high rise buildings with Pressurized staircase.

Notes: for Figure 10.32

- 1 = Fan supply air.
- 2 = Powered smoke and heat exhaust ventilator (extract fan).
- 3 = Supply air duct.
- 4 = Smoke reservoir.
- 5 = Fire resisting smoke control damper mounted on the surface of the duct.
- 6 = Air inlet.
- 7 = Fire resisting smoke extraction duct.
- 8 = Fire compartment.
- 9 = Fire damper.
- 10 = Submerged smoke control damper mounted on the surface of the duct.
- 11 = Submerged smoke extraction duct.
- A = $\geq 300\text{mm}$
- B = $\leq 1\text{m}$
- C = $\geq 1.83\text{m}$
- D = $\leq 15\text{m}$

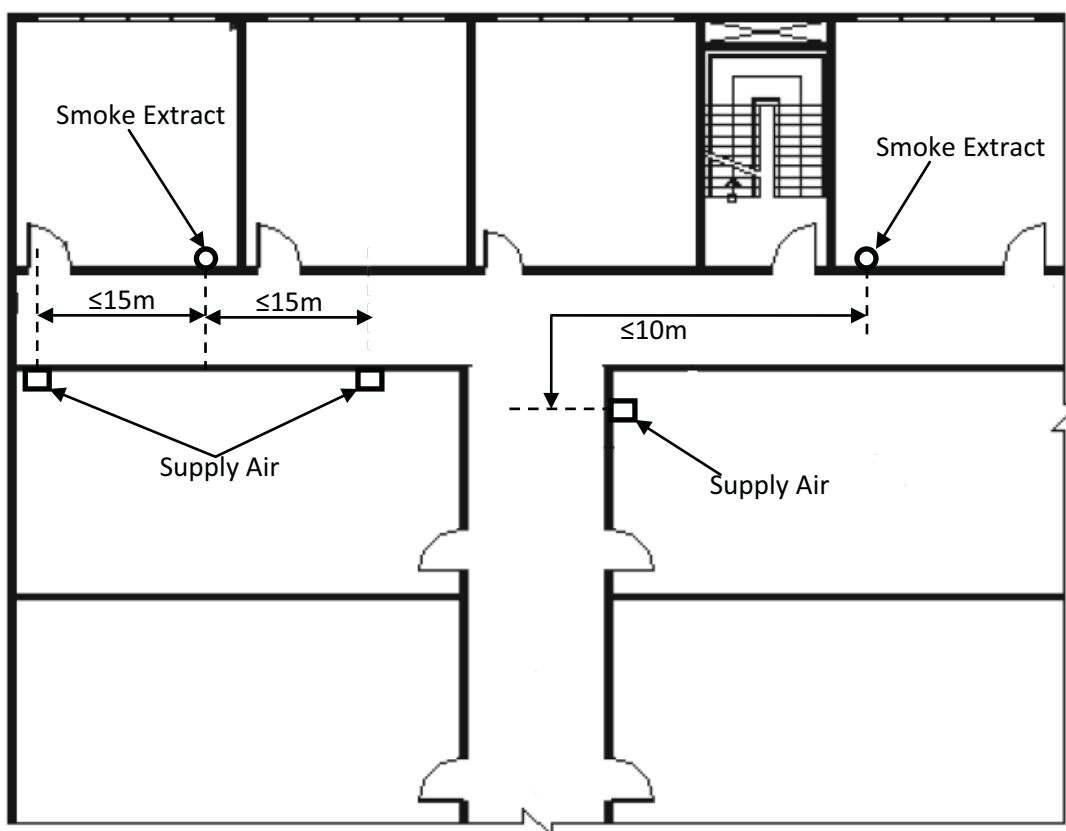


Figure 10.33: location of mechanical air supply inlets / smoke extraction outlets

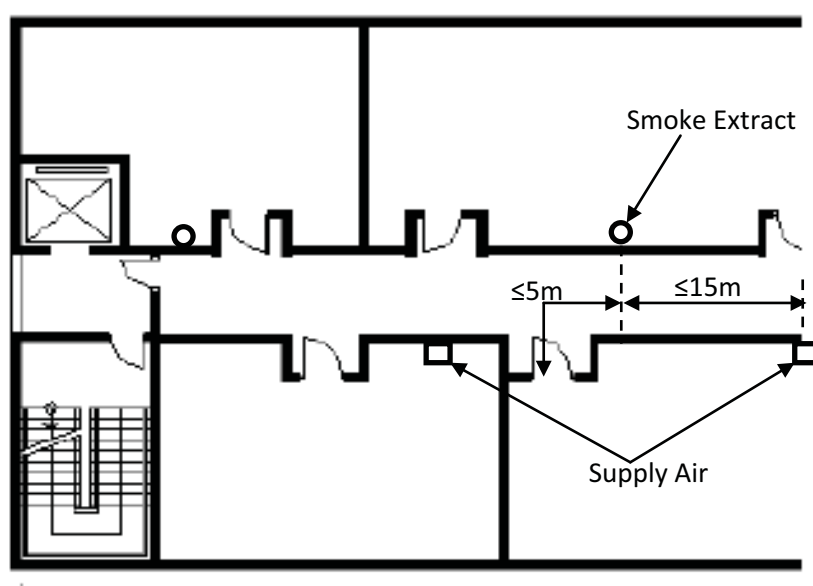


Figure 10.33a: location of door not located between air supply inlets and smoke extraction outlets



25.10 Mechanical smoke extraction in enclosed horizontal circulations must be carried out in accordance with the following rules:

25.10.1 Air supply inlets and smoke extraction outlets are distributed alternately, in staggered rows or not, by considering the localization of risks;

25.10.2 Smoke extraction outlets must have their lower part at least 1.830m above the floor and be located entirely within the higher third-part of the circulation; See **Figure 10.32** for illustrations.

25.10.3 Air supply inlets must have their lower part at least 300mm above the floor and their highest part at most 1m above the floor; they are preferably located in close proximity to firestop doors and access doors to staircases. If the air supply inlet is carried out through opening flaps, their free surface must be in the lower half of the premise; See **Figure 10.32** for illustrations.

25.10.4 The horizontal distance between supply and extraction, measured along the axis of circulation, should not exceed 15m in case of a rectilinear course and 10m in the contrary case. When a smoke extraction outlet is served by two air supply inlets, the distances between inlets/outlets must be equivalent. See **Figure 10.33** for illustrations.

25.10.5 Any door of a premise accessible to the public, not located between an air supply inlet and a smoke extraction outlet, must be at most 5m distant to one of them. See **Figure 10.33a** for illustrations.

25.10.6 Any section of a circulation in between a smoke extraction outlet and an air supply inlet must be swept by an extraction airflow at least equal to $0.5\text{m}^3/\text{s}$ per passage unit (round whole UP to the nearest value) in the circulation; however the total extraction airflow in a circulation (or a partitioned portion of a circulation) is limited to $8\text{ m}^3/\text{s}$;

25.10.7 During the smoke extraction system operation, the pressure gap in between the staircase and the circulation cleared from smoke must be lower than 50 Pa, all doors of the staircase being closed;

25.10.8 At the same level, several circulations or sections cannot be connected by the same ductwork, unless they make up only one smoke extraction zone.

25.11 Smoke extraction by mechanical extraction is carried out by mechanical smoke exhaust outlets and natural or mechanical air supply inlets laid out so as to ensure a correct sweeping of the concerned volume. This sweeping can be completed by setting a relative overpressure in areas to be protected from smoke.

25.12 If a room is ventilated continuously (air renewal, heating or air conditioning), the ventilation system can be used for smoke extraction provided that it adheres to the provisions of this chapter and that it does not interfere with the natural smoke movement. The presence of filters or sound attenuators is allowed on the supply ductwork.



- 25.13** Smoke extraction outlets are carried out through air outlets connected to an exhaust fan.
- 25.14** Mechanical air supply inlets are carried out through air inlets connected to a supply fan.
- 25.15** Natural air supply inlets are carried out either through:
- opening flaps in facade;
 - doors of the premises to be cleared from smoke and opening to the outside or volumes that can be ventilated with fresh air;
 - non-enclosed staircases;
 - air inlets.
- 25.16** Mechanical smoke extraction duct and mechanical air supply duct must have an efficient air tightness. Therefore, their total air leakage must be lower than 20% of the required flow considered at the most underprivileged level. Collective smoke extraction duct must be at a low pressure level.
- 25.17** Air velocity through air supply inlets must always be lower than 1.5 m/s. Natural air supply inlets must be designed for the overall extracted airflow. Mechanical air supply inlets must have airflow around 0.6 times the extracted airflow.
- 25.18** These various air inlets/outlets are equipped with closed dampers in their waiting position.
- 25.19** Supply and exhaust fans must be designed according to the connected ductwork features and the rated airflow increased by acceptable leakage (around 20%). The airflow measurement defined in the present technical instruction is carried out at ambient temperature. The fans must be operated by a relay box.
- 25.20** Exhaust fans and their duct connection must ensure their function during two hour with smoke at 400°C
- 25.21** The open or closed state of fans disconnecting switch must be reported to the security station or a frequently supervised station. This requirement is ensured by the relay box.
- 25.22** Exhaust fans must be installed either outside the building or in a technical premise separated from adjacent volumes by 1 hour degree fire resistant walls. The access door shall be 1/2 hour degree fire resistant and equipped with a door lock. The ventilation inside the premise shall be compatible with the operation of various equipments installed in this premise.
- 25.23** The control devices must ensure fans startup, within a maximum delay of 30 seconds in order to allow the operation of all activated security devices (dampers and doors) ensuring smoke extraction and partitioning of the smoke extraction zone.



- 25.24** Each smoke exhaust fan must be able to be shut down from the manual control location for security setting.

26. Malls and Atriums

- 26.1** Atrium spaces and Malls with a floor opening connecting more than two levels shall be provided with a smoke control system. See [Figure 10.34](#) for a typical atrium.
- 26.2** For atriums, an engineering analysis shall be performed that demonstrates that the building is designed to keep the smoke layer interface above the highest unprotected opening to adjoining spaces, or 1830 mm above the highest floor level of exit access open to the atrium, for a period equal to 1.5 times the calculated egress time or 20 minutes, whichever is greater.

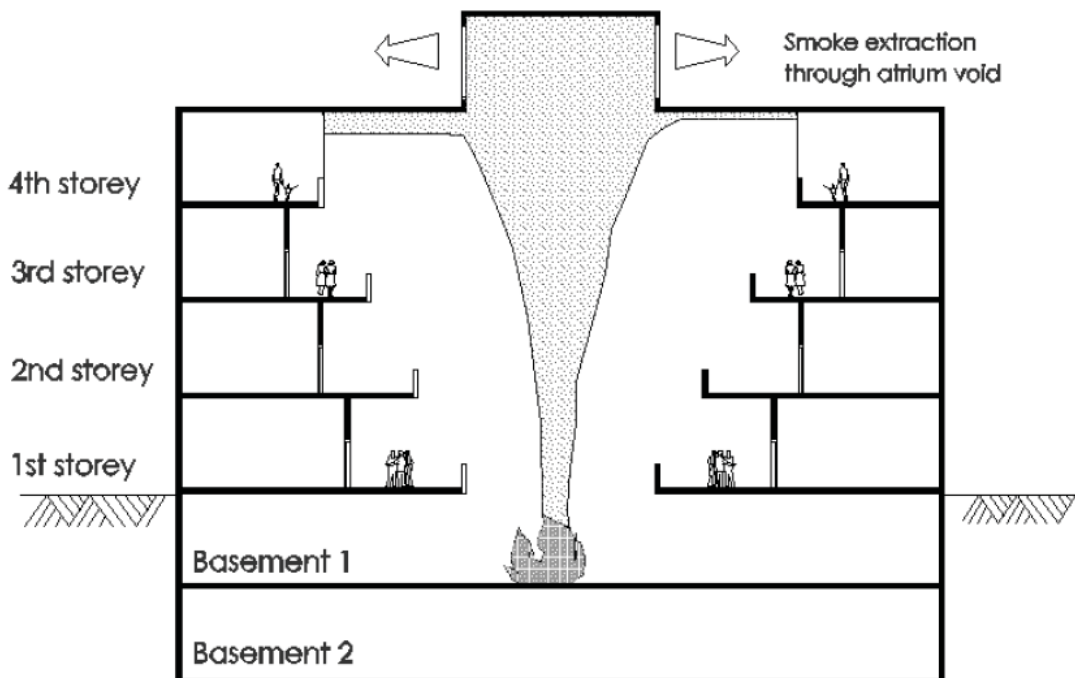


Figure 10.34 - Typical Atrium

27. Fire Engineering Analysis

- 27.1** Fire Engineering analysis should include the following elements:

- i. Fire dynamics
- ii. Fire size and location
- iii. Materials likely to be burning
- iv. Fire plume geometry



- v. Fire plume of smoke layer impact on means of egress
- vi. Tenability conditions during the period of occupant egress
- vii. Response and performance of building systems, including passive barriers, automatic detection and extinguishing, and smoke control
- viii. Response time required for building occupants to reach building exits, including any time required to exit through the atrium

27.2 For atriums, where an engineered smoke control system is installed to meet the above requirements, the system is independently activated by each of the following:

- i. Required automatic sprinkler system and smoke detectors (which ever activated first)
- ii. Manual controls that are readily accessible to the fire department

27.3 For large spaces where smoke stratification can occur, one of the following detection means shall be used:

- i. Beam-type smoke detector(s) aimed at an upward angle to intersect the smoke layer regardless of the level of stratification
- ii. Horizontally mounted beam-type smoke detector(s) located at the ceiling with additional beam-type smoke detector(s) located at other levels in the volume to cover any identified unconditioned (dead air) spaces
- iii. Horizontally mounted beam-type smoke detector(s) located below the lowest expected level of stratification

27.4 A means of manually starting and stopping the smoke management system shall be provided at the emergency command centre.

27.5 Smoke Exhaust fans shall be capable of operating effectively at 400°C for 2 hours.

27.6 Makeup air shall be provided by fans, openings to the outside leakage paths, or the combination thereof.

27.7 The supply points for the makeup air shall be located beneath the smoke layer interface.

27.8 Mechanical makeup air shall be less than the mass flow rate of the mechanical smoke exhaust.

27.9 It is recommended that makeup air be designed at 85 percent to 95 percent of the exhaust mass flow rate, not including the leakage through these small paths.



- 27.10** The makeup air shall not cause door-opening force to exceed allowable limits.
- 27.11** The makeup air velocity shall not exceed 1.02 m/s where the makeup air could come into contact with the plume unless a higher makeup air velocity is supported by engineering analysis.
- 27.12** Design fire load over 9.3 m² floor space shall be restricted to the following and shall be used in smoke engineering analysis:
 - a. For office building atrium, fire load shall be 2100 kW
 - b. For mercantile occupancies, fire load shall be 5275 kW
 - c. Malls and Atrium smoke engineering analysis shall be done by use of computer models.

28. Underground buildings

- 28.1** The underground portions of an underground structure shall be provided with approved mechanical ventilation system where the underground structure has the following features:
 - i. Occupant load of more than 100 persons in the underground portions of the structure
 - ii. Floor level used for human occupancy located more than 9140 mm below the lowest level of exit discharge, or more than one level located below the lowest level of exit discharge
 - iii. Combustible contents, combustible interior finish, or combustible construction

28.2 Basement Smoke Control System

- 28.2.1** Where the total aggregate floor area of all basement stories does not exceed 2000 m², automatic smoke vents shall be provided.
- 28.2.2** Where the total aggregate floor area of all basement stories exceeds 2000 m², engineered smoke control system shall be provided for all parts of basement with the following exceptions:
 - i. Where the basement or a portion of the basement is used as car park, provided it is compartmented from rest of the basement;
 - ii. Plant/equipment room with floor area not exceeding 250 m² and compartmented from rest of the basement, and provided with two doors for better reach in fire fighting operation.
- 28.2.3** Plant/equipment room with floor area exceeding 250 m² but not exceeding 2000 m², smoke vents or smoke purging system of at least 9 air-changes per hour shall be provided.



- 28.3** Service areas such as laundries, office, storeroom and workshops (restricted to staff only) which are compartmented with smoke venting or smoke purging system of at least 9 air-change per hour may be accepted for those areas in lieu of the engineered smoke control system. Automatic fire alarm/extinguishing system shall be provided where required.

28.4 Smoke Vents

- 28.4.1** Smoke vents shall be adequately distributed along perimeter of basement and their outlets shall be easily accessible during fire fighting and rescue operations. Installation shall comply with the following requirements:

- 28.4.2** The number and their sizes shall be such that the aggregate effective vent openings shall not be less than 2.5% of the basement floor area served.

- 28.4.3** The vent outlets if covered under normal conditions shall be operable in case of fire.

- 28.4.4** The position of all vents outlets and the areas they serve shall be suitably indicated adjacent to such outlets.

- 28.5** Where ducts are required to connect the vent to outlets, the ducts shall either be enclosed in structure or be constructed to give at least 1 hour fire resistance.

- 28.6** Separate ducts and vent outlets shall be provided for each basement storey.

28.7 Smoke Purging System

- 28.7.1** For basement having plant/equipment room and service areas such as laundries, office, storeroom and workshops, the following requirements shall be conformed with the following:

- i. The purge rate shall be at least 9 air changes per hour.
- ii. The smoke purging system shall be activated automatically by the building fire alarm system. In addition, a remote manual start-stop switch shall be located at the emergency command centre, or in the absence of an emergency command centre in the building, at the main fire alarm panel on the first storey.
- iii. Visual indication of the operational status of the smoke purging system shall also be provided with this remote control.
- iv. Horizontal ducts shall be fabricated from heavy gauge steel (1.2 mm thick).
- v. The exhaust fan shall be capable of operating effectively at 400°C for 2 hours and supplied from a secondary source of supply.
- vi. Replacement air shall be provided and if it is supplied by a separate mechanical system, such a system shall be connected to a secondary source of power.



29. Engineered Smoke Control System

29.1 The engineered smoke control system in the form of a smoke ventilation system by natural or mechanical extraction may be designed in accordance with:

- i. BR 186 - Design principles for smoke ventilation in enclosed shopping centers; and
- ii. BR 258 - Design approaches for smoke control in atrium buildings; or
- iii. Other acceptable standards.

29.2 Note: BR 186 and 258 are reports published by the Fire Research Station, Building Research Establishment, Borehamwood, Herts WD62BL.

29.3 Sprinkler System

The building to be provided with an engineered smoke control system shall be sprinkler protected.

29.4 Fire Size

Capacity of the engineered smoke control system may be calculated based on the incidence of a likely maximum fire size for a sprinkler controlled fire as recommended in the following **Table 10.2**:

Table 10.2: Fire Size for various occupancies

OCCUPANCY	FIRE SIZE	
	Heat Output (MW)	Perimeter of Fire (m)
Shops	5	12
Offices	1	14
Hotel Guest Room	0.5	6
Hotel Public Areas	2.5	12
Assembly Occupancy with fixed seating	2.5	12

29.5 Capacity of Smoke Ventilation System

The capacity of an engineered smoke control system shall be capable of handling the largest demand for smoke exhaust from the worst case scenario. See **Figure 10.35a** to **10.35c** for example scenarios.



Scenario A

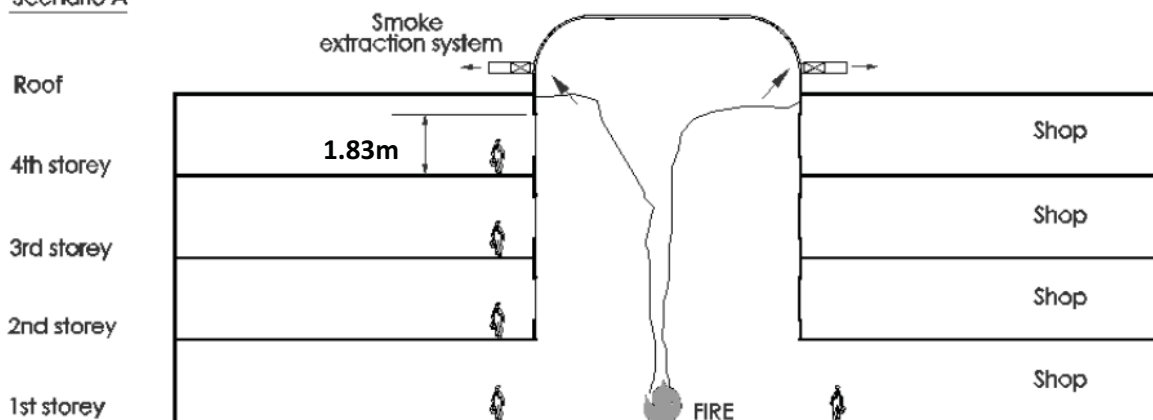


Figure 10.35a: Scenario A – Fire origin at lowest Atrium level

Scenario B

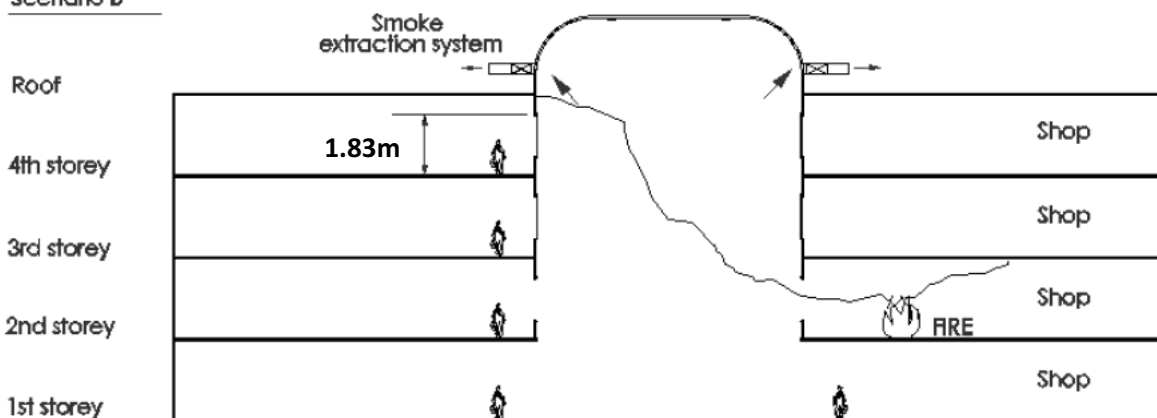


Figure 10.35b: Scenario B – Fire origin at 1st storey Shop space

Scenario C

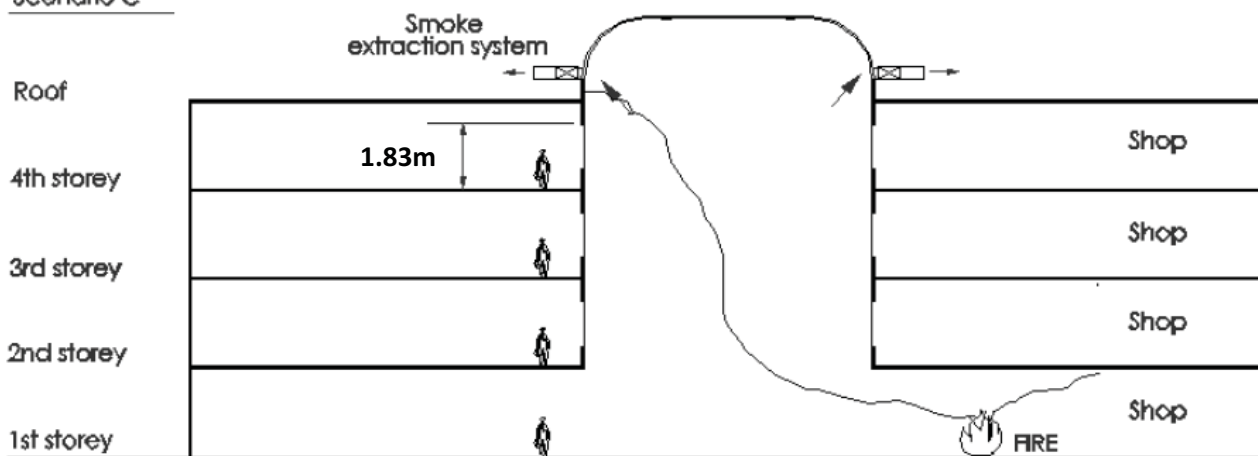


Figure 10.35c: Scenario B – Fire origin at 1st storey Shop space



29.6 Clear Layer

The design smoke layer base shall be above the heads of people escaping beneath it. The minimum height shall be 1830mm. See [Figure 10.36](#) for illustrations.

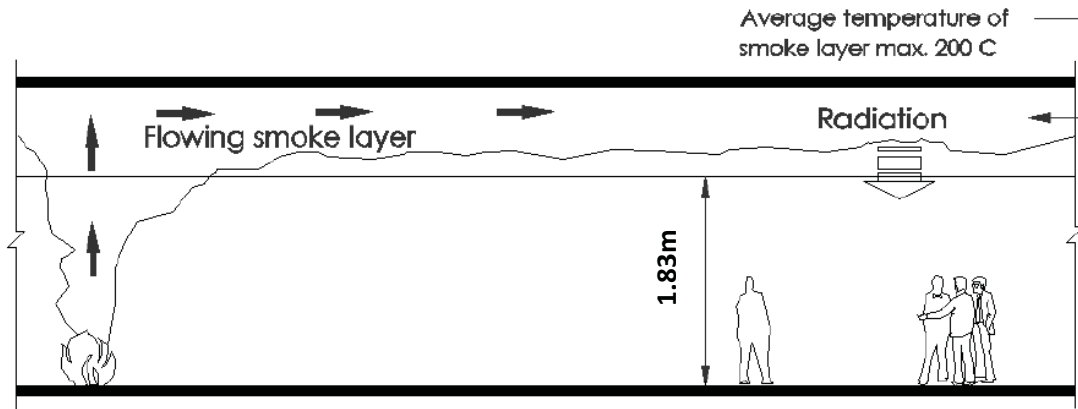


Figure 10.36: Clear smoke layer

29.7 Smoke reservoir

Smoke reservoirs to prevent the lateral spread of smoke and to collect smoke for removal shall be of non-combustible construction capable of withstanding smoke temperatures. See [Figure 10.37](#) for illustrations.

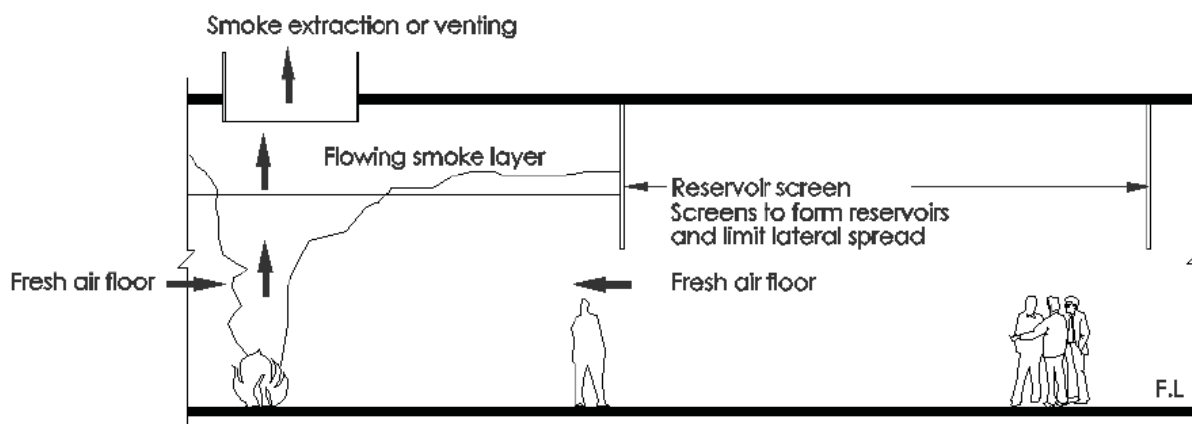


Figure 10.37: Smoke reservoir



29.8 For cases where smoke is removed from the room of origin the smoke reservoir size for a smoke ventilation system shall not exceed the following: (See [Figure 10.38](#) for illustrations)

- i. 2000 m² for natural smoke ventilation system.
- ii. 2600 m² for mechanical smoke ventilation system.

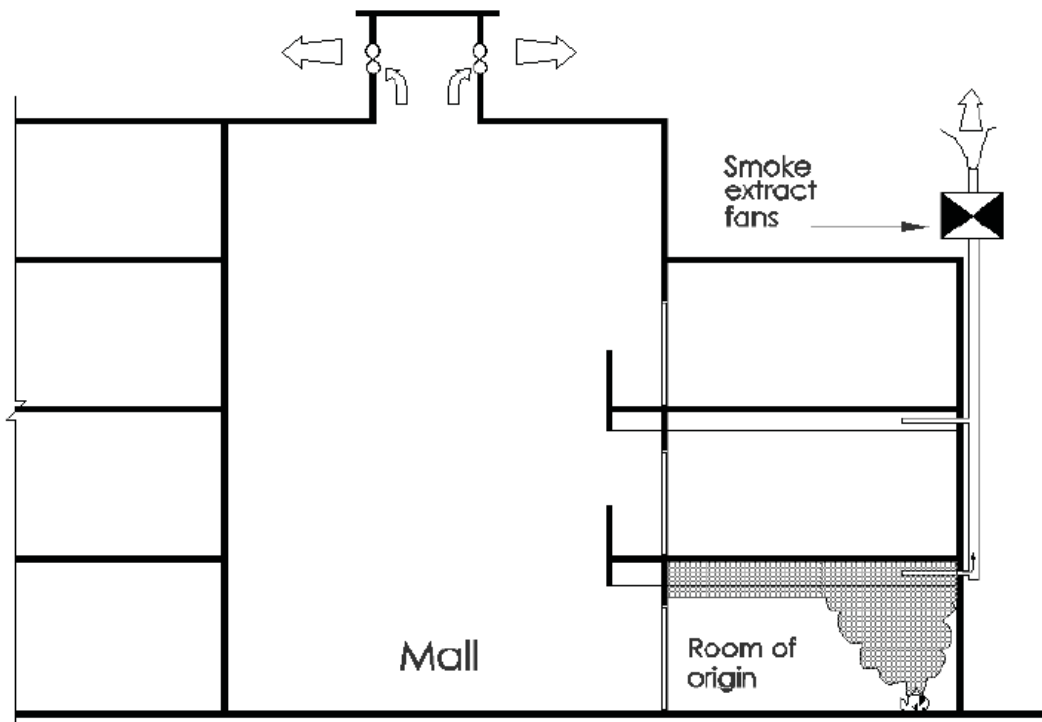


Figure 10.38: Smoke removed from room of origin

29.9 Removal of smoke from circulation or atrium space

For cases where smoke is removed from the circulation space or atrium space the smoke reservoir size for a smoke ventilation system shall not exceed the following: (See [Figures 10.39](#), [10.40](#) and [10.41](#) for illustrations)

- i. 1000 m² for natural smoke ventilation system.
- ii. 1300 m² for mechanical smoke ventilation system.



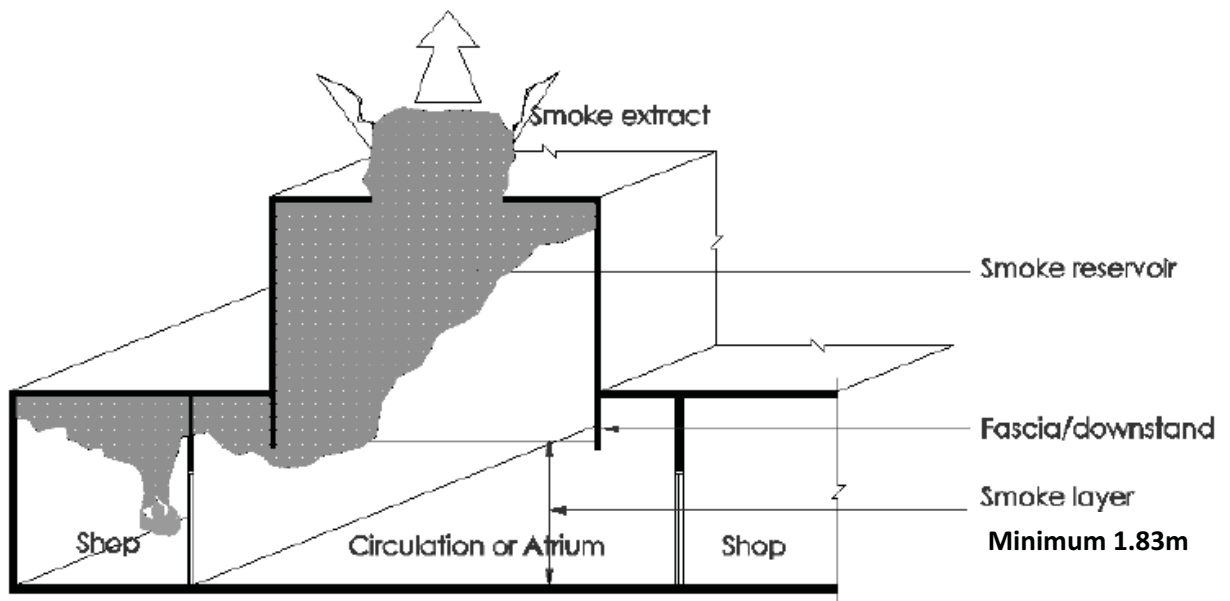


Figure 10.39: Removal of smoke from circulation or atrium space

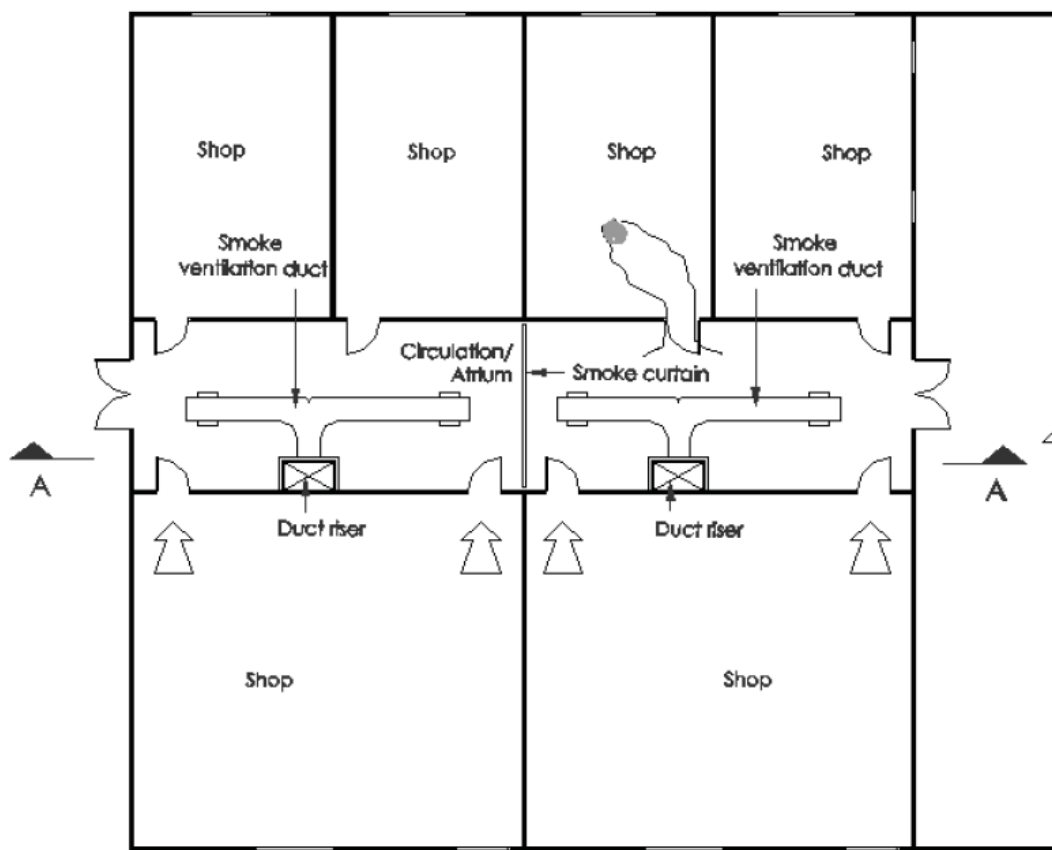


Figure 10.40: Removal of smoke from circulation or atrium space (Plan view)



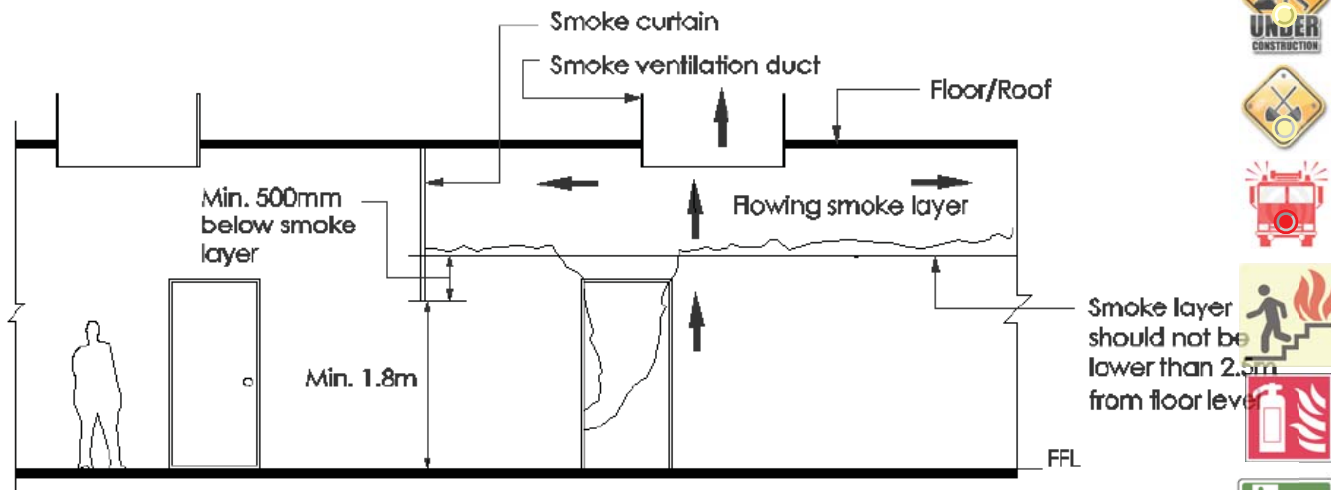


Figure 10.41: Removal of smoke from circulation or atrium space (Side view)

29.10 Discharge of smoke into circulation or atrium spaces

For cases where smoke is removed from the circulation space or atrium space, the rooms discharging smoke into the circulation space/atrium spaces shall either:

- have a floor area of not exceeding 1000 sq m (for natural ventilation system) or 1300 sq m (for mechanical ventilation system) or
- be subdivided such that smoke is vented to the circulation space or atrium only from part of the room with floor area not exceeding 1000 sq m (for natural ventilation system) or 1300m² (for mechanical ventilation system) that are adjacent to the circulation space or atrium. However, the remainder of the room needs to be provided with an independent smoke ventilation system(s). See [Figure 10.42](#) for illustrations.

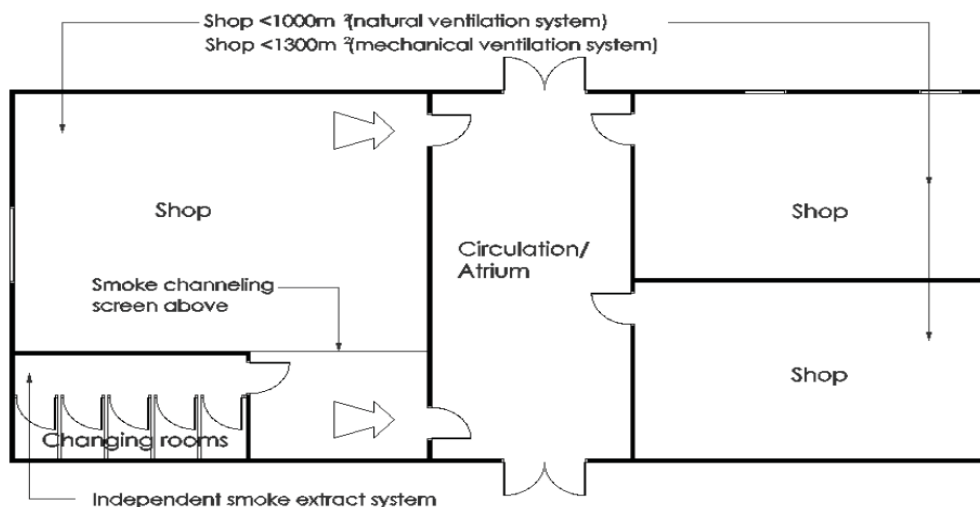


Figure 10.42: Discharge of smoke into circulation or atrium spaces

29.11 The maximum length of the smoke reservoir shall not exceed 60m or otherwise proved by CFD analysis.

29.12 Stagnant Regions

Adequate arrangement(s) shall be made in each smoke reservoir for the removal of smoke in a way that will prevent the formation of stagnant regions. See [Figure 10.43](#) and [10.44](#) for illustrations.

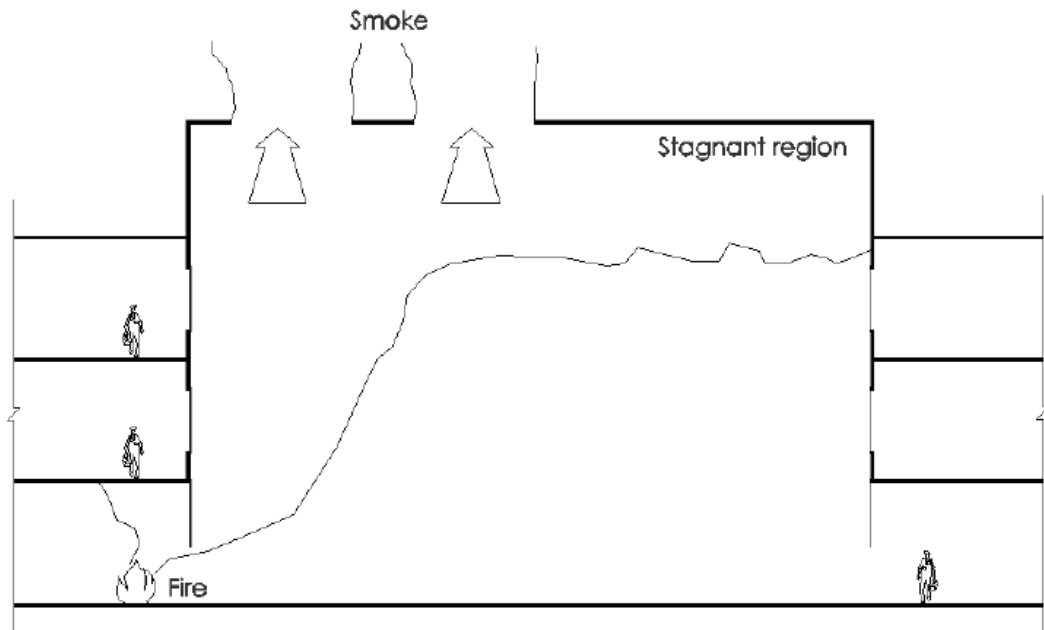


Figure 10.43: Stagnant region due to atrium ceiling design

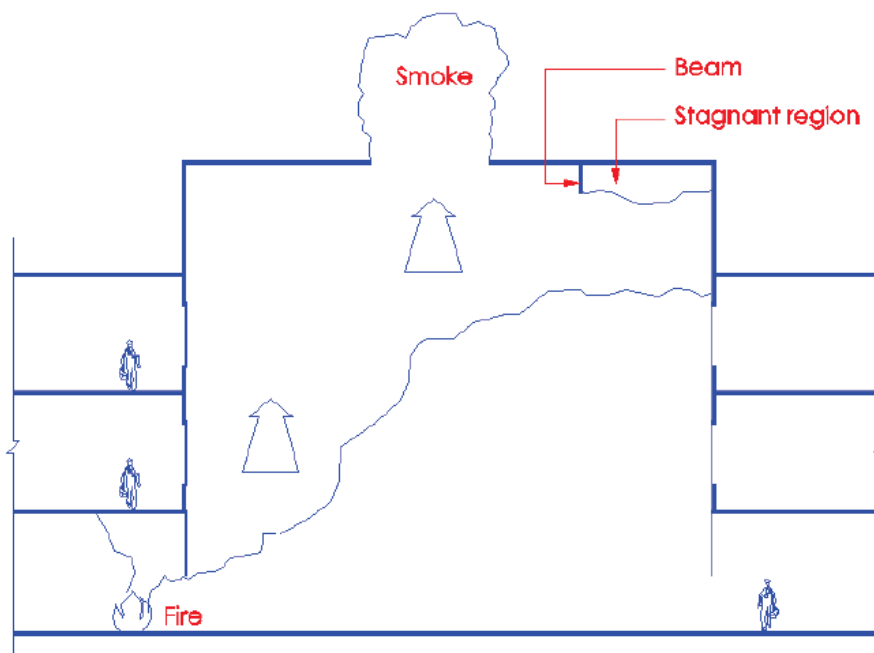


Figure 10.44: Stagnant region due to atrium ceiling obstruction



29.13 Any figures exceeding the above values shall be verified and reviewed through fire engineering analysis.

29.14 Maximum mass flow/smoke layer temperature

Owing to practical limitation, a smoke ventilation system shall have:

- i. a maximum mass flow not exceeding 175 kg/s; and
- ii. a minimum smoke layer temperature of 18degC above ambient.

29.15 Replacement air shall be by natural means drawing air directly from the external.

29.16 The design replacement air discharge velocity shall not exceed 5.0 m/s to prevent the escapees being hindered by the air flow.

29.17 Replacement air intake shall be sited at least 5 m away from any exhaust air discharge.

29.18 Replacement air shall be discharged at a low level, at least 1.5 m beneath the designed smoke layer, to prevent smoke logging of the lower clear zone. See [Figure 10.45](#) for illustrations.

29.19 Where the inlet cannot be sited at least 1.5 m below the smoke layer, a smoke curtain or a barrier shall be used to prevent replacement air distorting the smoke layer.

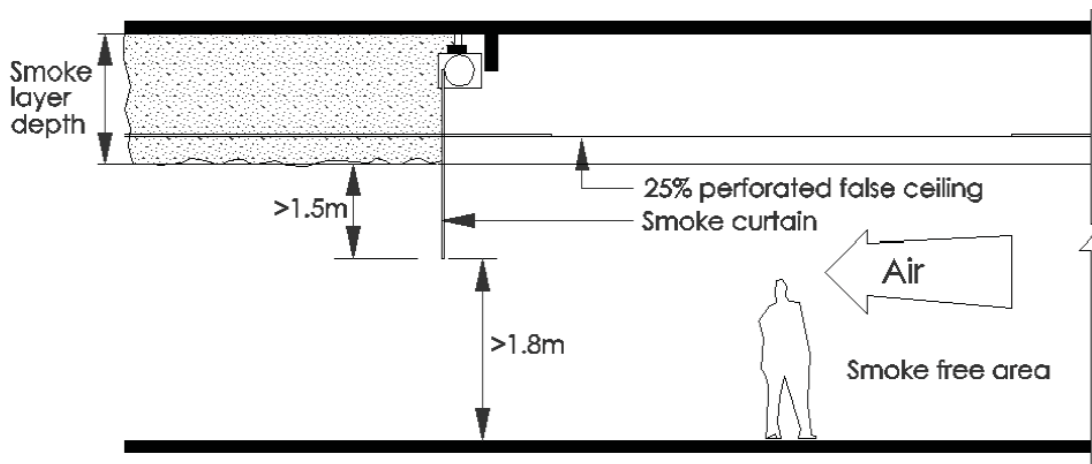


Figure 10.45: Smoke curtain used in relation to replacement air

29.20 Where replacement air is taken through inlet air ventilators or doorways, devices shall be incorporated to automatically open such inlet ventilators and doors to admit replacement air upon activation of the smoke ventilation system.



29.21 Perforated Ceiling

For cases where the smoke reservoir is above the false ceiling, the ceiling shall be of perforated type with at least 25% opening.

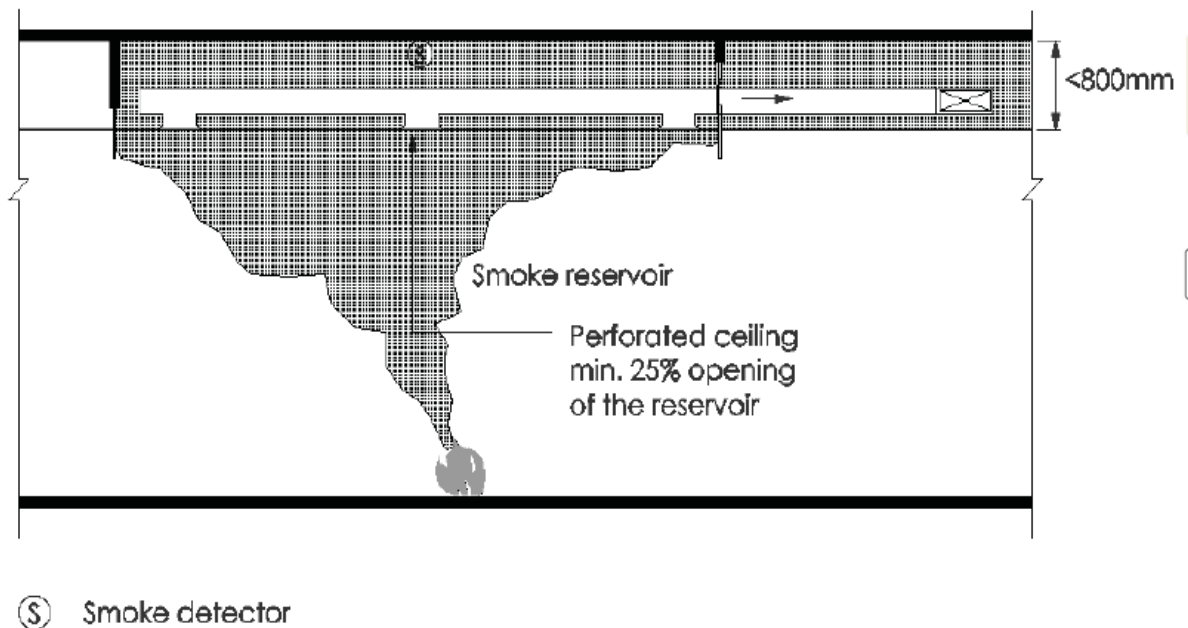


Figure 10.46: Perforated ceiling

29.22 Emergency power supply

The smoke ventilation system shall be provided with secondary source of power supply.

29.23 Mode of Activation

The smoke ventilation system shall be activated by smoke detectors or beam detectors located in the smoke control zone. Use of smoke or beam detectors for activation must be carefully designed so that accidental or premature activation of the detectors on a non-fire zone due to smoke spills or spread from other areas must be avoided. See [Figure 10.47](#) for illustrations.



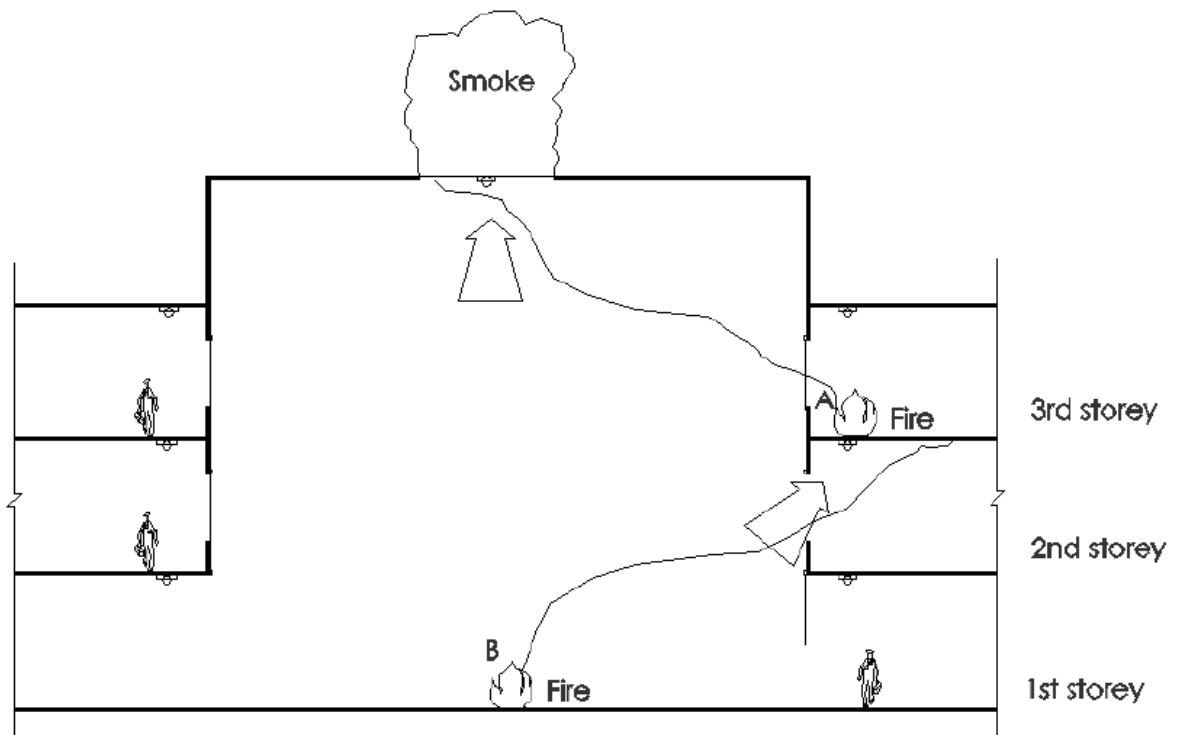


Figure 10.47: Activation by smoke or beam detectors

29.24 Manual activation

29.25 A remote manual activation and control switches as well as visual indication of the operation status of the smoke ventilation system shall also be provided at the fire command centre and where there is no emergency command centre, at main fire indicator board.

29.26 Shut down of all other air-conditioning and ventilation systems.

All air-conditioning and ventilation systems within the areas served shall be shut down automatically upon activation of the smoke ventilation system.

29.27 Automatic shut down of Air Handling Unit shall not affect the ventilation of the following areas:

- Exit staircases and exit passageways.
- Smoke free lobbies and fire fighting lobbies.
- Lift shafts.
- Area of refuge
- Basement carparks.
- Emergency command centre
- Flammable and hazardous material storage.
- Emergency generator room
- Fire pump room



29.28 Stand fans or multiple fans

Either a standby fan or multiple fans with excess capacity shall be provided for each mechanical smoke ventilation system such that in the event the duty fan or the largest capacity fan fails, the designed smoke extraction rate will still be met. The standby fan shall be automatically activated in the event the duty fan fails. See [Figure 10.48](#) for illustrations.

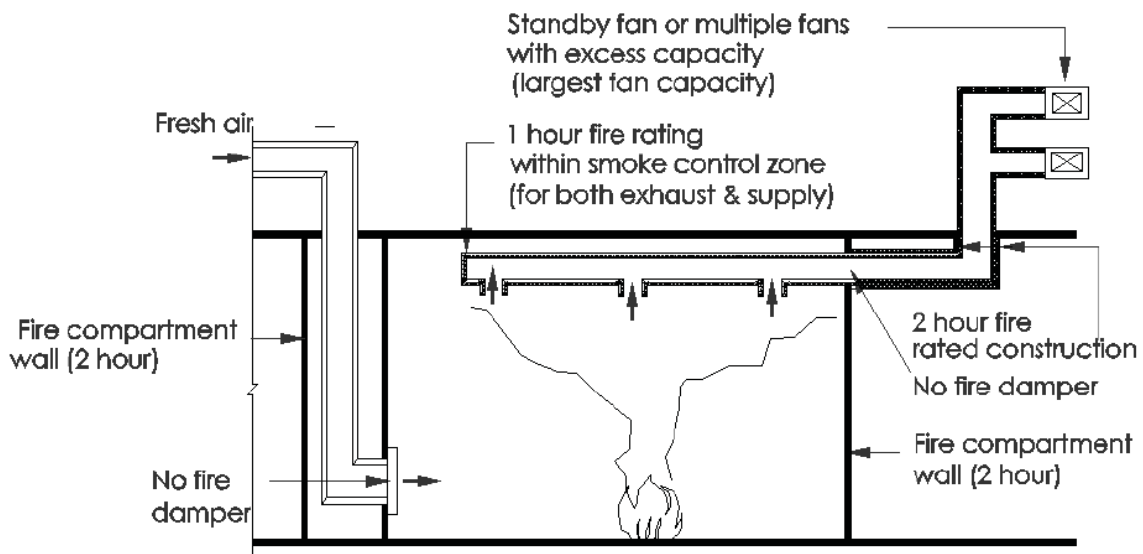


Figure 10.48: Standby or multiple fans

29.29 Protected circuits

Fans shall be capable of operating at 400°C for 2 hours. The fans and associated smoke control equipment shall be wired in protected circuits designed to ensure continued operation in the event of the fire.

29.30 The electrical supply to the fans shall, in each case, be connected to a sub-main circuit exclusive thereto after the main isolator of the building. The cables shall be of at least 1-hour fire resistance.

29.31 Fire rating of Ducts

Smoke ventilation ducts (both exhaust and replacement air ducts) shall be of at least 1 hour fire resistance. Where a duct passes through other fire compartment of higher rating, the duct shall be constructed to have the rating as that of the compartment.



29.32 The rating shall apply to fire exposure from both internal and external of the duct or structure.

29.33 Fire Damper

Fire damper shall not be fitted in the smoke ventilation system.

29.34 Fire damper is not allowed to be fitted in the duct work of the atrium smoke control.

29.35 Activation of system

The time taken for the smoke ventilation system within a smoke zone to be fully operational shall not exceed 60 seconds from system activation.

29.36 Fail safe system

For natural smoke ventilation system, the natural ventilators shall be :

- a. in the “open” position in the event of power/system failure; and
- b. positioned such that they will not be adversely affected by positive wind pressure.

29.37 Natural/Power exhaust ventilation

Natural exhaust ventilation shall not be used together with powered smoke exhaust ventilation.

29.38 Smoke curtains

All smoke curtains where required, unless permanently fixed in position, shall be brought into position automatically to provide adequate smoke-tightness and effective depth.

29.39 Obstruction to means of egress

Smoke curtain or other smoke barrier at any access route forming part of or leading to a means of escape shall not in their operational position obstruct the escape of people through such route. See **Figure 10.49** for illustrations.



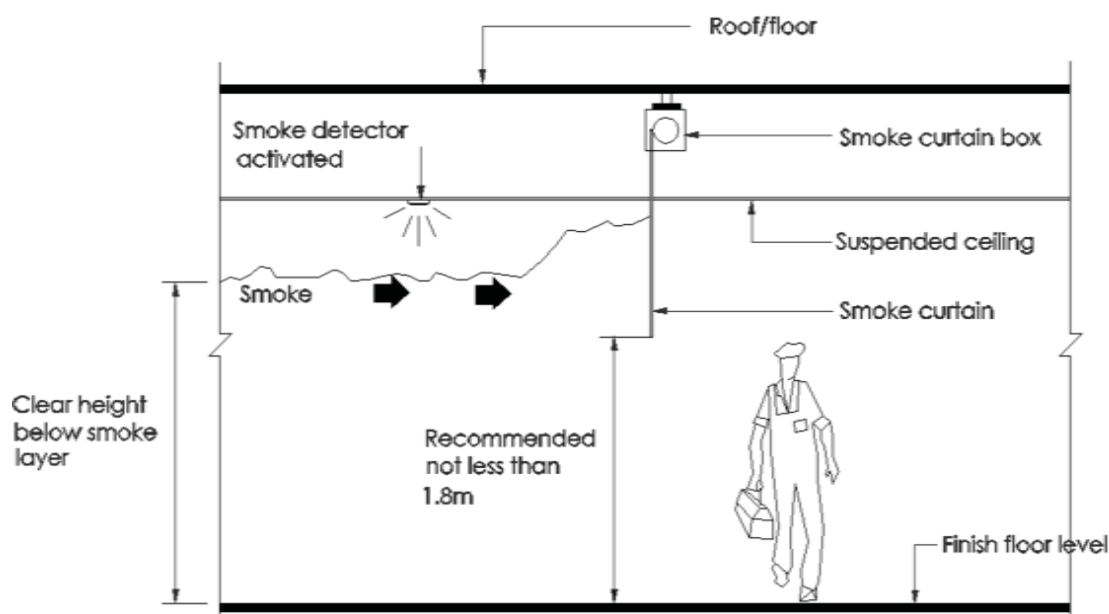


Figure 10.49: Obstruction to means of egress

29.40 Smoke or channeling Screens

Where glass walls or panels are being used as smoke screens to form a smoke reservoir or as channeling screens, they shall be able to withstand the design highest temperature. See [Figures 10.50](#) and [10.51](#) for illustrations.

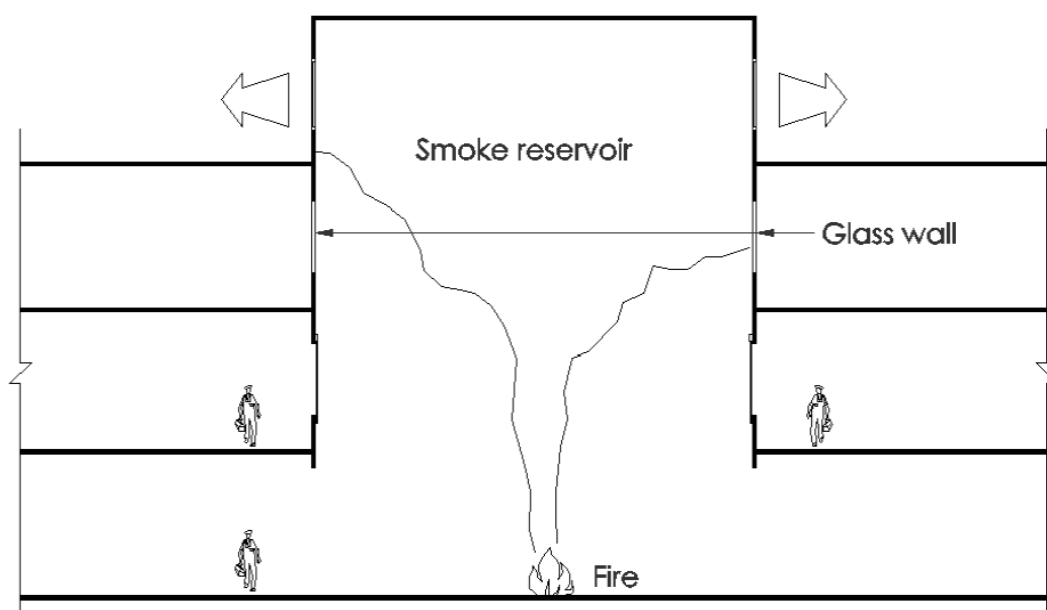


Figure 10.50: Smoke or Channeling Screen



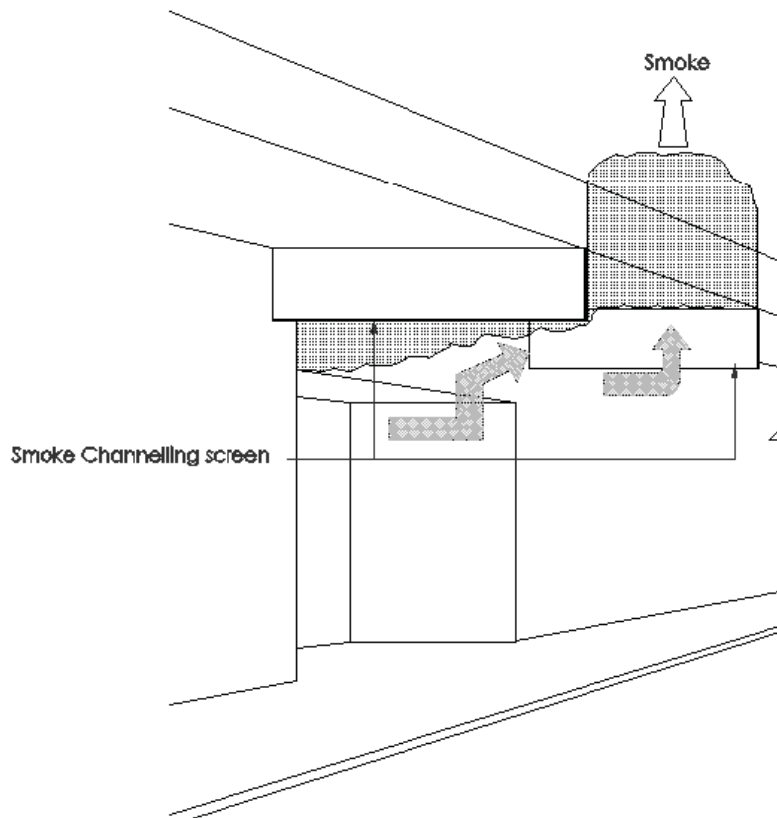


Figure 10.51: Smoke or Channeling Screen

29.41 All smoke control equipment (including smoke curtains) may be supplied and installed in accordance with the accepted standards e.g. BS 7346.

30. Smoke Control System for Auditorium (Used or Intended for Cinema, Concert Hall, Performance Theatre)

30.1 Automatic smoke ventilation system shall be provided for auditoriums which include cinema, concert hall, performance theatres or such similar premises. An engineered smoke control system would be considered as acceptable.

31. Enclosed Car Parking

31.1 Where mechanical ventilation system is required for car parking areas in basements or enclosed with total floor area exceeding 2000 m², at least a smoke purging system which is independent of any systems serving other parts of the building shall be provided to give a purging rate of not less than 9 air-change per hour.



- 31.2** The smoke purging system shall be activated automatically by the building fire alarm system. In addition, a remote manual start-stop switch shall be located at fire command centre or at main fire alarm panel on first storey (where there is no emergency command centre in the building). Visual indication of the operation status of the smoke purging system shall also be provided with this remote control.
- 31.3** Supply air shall be drawn directly from the external and its intake shall not be less than 5 m from any exhaust discharge openings. Outlets for the supply air shall be adequately distributed over the car park area.
- 31.4** Where there is natural ventilation for such basement car park based upon openings equal to not less than 2.5% of the floor area of such storey, such natural ventilation may be considered as a satisfactory substitute for the supply part of the smoke purging system. The openings shall be evenly distributed over the car park areas.
- 31.5** Exhaust air shall be discharged directly to the external and shall not be less than 5m from any air intake openings.
- 31.6** Exhaust ducts shall be fabricated from heavy gauge steel (1.2mm thick) for the basement car park smoke purging system.
- 31.7** Exhaust fans of the basement car park smoke purging system shall be capable of operating effectively at 400°C for 2 hours. See [Figure 10.52](#) for illustrations.

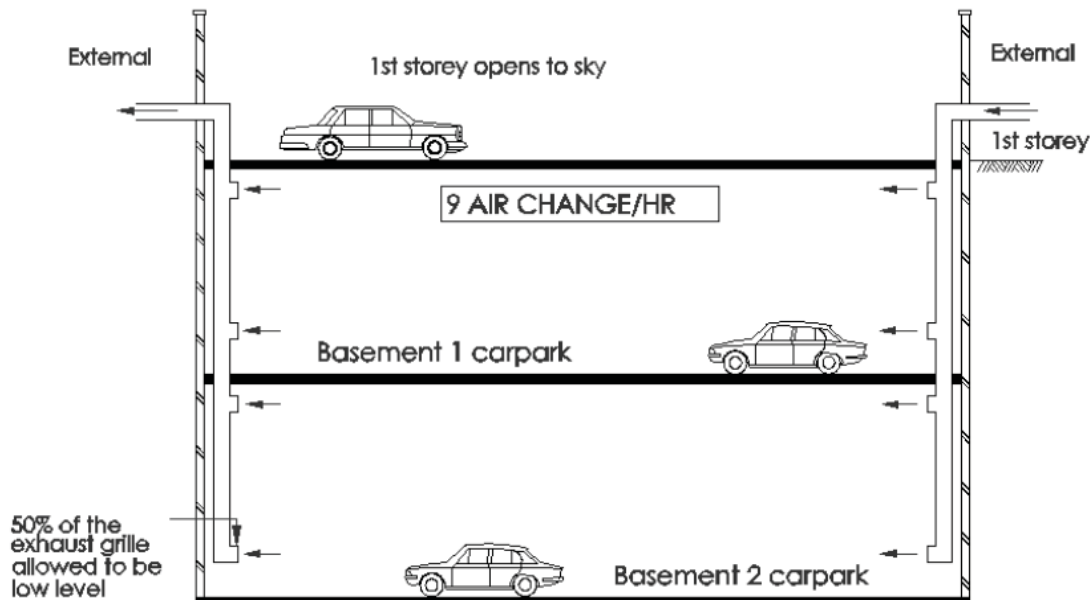


Figure 10.52: Smoke purging for enclosed car park structure

32. Open Car park

- 32.1** A car park located beneath the first storey of a building (not open to sky) can be considered an open or an unenclosed car park and do not required automatic sprinkler system if all of the following complies:
- 50% of the car park perimeter shall be having permanent natural ventilation opening.
 - At least $\frac{3}{4}$ of the car park perimeter is having the 50% natural ventilation opening.
 - Any part of the car park shall be within 30m of a permanent natural ventilation opening.
 - The car park area shall not be more than 2230m²
 - Such car parks cannot be more than 3 levels of parking.
- 32.2** This does not apply to car parks underneath buildings with automatic sprinklers and car parks which are more than 23m. In this case, automatic sprinklers shall be provided for the car park. See [Figure 10.53](#).

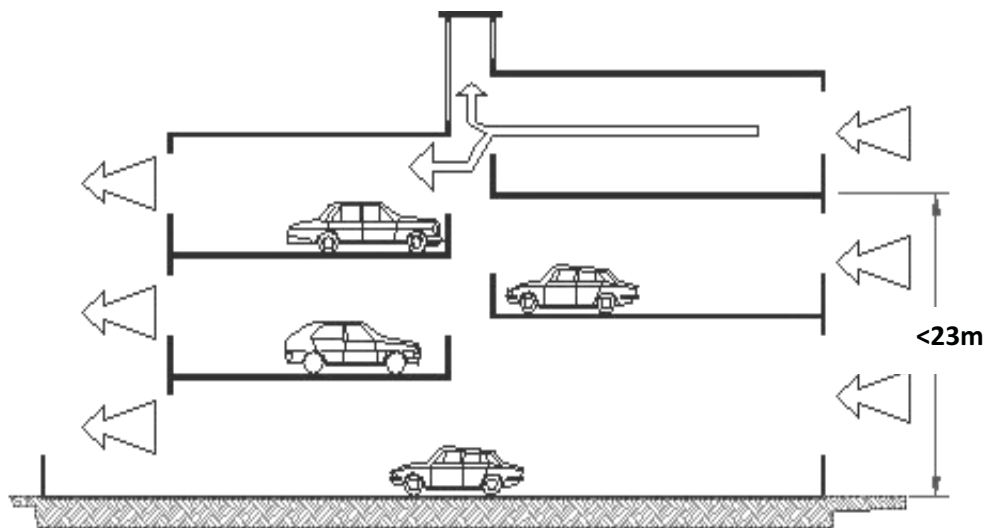


Figure 10.53: Natural ventilation for open car park structure



33. Ductless Jet Fans System in Car Parks

33.1 Objectives

33.1.1 The objectives of the ductless jet fans system are as follow:

- i. To relief heat and smoke from the car park in the event of fire.
- ii. To assist fire-fighters in locating and attacking the fire safely.

33.2 Scope

33.2.1 This set of requirements is only applicable to conventional car parks where passenger cars/light weight vehicles are parked alongside each other with common driveways and is not intended for mechanized car park system or other forms of car parking systems.

33.3 Design Considerations

33.3.1 Provision of sprinkler system in car park

33.3.2 The basement car park shall be sprinkler protected.

33.3.3 The arrangement of the sprinkler heads and the jet fans shall be such that, upon the operation of the jet fans, the effect on the spray pattern of the sprinklers is minimized.

33.4 Zoning of car park

33.4.1 The car park space shall be divided into smoke control zones with each zone not larger than 2000m² (excluding plant rooms and circulation spaces) for purpose of smoke containment and faster location of fire. As the zones are virtual smoke zones, it has to be demonstrated that smoke can be contained within the zone boundaries and channeled to the extract fans. Demonstration is to be carried out using hot smoke test as part of the commissioning test.

33.4.2 Each smoke control zone shall have its own jet fans system (fresh air fans, exhaust air fans and jet fans) to purge smoke from the affected zone. The ducts shall be fabricated from heavy steel gauge steel of 1.2mm thick. Alternatively, sharing of the fresh air and exhaust air fans is permitted provided the fans, wiring and control panel are protected with at least 1-hr fire resistance rating. The exhaust fan system shall also be designed to run in at least two parts, such that the total exhaust capacity does not fall below 100% of the required rate of extract for the zones affected in the event of failure of any one part. This requirement is also applicable for mechanized supply fan system, if it is used.

33.5 Jet fans system

33.5.1 The jet fans system shall be activated by the sprinkler system serving the basement car park level and any other areas located within the same level or



manual call point. The activation of the jet fans system shall at least be confined to the smoke control zone on fire and all its adjacent zones. A fireman cut off and activation (override) switch shall be provided at the Fire Command Centre.

- 33.5.2** The jet fans system shall be provided with a secondary source of power supply through automatic operation of an emergency generator in case of failure of the primary power supply source.
- 33.5.3** The jet fans shall be distributed at a spacing of 2/3 of the tested effective range of the particular jet fan. The tested effective range of the jet fan shall be taken as the distance up to the point at 0.2m/s of the air-velocity distribution profile.
- 33.5.4** The minimum headroom for the installation of the jet fans system is 3m.
- 33.5.5** The interaction of the various components of the jet fans system shall be in the following manner:
- i. Each group of exhaust fans for each smoke control zone shall be interlocked with its corresponding groups of jet fans for that zone.
 - ii. If the group of exhaust fans stops/fails in any smoke control zone, its corresponding groups of jet fans in that zone shall stop. But if any of the exhaust fan is still in operation in a particular smoke control zone, all the jet fans shall continue to operate in that zone.
 - iii. The exhaust fan shall continue to run even if any corresponding group of jet fans fails.
 - iv. The other groups of jet fans shall continue to run even if any one group of jet fans fails.
 - v. If the fire alarm signal is isolated, the exhaust fans and jet fans shall continue to run at high speed. If the fireman stops the fans and restart them, both the exhaust fans and jet fans shall continue to run at high speed. This continues to be so until the fans are reset to low speed at the field control panel.
- 33.5.6** The jet fans system shall be independent of any systems serving other parts of the building.
- 33.5.7** The jet fans system design shall be such that the bulk air velocity induced by the jet fans is sufficient to stop the advance of the ceiling jet within 5m from the fire location in the direction opposite to the induced bulk air flow.
- 33.5.8** There shall be at least one viable approach route for the fire-fighters to any possible fire location up to a distance of 5m from that fire. As such, information as to the viable approach route should be displayed at the main fire alarm panel.



This can be achieved by arranging the sprinkler control zone to correspond with that of the smoke control zone. Upon detection of the fire within a particular smoke control zone/sprinkler zone, reference can be made to the display showing the viable approach route for that particular smoke control zone.

33.5.9 The MV sub-panel in each smoke control zone is to be connected to the main MV panel, such that any isolation of jet fans system at a particular zone is automatically displayed at the main MV panel.

33.5.10 The car park main MV panel at FCC/Guard House and remote local panel are required to show the status lights of the fan speeds (i.e. low and high speeds) for the supply and exhaust fans. The panels are also required to have the individual group of jet fans indication lights interlocked with the main exhaust fans in the respective smoke control zones.

33.5.11 In the event of failure of the primary source of power supply and subsequent operation of the secondary power supply, the mode of operation of the jet fans system during the fire mode shall follow that prior to the failure of the primary power supply. For example, if the operation of jet fans system in a particular smoke control zone is switched off by the fireman during fire mode condition and the primary source of power fails, the subsequent operation of the secondary power supply will be such that the jet fans system remains in the previous fire mode condition i.e. non-operational mode for that smoke control zone while the other smoke control zones resume operation.

33.5.12 The jet fans system design shall take into consideration the presence of any down-stand beams and other obstruction that are of depths of more than 1/10 of the car park floor to ceiling height so as to account for any resistance to airflow and turbulence.

33.5.13 On activation of the jet fans system, the movement of smoke towards the extract point(s) should not adversely affect the means of escape and cause smoke to be blown into the lobby area or exit staircases.

33.5.14 The operation of the jet fans system should be such that there are no stagnant areas where smoke can accumulate in the event of fire.

33.5.15 The operation of the jet fans system should not cause the volume of air movement to be greater than that volume extracted by the main exhaust fans.

34. Wiring arrangement of jet fans

34.1 All jet fans shall be connected to the local jet fan control panel in groups of not more than 3 jet fans.

34.2 Each group will be connected by fire rated cabling.

34.3 Each group of jet fans will be protected by a MCB (main circuit breaker).



34.4 The incoming power supply for the jet fan panel shall comply with CP5. Should there be a fault with 1 jet fan, it will trip the MCB of the group only; it will not trip the main RCB protecting the other groups. As each group of 3 jet fans is protected by a MCB, this MCB will trip before affecting the main MCB at the incoming power supply in the event of an overload.

34.5 The jet fans shall also be wired in a zigzag configuration and no two consecutive jet fans in a straight line is to be wired as the same group. In the event of failure of 1 group of jet fans, the next corresponding group will be able to drive the smoke towards the exhaust location to be extracted (please see [Figures 10.54](#) and [10.55](#)). Should one group of jet fans, all other groups shall still continue to run.

34.6 The location of the local control panel for the operation of the jet fans within each zone shall be in a relatively safe area within the zone and be spaced as least 5m apart from the local control panels of adjacent zones. This is to minimize the risk of a fire affecting all the control panels if they be spaced closely together, and thus rendering the ineffectiveness of the jet fans system.

35. Provision of supply air for jet fan systems

35.1 Supply air to the car park can be provided via mechanized supply air fans or by permanent openings of at least 2.5% of the floor area. Whether supply air is provided via permanent openings or by mechanized supply fans, the maximum inlet air speed should be 2m/s to prevent recirculation of smoke. Supply air can be provided by natural and mechanical means provided the acceptance criteria as stipulated in [Section 39](#) can be achieved through fire modeling.

35.2 The air velocity within escape routes and ramps shall not exceed 5m/s to prevent escapees from being hindered by the air flow.

35.3 The replacement air intakes shall face away from any smoke exhaust points and sited at least 5m apart so as to prevent recirculation of smoke. If the supply and exhaust louvers are located on the same building façade, they shall also be separated at least 5m apart.

35.4 The replacement air intake should also be located on the opposing end of the smoke exhaust points so that there is no opposing flow between the supply air and the smoke that is drawn towards the exhaust fan.

36. Exhaust fan design for jet fan system

36.1 The car park shall be provided with at least 12 air-changes per hour during fire condition. A lower air-change may be permitted provided the acceptance criteria as stipulated in [Section 39](#) can be achieved through fire modeling.

36.2 The capacity of the exhaust fan and any associated ducting should be calculated on the basis that the pressure in the car park close to the extract points is equal to the external atmospheric pressure.



36.3 Each smoke control zone of the car park shall have its own exhaust fan system. The exhaust fan system in each zone should be designed to run in at least two parts, such that the total exhaust capacity does not fall below 50% of the required rate of extract in the event of failure of any one part and that a fault or failure of the exhaust fan system in one zone will not affect the operation of the exhaust fan system in the other zones. The above requirement is also applicable for mechanized supply fan system, if it is used. (Note: If there is sharing of the exhaust air fans, see [Clause 33.4.2.](#))

36.4 The smoke discharge points should be located such that the smoke extracted from the smoke exhaust fans does not affect any occupied area or means of escape at the level where smoke is discharged.

37. Fire resistance of jet fans system

37.1 The jet fans system such as the mechanized air supply fans, smoke exhaust fans, jet fans, duct works and wiring shall be capable of operating effectively at 250°C for 2 hours. The fans, ducts and wiring may be tested in accordance with BS7346: Part 2, BS476: Part 24, NFPA 70 and any approved recognized standards.

38. Verification of Jet Fans System Designs

38.1 Hot smoke test / CFD fire modeling

38.1.1 The effectiveness of the jet fans system design shall be demonstrated using hot smoke test (see [Section 43 Commissioning test](#)). The heat release rate of the fuel load for the hot smoke test must be at least 1MW. The relevant PE or Fire Safety Engineer should decide on the fire location(s) that is (are) deemed most onerous with justification.

38.1.2 In addition to the hot smoke test, CFD fire modeling will also be required in the following instances:

- i. If air-change per hour is smaller than 12.
- ii. If there are general goods vehicle or coaches where design fire size exceeds 4 MW (i.e. car fire).
- iii. If replacement air is a combination of natural and mechanical means.
- iv. If spacing of jet fans is more than 2/3 of the tested effective range.

38.1.3 The CFD study is to be endorsed by a FSE to verify the conformance of the jet fans system with the acceptance criteria as stipulated in section 39. The FSE is also required to put up a fire engineering report. Some of the accepted fire modeling software includes FDS, Swift-AVL, Fluent and Pheonics.



39. Acceptance criteria for jet fan system

39.1 Not more than 1000m² of the car park space can be smoke-logged for at least 20 mins, regardless of whether the fire is located within the smoke control zone or across the zone boundaries (Note: After the 20mins duration, smoke is expected to remain confined within the 1000m² area). Within this smoke-logged area, there shall be at least 1 viable route for the fire-fighters where the following conditions are satisfied:

- i. Smoke temperature shall not exceed 250 °C at a height of 1.7m from floor level.
- ii. Visibility shall not be less than 5m at a height of 1.7m from floor level.

39.2 These conditions shall commence at a distance of 5m from the fire location in the direction opposite to the induced bulk air flow induced by the jet fans. All other areas outside the smoke-logged area shall be kept substantially free from smoke i.e. smoke temperature not more than 60°C and visibility of at least 25m (please see [Figure 10.54](#) and [10.55](#)).

39.3 Note: If hot smoke test is performed, assessment is to be made on the operation of the jet fans system, movement of smoke towards the extraction points and smoke spread. The latter 2 aspects can be generally verified using the above visibility criterion. The temperature criterion need not be verified in view of the nature of the hot smoke test.

40. CFD fire modeling input parameters for jet fan system

40.1 Fire Size

40.1.1 The design fire size shall be based on at least 4MW steady-state fire (i.e. car fire). For general goods vehicle, the design fire size shall be based on at least 10MW steady state fire (FSE is expected to provide justification for the bigger fire size other than the car fire).

40.2 Type of fire

40.2.1 The type of fire shall be flaming polyurethane.

40.3 Location of fire

40.3.1 Generally, the fire should be located furthest away from the exhaust points and in between zones. The relevant Professional Engineer or Fire Safety Engineer should decide on the fire location(s) that is (are) deemed most onerous with justification.



40.4 Down-stand beams and other obstruction

- 40.4.1** The CFD model shall take into consideration the presence of any down-stand beams and other obstruction that are of depths of more than 1/10 of the car park floor to ceiling height so as to account for any resistance to airflow and turbulence.

41. Jet fan velocity profile

- 41.1** Validation model of the velocity profile is to be carried out for a single jet fan. The data from the model shall be compared against physical test data. As such, the jet fan shall be tested for velocity profile by an accredited testing laboratory for comparison with the simulated velocity profile. The test report is to be attached to the Fire Engineering Report.

- 41.2** The equation to be used for the deviation between the CFD profile and actual test profile is as follows:

Equation: $\text{Deviation} = [(A-B) / B] \times 100\%$

Where: A = distance/width/height from CFD profile
B = distance/width/height from actual test profile

- 41.3** The deviation of the distance, width and height of the actual profile from the simulated profile at the various air velocities should be within 10%.

41.4 Duration of fire simulation

- 41.4.1** The duration of the fire simulation shall be at least 20mins.

41.5 Sprinkler activation

- 41.5.1** The model shall assume there is no sprinkler activation for the design fire size specified in [Section 40](#).

41.6 Grid resolution

- 41.6.1** The grid size to be used in the fire model shall not be larger than 0.2m X 0.2m X 0.2m in the smoke control zone where fire is located and its adjacent zones. Other than these zones, the grid size shall not be larger than 0.4m X 0.4m X 0.4m. Alternatively, the relevant PE or FSE undertakes a grid resolution study to ascertain the appropriate grid size needed for the fire size and smoke flows modeled (e.g. outcome of study showing that additional resolution does not make much of a difference to the results).

41.7 Sensitivity study

- 41.7.1** A sensitivity study is to be carried out to show the impact of 1 group of jet fan failure nearest the fire on the overall effectiveness of the jet fans system. This



study is applicable to both fire modeling and hot smoke test. Notwithstanding the failure of 1 group of jet fans, the acceptance criteria must still be maintained.

42. Operations and Maintenance Manual for jet fan systems

- 42.1** An operations and maintenance manual shall be attached. The manual shall contain the roles and responsibilities of the building owner/operator, the restrictions placed on the building, identification of the sub-systems, servicing and maintenance plan, fault identification, etc. The manual can also be used as a guide for future renovations and changes to the building.

43. Commissioning Test for jet fan system

- 43.1** The Registered Inspector who carries out commissioning test of the jet fans system may make reference to Table 2 of BS 7346 - Part 7 as a guide. When hot smoke test is performed, the Professional Engineer/Fire Safety Engineer shall use a test fire size of 1MW. Reference may be made to AS 4391 on hot smoke test or any approved matured standards.
- 43.2** Note: This standard is more relevant for an engineered smoke control system rather than jet fans system. Nevertheless, there are some aspects in this standard where the Fire Engineer may find useful, such as how the test can be prepared and carried out in a proper manner.

Wiring of jet fan system

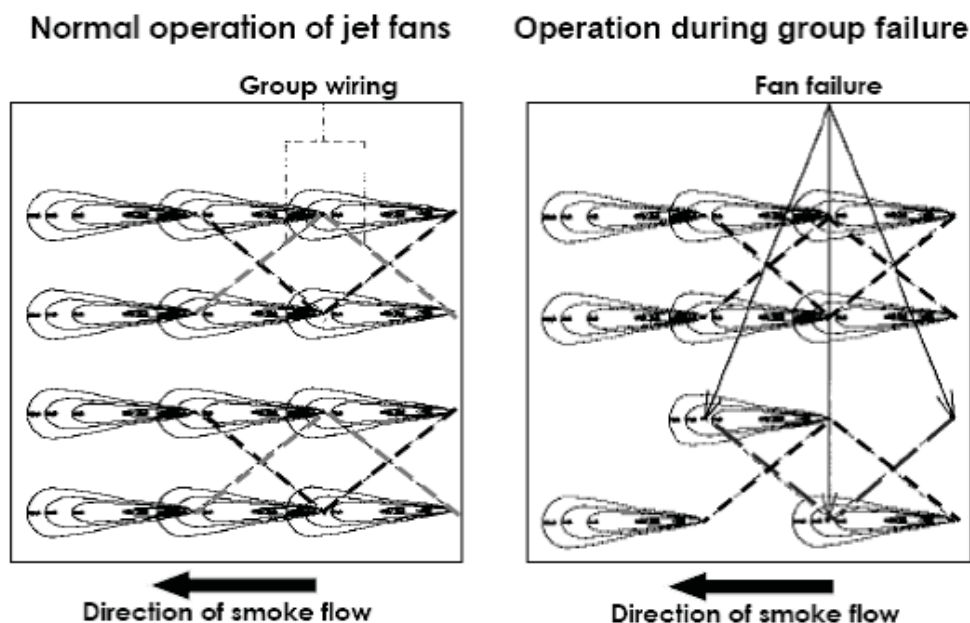


Figure 10.54: Wiring configuration of jet fan system



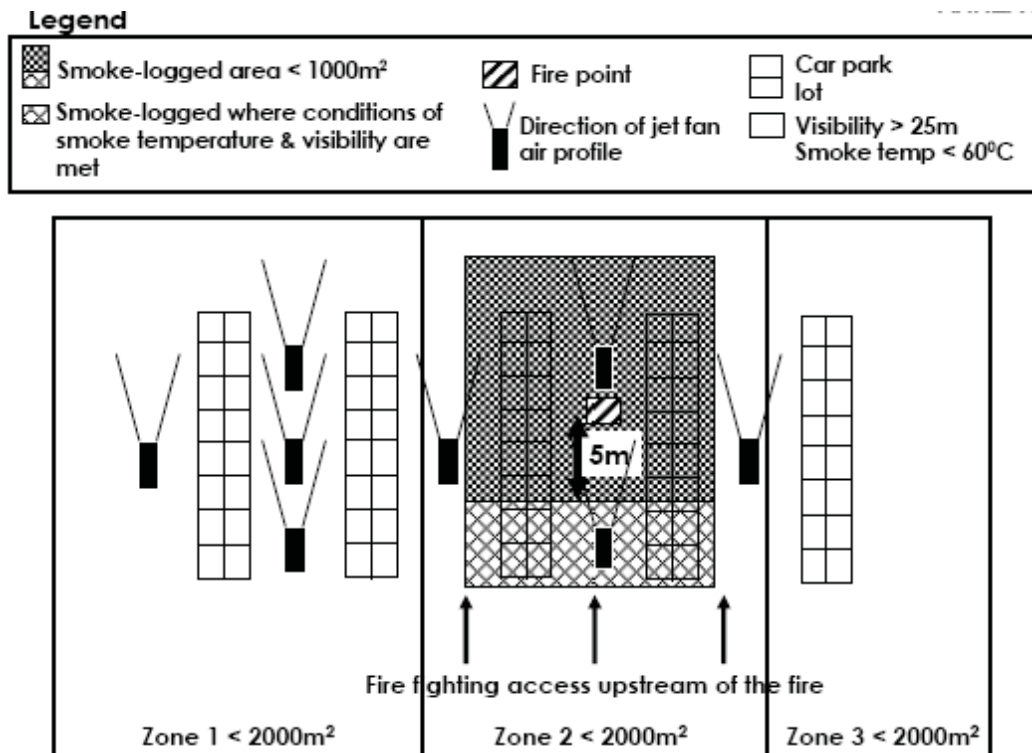


Figure 10.55: Zoning of jet fan system

44. Material Approval

- 44.1** All the Materials, Systems, Assemblies, equipment, Products and Accessories, referred to in this chapter with respect to Life Safety, Fire Safety and Emergency Services shall be Listed, Approved and Registered by the Civil Defence Material Approval Department.
- 44.2** The above requirement applies to all the products with or without international listing, registration or approval.

45. Further References

- 45.1** The following International Codes and Standards were referred, studied and consulted for this chapter. Further details where applicable can be referred to in these Codes and Standards. Also see **XV. ACKNOWLEDGEMENT OF INTERNATIONAL CODES AND STANDARDS.**

- NFPA 90A: Standard for the Installation of Air-Conditioning and Ventilating Systems
- NFPA 90B: Standard for the Installation of Warm Air Heating and Air-Conditioning Systems
- NFPA 92: Standard for Smoke Management Systems
- NFPA 92A: Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences



- NFPA 92B: Standard for Smoke Management Systems in Malls, Atria, and Large Spaces
- NFPA 96: Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
- EN 1366-2: Fire resistance tests for service installations - Part 2: Fire dampers
- EN 1366-10: Fire Resistance tests for service installations – Part 10: Smoke control dampers.
- EN 12101-3: Smoke and heat control systems – Part3: specification for powered smoke and heat exhaust ventilators
- EN 12101-4: Smoke and heat control systems - Part 4: Installed SHEV systems for smoke and heat ventilation
- EN 12101-8: Smoke and Heat control systems- Part 8: Smoke control dampers
- EN 15650: Ventilation for buildings – Fire dampers
- EN 13501-3: Fire classification of construction products and building elements – Part 3: Classification using data from fire resistance tests on products and elements used in building service installations: fire resisting ducts and fire dampers
- EN 13501-4: Fire classification of construction products and buildings elements – Part 4: Classification using data from fire resistance tests on components of smoke control systems.



CHAPTER 11

FIRE SAFETY GUIDELINE FOR LIQUEFIED PETROLEUM GAS (LPG) INSTALLATIONS

1. Scope

- 1.1.** This Fire Safety Guidelines covers outdoor and indoor LPG cylinder installations. It is intended to provide centralized gas supply for commercial, industrial and residential premises with eating outlets, eating places, canteens, restaurants and other eateries which use LPG cylinders for cooking purposes. This guideline also covers installation requirements for rooftop LPG containers.

2. General Requirements for LPG Cylinder Installations

- 2.1.** Cylinder type LPG installations in all new and modified buildings is not allowed. It is the strong intention of Civil Defence to install Centralized LPG systems in all new and modified buildings.
- 2.2.** Permission to install LPG cylinders is strictly subjected to approval of Civil Defence based on site and building inspection.
- 2.3.** All LPG cylinder installations shall be located outdoors and on the ground levels for all commercial and industrial buildings. Locating LPG cylinders indoor is normally not permitted, unless otherwise approved by Civil Defence under special circumstances and in compliance with the requirements mentioned in this guideline.
- 2.4.** NFPA 54 and NFPA 58 shall be referred to for requirements not effected or covered under this Fire Safety Guidelines.
- 2.5.** All LPG cylinders installations including their manifold/piping systems, shall be approved by Civil Defence. LPG plans submitting for approval shall include the following items:
- Written permission from building owner for LPG cylinders to be used by the tenants and undertake that the total quantity is kept below 450kg for the entire building at only *one* Civil Defence approved location.
 - Approved Consultant's endorsements of LPG's storage and manifold system
 - Location and site plans
 - Schematic diagrams of the LPG supply system showing change-over valve, vaporizer, regulator, emergency shut-off valve, remote cut-off device, knock-out pot, pipe entry and all other required safety features
 - Plan and elevation views showing the following details:



- vi. Location, quantity and capacity (in kg) of LPG cylinders
- vii. Locations of ancillary fixtures and fittings, e.g. vaporizer, regulators, emergency shut-off valve, change-over valves, remote cut-off device, knock-out pot, pipe entries, etc.
- viii. Housing for the LPG cylinders, e.g. cabinets, fencing, compartment wall, etc.
- ix. all openings (doors, air intakes, windows, drains, manholes, etc.) and exits adjacent to the LPG installation
- x. Locations of hydrant, access way, access road, car parking area, building and boundary lines, source of ignition, etc.
- xi. Fire safety provisions, e.g. fire hose reel, fire extinguisher, sprinkler protection, gas leak detector, and other related features.
- xii. For LPG cylinders installation involving mechanical ventilation system and/or fire suppression system, separate Mechanical Ventilation plan and/or Fire Protection plan shall be submitted to Civil Defence for approval.

3. LPG Cylinder Installation Requirements

3.1. Main Considerations for Use of LPG

- 3.1.1. The following factors shall be taken into consideration when deciding on the practicality and reasonableness to use LPG:
 - i. Adequacy of ventilation
 - ii. Extent of usage of individual rooms
 - iii. Existing fire hazard
 - iv. Suitable means of escape
 - v. Fire fighting equipment and provisions.

3.2. Codes of Practice & Standards

- 3.2.1. All cylinders and their ancillary fittings shall be designed, fabricated and tested in accordance with the accepted code or standard as stated in **Annex A**.

3.3. Fire Stopping

- 3.3.1. All pipes penetrating fire wall or floor slab shall be fire stopped appropriately.



3.4. Pressure

- 3.4.1.** No liquid LPG or LPG vapor at pressure exceeding 20 psi (approximately 138 kPa) shall be piped into any building.

3.5. Fire Extinguisher

- 3.5.1.** The LPG installation shall be provided with at least one approved portable B:C rating dry chemical fire extinguisher having a minimum capacity of 9kg.

3.6. Warning Sign / Notice

- 3.6.1.** A warning sign or notice of minimum size of 800mm x 600mm shall be permanently and legibly displayed at the front of the installation.
- 3.6.2.** Red letterings of minimum height of 50mm which reads: "LPG / HIGHLY FLAMMABLE / NO SMOKING / NO NAKED LIGHTS" on white background shall be written on the left portion of the warning sign/notice.
- 3.6.3.** Immediately under the classification of Hazmat, three equal boxes showing: (1) the emergency action (Hazchem Code); (2) the licensed quantity in liters and (3) the telephone number and name of the supplier company whom specialized advice can be obtained at all times. (see [Annex D](#))

4. Requirements for Outdoor LPG Cylinder Installation

4.1. Locating of LPG Cylinders

- 4.1.1.** LPG cylinders shall be placed on a firm, clean, dry and level base. They shall be sited at ground level and a well-ventilated area where any gas leakage can safely and rapidly disperse. They shall not be placed close to any passageways or exits and shall not cause any obstruction or danger to the occupants during gas leakage or fire. (See Annex A for illustrations).
- 4.1.2.** LPG cylinders shall not be located within less than 3m of any fire exit route of a building having only one exit. If the 3m distance cannot be complied with, a 2-hour fire rated masonry wall shall be provided between the fire exit and the LPG installation so as to achieve the equivalent 3m horizontal distance. The masonry wall shall be at least 1.8m high.
- 4.1.3.** The LPG cylinders shall be located at least 1.5m horizontally away from any openings (windows, doors, air vents, balanced-flue outlets, etc.) of the building having more than one exit. If the 1.5m distance cannot be complied, a 2-hour fire rated masonry wall must be provided between the openings and the installation so as to maintain a 1.5m horizontal distance. The masonry wall should be at least 1.8m high.



- 4.1.4.** A minimum horizontal distance of 3m shall be maintained for quantities more than 270kg (6 x 45kg cylinders) from any openings (windows, doors, air vents, balanced-flue outlets, etc.) of the building having more than one exit. If the 3m distance cannot be complied, a 2-hour fire rated masonry wall must be provided between the openings and the installation so as to maintain a 3m horizontal distance. The masonry wall should be at least 1.8m high.
- 4.1.5.** A minimum distance of 3m must be maintained between the edge of a vehicle parking lot.
- 4.1.6.** LPG cylinders shall be located at least 5m horizontally from any mechanical air intake which is below any part of the manifold system and 1.5m from any mechanical intake which is above any part of the manifold system.
- 4.1.7.** LPG cylinders may be installed below windows or openings provided that there is a minimum distance of 150mm between the top of any cylinder or the manifold system and the bottom of the windows or openings.
- 4.1.8.** LPG cylinders of total capacity up to 270kg shall be located at least 1.5m from any uncovered opening that is below the level of the cylinders, such as drains, pits, openings to basements, etc. For LPG cylinders having total capacity above 270kg to 450kg, the distance from any uncovered opening shall be at least 3m.
- 4.1.9.** LPG cylinders shall be located at least 3m away from any boundary and any fire engine accessway.
- 4.1.10.** LPG cylinders shall be located at least 10m away from any fire hydrant.

4.2. Protection to LPG Cylinder Installation

- 4.2.1.** LPG cylinders located in places accessible to the public shall be protected and locked against tampering and accidental damage by fencing of height not less than 1.8m, a suitable housing or a cabinet made of non-combustible material.
- 4.2.2.** There shall not be any corrosive, toxic or oxidizing materials located within 6 meters from the cylinder installation.

4.3. Safety Provisions

- 4.3.1.** An approved gas-leak detection system shall be provided in the area or compartment where the internal LPG pipes and fittings are installed, with a local alarm connected to a main fire alarm panel. The system shall be linked to the exhaust fan system and the emergency shut-off valve where applicable. (see [Annex A](#))



- 4.3.2. For kitchen provided with fixed fire suppression system, activation of the system shall automatically shut off the supply of LPG to the kitchen.
- 4.3.3. Remote Emergency shut-off valve shall be located at least 3m away from the edge of the installation. It shall be clearly marked and placed at a suitable height for easy access during emergencies. (see Annex B).
- 4.3.4. There shall be no ignition source within 3m from the cylinder installation.
- 4.3.5. All fixed electrical equipment within 1.5m of the installation shall be spark-proof and intrinsically safe in accordance with the relevant clause in NFPA 70.
- 4.3.6. Vaporizers shall not be installed inside the steel cabinet or within the same housing of the LPG cylinders. Wall-mounted vaporizers shall be located at least 1.8m above the ground and 600mm away from any LPG cylinder.
- 4.3.7. The distance between two separate manifold systems shall be at least 3m. If a 2-hour fire rated wall is constructed, the distance between the two nearest cylinders may be halved to 1.5m. If any one of the manifold system have more than 270kg of LPG, the distance between the two manifold systems shall be 6m. This distance can be reduced to 3m if a 2-hour fire rated wall is constructed between them.

4.4. Allowable Quantities

- 4.4.1. LPG cylinder installation with capacity up to a maximum of 450kg by weight attached to a single manifold system installed adjacent to a building is allowed provided that the following requirements are fully complied with (see [Annex A and B](#)):
 - i. Maximum two numbers of steel cabinets are allowed for each installation, and each cabinet is allowed to house a maximum of 5 x 45kg LPG cylinders;
 - ii. The separation distance between the two cabinets shall be at least 600mm.
 - iii. The building is of non-combustible construction and the wall has a fire rating of at least 2 hours resistance.
 - iv. The maximum allowable quantity of LPG shall be 450kg per building or 10 cylinders whichever lesser.

5. Requirements for Indoor LPG Cylinder Installation

5.1. General

- 5.1.1. LPG cylinder installation inside the building is generally not permitted.



5.1.2. LPG cylinder installation shall be properly located so as not to cause any obstruction to the fire escape and any danger to the public. Suitable access to the cylinder for emergency services shall be provided.

5.1.3. The edge of the installation shall be at least 3m from any boundary or any fire engine access way.

5.2. Safety Provisions

5.2.1. An approved gas leak detector system shall be provided in that compartment, kitchen and dining area, with a local alarm connected to a main fire alarm panel. The leak detector should link to the exhaust fan control panel and the emergency shut-off valve where applicable. (see Annex A)

5.2.2. The location of the gas leak detector should preferably be not more than 30cm above the ground level and not more than 1.5m away from the edge of the installation and the point of consumption.

5.2.3. Remote Emergency shut-off valve shall not be installed inside the compartment and be at least 1.5m away from the edge of the installation. It shall be clearly marked and at a suitable height to access during emergencies.

5.2.4. Fixed fire suppression system, if installed, shall be linked to the LPG cylinder installation in such a way that activation of the system shall automatically shut off the supply of LPG to the kitchen.

5.2.5. Vaporizers (where applicable) shall not be installed inside the compartment or within the same housing of the LPG cylinders.

5.2.6. The compartment shall only be used for LPG cylinder installation. No other usage is allowed.

5.2.7. The floor of the compartment shall be a smooth concrete base (rough surface might cause sparking during loading/unloading of cylinders) containing no opening or drain where vapor may accumulate and shall be level or slope down towards the ventilated external wall.

5.2.8. A ramp or sill of 250mm high shall be provided across the doorway (where applicable) into the compartment where LPG cylinders are installed to contain any heavy LPG vapor within the compartment.

5.2.9. All electrical connections and appliances shall be installed in accordance with the relevant clauses in NFPA 70 and 72.



5.3. LPG Cylinder installation in separate compartment

- 5.3.1.** LPG cylinders are allowed to be installed in a separate compartment on the ground floor, provided with the following requirements are complied with: (See [Annex A and C](#))

5.4. Allowable Quantity

- 5.4.1.** A maximum of 270kg of LPG is allowed to be installed using a single manifold system inside a compartment. The quantity of cylinder is restricted to 6, regardless of the capacity of each cylinder (e.g. 6 x 45kg cylinders or 6 x 15kg cylinders).
- 5.4.2.** The separation distance between the two banks of cylinders shall be at least 600mm
- 5.4.3.** The maximum allowable quantity of LPG shall be 270kg per building or 6 cylinders whichever lesser.

5.5. Compartment

- 5.5.1.** The compartment shall have at least one external wall and there shall be no access from the compartment into the building.
- 5.5.2.** Walls common to the compartment and the internal spaces of the building shall be 2-hour fire rated and shall be of masonry construction.
- 5.5.3.** Each compartment shall contain only one number LPG manifold system.

5.6. Ventilation

- 5.6.1.** Doors shall have high and low level louvers and shall be opened outwards.
- 5.6.2.** Natural ventilation is allowed if the distance between the external wall and its opposite wall is not more than 1.5m. Otherwise, mechanical ventilation shall be provided.
- 5.6.3.** High and low vents shall be provided on the external wall at just below ceiling level and above floor level. The total free area of the vents provided shall be at least 300 cm²/m² of floor area.
- 5.6.4.** The vent openings shall be kept free from obstruction and shall not discharge directly onto a public place, e.g. a pavement or path. It shall not be less than 5m from any air intake openings and shall be at least 1.5m horizontally away from any building opening which is below the vent opening level.
- 5.6.5.** Where mechanical ventilation is used, air circulation shall be at least 0.3 m³/min.m² of floor area. Discharge outlets shall be at least 1.5m



horizontally away from any building opening which is located below the discharge level.

5.7. Location

- 5.7.1.** The edge of the compartment shall not be located within less than 1.5m of any fire exit route from a building that has only one designated means of exit. If the 1.5m distance cannot be complied with, a 2-hour fire rated masonry wall shall be provided between the fire exit and the installation so as to achieve the 1.5m horizontal distance.
- 5.7.2.** The edge of the compartment shall be located at least 1.5m from any horizontal openings (windows, doors, air vents, balanced-flue outlets, etc.) of the building having more than one designated means of escape, measured horizontally from the nearest LPG cylinder. If the 1.5m distance cannot be complied with, a 2-hour fire rated masonry wall shall be provided between the openings and the installation so as to achieve the 1.5m horizontal distance.
- 5.7.3.** The edge of the compartment shall be located at least 3m from ignition source.
- 5.7.4.** A minimum distance of 3m horizontal distance must be maintained between the nearest edge of a vehicle parking lot to the recessed area.
- 5.7.5.** Compartment located below windows or openings shall maintain a minimum distance of 150mm between the top of the compartment and the bottom of the windows or openings.
- 5.7.6.** The edge of the compartment shall be located at least 5m horizontally from any mechanical air intake which is below any part of the compartment and 1.5m from any mechanical intake which is above any part of the compartment.

5.8. Safety

- 5.8.1.** Any pipe penetration on the walls of the recess area shall be suitably fire stopped to maintain the 2-hour fire resistance of the walls.
- 5.8.2.** An approved gas leak detector system shall be provided in the compartment where the LPG pipes pass through, with a local alarm connected to a main fire alarm panel. The gas leak detector shall be linked to the exhaust fan control panel and the emergency shut-off valve where applicable. (see [Annex A](#))



6. Fire Safety Guidelines for Roof Top Central LPG Container Installations

6.1. General Description

- 6.1.1.** This part of the LPG guideline is intended for LPG containers installed on roof top of buildings. It provides separation distances, allowable quantities, construction material, detection system, suppression system, fire fighting requirements and other system configurations in relation to roof top installation.

6.2. System Design Requirements

- 6.2.1.** Central tank LPG is preferred to be installed underground or above ground locations rather than roof top locations.
- 6.2.2.** LPG containers are not allowed to be installed on the roof of high-rise buildings. However, considering the UAE's building and space trend, it is permitted on roof subjected to strict compliance with Code and regulation requirements.
- 6.2.3.** The building shall be of Type I, 443 or 332, or Type II, 222, construction as specified in NFPA 220, Standard on Types of Building Construction. For other types of construction, the total allowable quantity shall be reduced to 1000 gal.
- 6.2.4.** The LPG container shall always be filled by two operators, one at the controls of the vehicle supplying LPG and another at the controller of the container.
- 6.2.5.** Containers shall be installed in external locations only.
- 6.2.6.** Fill line and connection shall be located entirely outside the building.
- 6.2.7.** Containers shall be installed on a level surface.
- 6.2.8.** The container shall be secured to the building structure.
- 6.2.9.** All valves and controls shall be easily accessible and have sufficient space for maintenance.
- 6.2.10.** All liquid and vapor withdrawal openings that are 3.2cm or larger shall be equipped with internal valves.
- 6.2.11.** The internal valves shall be remain closed except during periods of operations.
- 6.2.12.** Internal valves shall be equipped with remote closure and automatic shutoff through thermal activation.
- 6.2.13.** A positive manual shutoff valve shall be installed as close as practical to each internal valve.



- 6.2.14.** All liquid and vapor inlet openings shall be equipped with a backflow check valve where applicable installed with a positive manual shut off valve installed as close as practical to the backflow check valve.
- 6.2.15.** Insulation of container shall be able to limit the container to not over 427 degree Celsius for a minimum period of 50 minutes.
- 6.2.16.** The support of the container shall be designed to the same seismic criteria as the building.
- 6.2.17.** The roof which the container is located shall be able to support the weight of the container filled with water.

6.3. Safe Distances and Allowable Quantities

- 6.3.1.** Containers shall be located in areas where there is free air circulation, at least 3m from building openings such as windows and doors. It shall be at least 6.1m from air intakes for air-conditioning and ventilation systems. Distance between container and the edge of building can be reduce to 3m if the distance between containers is increased to 7.6m
- 6.3.2.** Fill connection shall be located at least 2.4m above the ground.
- 6.3.3.** The total allowable quantity to be installed on a roof top shall be 2000gal. Total quantities above 2000gal shall require risk analysis and emergency planning based on NFPA 58 as well as permission from Civil Defence prior to planning of such installations.
- 6.3.4.** If more than one container (e.g. 2 numbers of 1000gals), the distance between the container(s) shall be in accordance to the [Table 11.1](#).

Table 11.1 : Minimum roof top tank separation distances

Table 11.1 : Minimum roof top separation distances from the tank surface				
AGGREGATE WATER CAPACITY	DISTANCE TO AIR INTAKE FOR AIR-CONDITIONING AND VENTILATION SYSTEMS	DISTANCE TO BUILDING OPENINGS, I.E. DOORS, SHAFTS AND WINDOWS	DISTANCE TO EDGE OF BUILDING ROOF	BETWEEN CONTAINERS
gal	m	m	m	m
Less than 125	6.1	3	0	0
125 - 250	6.1	3	3	0
251 - 500	6.1	3	3	1
501 - 2000	6.1	3	7.6	1
More than 2000	Not allowed on roof top, on podium locations			

(See [Annex E](#) for examples of acceptable location and distances)



6.4. Piping and Connections

6.4.1. If the container location is higher than 7m from the ground, or the filling hose cannot be monitored by the operator in its entire length, the container shall be a filling line constructed to withstand liquid transfer and shall have the following appurtenances:

- i. Filler valve with back check valve.
- ii. Filler valve cap.
- iii. Two control valves.
- iv. Hydrostatic relief valve.
- v. Venting line.

6.4.2. The liquid and vapor fill connections shall be conspicuously marked or labeled.

6.4.3. No liquid phase LPG shall be allowed to be piped into the building.

6.4.4. LPG pipe installation shall not be permitted in the following areas.

- i. In the ground under concrete flooring within the building.
- ii. Under building foundation.
- iii. Within lift shafts and cavity walls.
- iv. In compartments or ducts dedicated for electrical switchgears, transformers or generators.
- v. In refrigeration chambers, cold rooms, air handling unit rooms and ventilation or air-conditioning ducts.
- vi. Adjacent to pipes and vessels containing flammable, oxidizing, corrosive and other hazardous materials.

6.4.5. Proper pipe sleeves shall be installed for LPG pipes running in enclosed, unventilated areas or basement floor and at least one end exposed directly to the exterior open safe space. Pipe sleeves and gas leak detectors shall be located such that it facilitates detection of gas leak effectively.

6.5. Pipe Material

6.5.1. LPG fill line shall be seamless steel to ASTM A53, A106 GrB, API 5L GrB schedule 80.

6.5.2. Below ground Distribution pipe work shall be seamless steel to ASTM A53, A 106 with Denso /Bitumen Tape wrapping or HDPE/MDPE SDR11.

6.5.3. Above ground distribution pipe work shall be Seamless Carbon steel Pipe to ASTM A53, Grade B.

6.5.4. Above Ground copper Pipe shall confirm to ASTM B280/ BS 2871.

6.5.5. Final connections to equipment shall be Flexible Hose



6.6. System Shut- Off Configuration

- 6.6.1. Gas leak detectors shall be provided in areas where there is insufficient ventilation and where accidental accumulation of LPG vapor could occur.
- 6.6.2. The gas leak detector shall be linked to the exhaust fan and the emergency shut-off valve as well as the fire alarm where applicable.
- 6.6.3. A remote shutdown station shall be provided within 4.6m of point of transfer.
- 6.6.4. At least an additional remote shutdown station shall be installed not less than 7.6m or more than 30.5m from the transfer point.
- 6.6.5. Kitchen suppression system, if installed, shall be linked to the LPG cylinder installation in such a way that the activation of the system shall automatically shut off the supply of LPG to the kitchen. See **Figure 11.1** of Annex A for the connection between LPG shut-off, gas leak detection, kitchen exhaust, and kitchen suppression system.

6.7. Protection and Fire Fighting Requirement.

- 6.7.1. A product release prevention and incident preparedness review may be required to be submitted by the owner, operator or the authorized person if requested by Civil Defence. The review shall be an evaluation of the total Liquefied Petroleum Gas control system, such as emergency shut-off and internal valves equipped for remote closure as well as automatic shut off through thermal actuation.
- 6.7.2. The location of the container shall have at least 2 fixed protected stairs to reach it.
- 6.7.3. Wet standpipe system equipped with landing valves shall be provided inside the protected staircase.
- 6.7.4. Fire engine accessway and other means of access for fire fighting access shall be provided. Emergency controls shall be conspicuously marked and the controls shall be located so as to be readily accessible in emergencies.
- 6.7.5. Water spray fixed system or monitors shall be used and shall be automatically activated by fire alarm.
- 6.7.6. The water spray fixed system or monitors shall be able to be activated manually and shall be positioned so as to wet all surfaces of the container exposed to fire.
- 6.7.7. NFPA 58 and NFPA 54 shall be referred for other relevant requirements concerning roof top LPG installation.



6.8. LPG Storage Tank

6.8.1. Containers shall be designed, fabricated, tested and marked (or stamped) in accordance with one of the following

- i. Regulations of the U.S Department of Transportation (DOT), the “Rules for the Construction of Unfired Pressure Vessels”, Section VIII, Division 1
- ii. ASME Boiler and Pressure Vessel Code
- iii. API-ASME Code for Unfired Pressure Vessels for Petroleum Liquids and Gases.
- iv. BS5500 or EN 12542/EN 14075
- v. AD Merkblatt Standards.

6.8.2. Heating or cooling coils shall not be installed inside storage containers.

6.8.3. Each tank shall be equipped with Magnetic Level Gauge , fixed level Gauge , Safety Relief Valve , Shut off Valve , Pressure Gauge , Multi Valve , Back flow Check Valve , Drain Valve , Excess Flow Valve and other related accessories.

7. Fire Safety Guidelines for Aboveground Central LPG Container Installations

7.1. For aboveground LPG central container, the separation distances from the tank surface to any point of structure or the property boundary shall be according to the **Table 11.2**

7.2. All other design, installation, piping and safety considerations shall be in accordance with **section 6**.

Table 11.2 : Minimum Aboveground LPG Container separation distances

Table 11.2 : Minimum aboveground LPG container separation distances				
AGGREGATE WATER CAPACITY	DISTANCE TO AIR INTAKE FOR AIR-CONDITIONING AND VENTILATION SYSTEMS	DISTANCE TO BUILDING OPENINGS, I.E. DOORS, SHAFTS AND WINDOWS	DISTANCE TO ANY POINT OF THE STRUCTURE OR BUILDING	BETWEEN CONTAINERS
gal	m	m	m	m
Less than 125	6.1	3	0	0
125-250	6.1	3	3	0
251-500	6.1	3	3	1
501-2000	6.1	3	7.6	1
2001-30,000	6.1	3	15	1.5
30,001-70,000	6.1	3	23	¼ of the diameter of the adjacent containers
70,001-90,000	6.1	3	30	
90,001-120,000	6.1	3	38	
120,001-200,000	6.1	3	61	
200,001–1,000,000	6.1	3	91	
More than 1,000,000	6.1	3	122	



8. Fire Safety Guidelines for Underground and Mounded Central LPG Container Installations

- 8.1.** For underground and mounded LPG central container, the separation distances from the tank surface to any point of structure or the property boundary shall be according to the **Table 11.3**
- 8.2.** All other design, installation, piping and safety considerations shall be in accordance with **section 6**.

Table 11.3 : Minimum Underground LPG container separation distances

AGGREGATE WATER CAPACITY	DISTANCE TO AIR INTAKE FOR AIR-CONDITIONING AND VENTILATION SYSTEMS	DISTANCE TO BUILDING OPENINGS, I.E. DOORS, SHAFTS AND WINDOWS	DISTANCE TO ANY POINT OF THE STRUCTURE OR BUILDING	BETWEEN CONTAINERS
gal	m	m	m	m
Less than 125	6.1	3	3	0
125-250	6.1	3	3	0
251-500	6.1	3	3	1
501-2000	6.1	3	3	1
2001-30,000	6.1	3	15	1.5
30,001-70,000	6.1	3	15	¼ of the diameter of the adjacent containers
70,001-90,000	6.1	3	15	
90,001-120,000	6.1	3	15	
120,001-200,000	6.1	3	15	
200,001-1,000,000	6.1	3	15	
More than 1,000,000	6.1	3	15	



ANNEX A**STANDARDS AND SPECIFICATIONS FOR LPG CYLINDER INSTALLATIONS****1. Standards**

1.1. The standards for LPG cylinders and ancillary fittings shall be complied with NFPA 54 and 58.

2. Specifications**2.1. LPG Cylinder Fittings****2.1.1. Flexible hoses**

Hoses or flexible connectors used to supply LPG to utilization equipment or appliances shall be installed in accordance with the relevant clauses of NFPA 54 and NFPA 58. The hose shall be securely connected to the appliance. The use of rubber slip ends without hose clips shall not be permitted for domestic cylinders.

2.1.2. Regulators

Regulators shall comply with the standards as specified in the table above.

2.1.3. Over Pressure Protection Device

- i. An over pressure protection device (OPD) is a device to protect the down stream installation and shut off the gas flow if the outlet pressure exceeds the set limit.
- ii. In general, a regulator with OPD shall be designed to achieve the following:
 - a. ensuring reliable and continuous supply of LPG;
 - b. protecting down stream system against over pressure; and
 - c. protecting against failure of any regulating device.
- iii. Setting of OPD shall not be more than 30% of maximum operating pressure.

2.1.4. Valves**2.1.4.1. Cylinder Valves**

Cylinder valves shall comply with the standards as specified in the table above.



2.1.4.2. Safety Valves

- i. Hydrostatic relief valves designed to relieve the hydrostatic pressure that might develop in sections of liquid piping between two isolating valves shall be installed in each section. Hydrostatic valves shall comply with UL 132, Standard for Pressure Relief Valves for LPG.
- ii. Emergency shut-off valve (ESV) shall be provided after the knockout pot. The ESV shall be linked to a release mechanism so that the valve can be closed from a safe distance of at least 3m from the LPG cylinders. The ESV may incorporate fusible element which melts at not more than 250 degree Celsius when exposed to fire, allowing the ESV to close by itself.
- iii. An accessible gas shutoff valve shall be provided at the upstream of each gas pressure regulator. Where two gas pressure regulators are installed in series in a single gas line, a manual valve shall not be required at the second regulator.
- iv. Main gas shut-off valves controlling several gas piping systems shall be prominent and readily accessible for operation and properly installed so as to protect it from physical damage. They shall be marked with a metal tag or other permanent means attached by the installing agency so that the gas piping systems supplied through them can be readily identified.
- v. An exterior shut-off valve to permit turning off the gas supply to each building in an emergency shall be provided and plainly marked.

2.1.5. Piping

- i. Pipe design and specifications shall be in accordance with the relevant clauses in NFPA 54 and NFPA 58. No polyethylene material is allowed to be used for the piping system except for necessary industrial applications.
- ii. Pipe material shall be tested and certified according to recognized ASTM or British Standard. The pipe supplier shall produce Mill certificates.
- iii. The manifold and main LPG supply pipeline shall be welded together as far as practicable. Welders for the piping work must be qualified and certified by a recognized body.
- iv. Pipelines pressure test must be witnessed and certified by a Professional Engineer (Mechanical) or 3rd Party Inspector.
- v. The liquid LPG pipelines shall be painted in “Blue” and the vapor LPG pipelines in “Yellow” with the marking of the word “LP-Gas” at intervals of not more than 3m.



- vi. When connecting additional gas utilization equipment to a gas piping system, the existing piping shall be checked to determine if it has adequate capacity. If inadequate, the existing system shall be enlarged as required, or separate gas equipment of adequate capacity shall be provided.

2.1.6. Pigtail

- i. Pigtail shall include a 6mm flexible hose or tube, a 6mm tee-check valve or excess flow valve and a 6mm ball valve.
- ii. Flexible hose shall be fabricated of materials resistant to LPG reaction both in liquid and vapor state. It shall be designed for a minimum bursting pressure of 1,750 PSI (121 bar) and working pressure of 350 PSI (24 bar). The hose shall be marked "LPG" at intervals of not more than 3m.
- iii. The tee-check valve shall be Underwriters Laboratories Inc. (UL) listed or it shall comply with other recognized/approved standard.
- iv. The ball valve shall be rated to at least 600 PSI (41 bar).

2.1.7. Pressure Gauge

- i. Each bank of LPG cylinder manifold shall have a pressure gauge.
- ii. For high-pressure section, the gauge shall have a range of 0 to 300 PSI (0 to 20.1 bar)
- iii. For low-pressure section, the gauge shall have a range of 0 to 50 PSI (0 to 3.45 bar)

2.1.8. Vaporizer

- i. Vaporizers, where applicable, shall be constructed in accordance with the applicable provision of NFPA 58, ASME Code or other recognized pressure vessel codes and standards for a design pressure of 250 PSI (17.24 bar) and shall be permanently and legibly marked with:
 - a. markings required by the Code;
 - b. the allowable working pressure and temperature for which it is designed; and
 - c. the name or symbol of the manufacturer.
- ii. Vaporizers shall be provided with a suitable automatic means to prevent the passage of liquid through the vaporizer to the vapor discharge piping. This feature shall be permitted to be integrated with the vaporizer or otherwise provided in the external piping.



- iii. Vaporizers shall have a manual shut-off valve and an automated valve (e.g. thermostatic, magnetic or float) which closes in the event of power failure or overload.
- iv. Vaporizers shall have relevant temperature control and the necessary safety features.
- v. Vaporizers shall have a pressure relief valve set at 250 PSI (17.24 bar) with the release point directed upward.

2.1.9. Knock-out pot

The knockout pot shall have at least two drain valves. The drain shall end at ground level and plugged at the end.

2.1.10. Gas Meters

- i. Installation and application of gas meters shall be in accordance with the relevant clauses in NFPA 54 and must be able to take a pressure of 20 PSI (1 PSI = 6.895 KPa).
- ii. Gas meters shall be selected for the maximum expected pressure and permissible pressure drop.
- iii. Vapor meters of the tin or brass case type of soldered construction shall not be used at pressure in excess of 1 PSI (7 KPa).
- iv. Vapor meters of the die cast or iron case type shall be permitted to be used at any pressure equal to or less than the working pressure for which they are designed and marked.
- v. Gas meters shall be located in ventilated spaces readily accessible for examination, reading, replacement or necessary maintenance.
- vi. Gas meters shall not be placed where they will be subjected to damage, such as adjacent to a driveway, under a fire escape, in public passages, halls or where they will be subjected to excessive corrosion or vibration.
- vii. Gas meters shall be located at least 1m from sources of ignition.
- viii. Gas meters shall not be located where they will be subjected to extreme temperatures or sudden extreme changes in temperature. Meters shall not be located in areas where they are subjected to temperatures beyond those recommended by the manufacturer.



- ix. Gas meters shall be supported or connected to rigid piping so as not to exert a strain on the meters.
- x. Gas meters shall be protected against over pressure, backpressure, and vacuum, where such conditions are anticipated.

2.1.11. Strainers

Strainers shall be designed to minimize the possibility of particulate materials clogging lines and damaging meters or regulators. The strainer element shall be accessible for cleaning.

2.2. Electrical Bonding and Grounding

- 2.2.1. Electrical circuits shall not utilize gas piping or components as conductors.
- 2.2.2. All electrical connections between wiring and electrically operated control devices in a piping system shall conform to the requirements of NFPA 70.
- 2.2.3. Any essential safety control (in the vaporizer) depending on electrical current as the operating medium shall be of a type that will shut off (fail safe) the flow of gas in the event of current failure.

2.3. Gas Leak Detection

- 2.3.1. Gas leak detection system shall be provided for LPG pipes running in air conditioned areas (including the dining & kitchen area) or within basement floor).
- 2.3.2. Gas leak detectors shall be connected to a localized alert alarm, emergency shut-off valve as well as the kitchen exhaust systems. The gas supply safety shut-off valve system shall also be interlocking with the kitchen automatic fire suppression system (see Figure 11.1.)

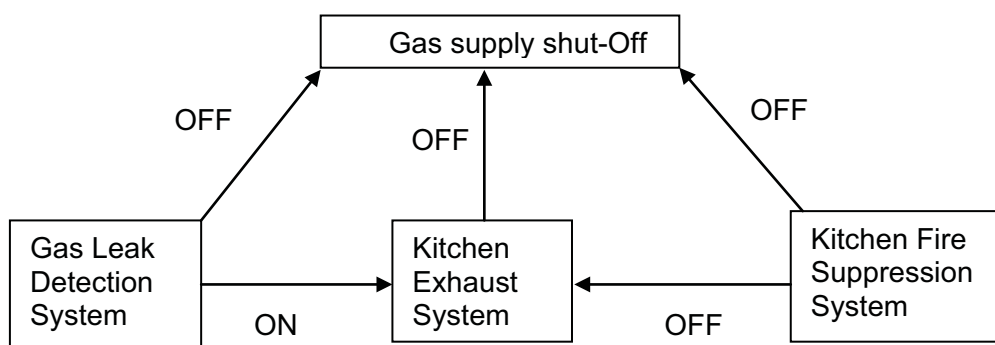


Figure 11.1: Interconnection of gas leak detector, kitchen exhaust, kitchen suppression and gas supply systems.



3. Prohibited Places

3.1. LPG cylinders and pipe installation shall not be permitted in the following areas:

- i. In the ground under concrete flooring within building
- ii. Under building foundations
- iii. Within lift shafts and cavity walls
- iv. In compartments or ducts dedicated for electrical switchgears, transformers or generators
- v. In refrigeration chambers, cold rooms, air handling rooms and ventilation or air-conditioning ducts
- vi. Adjacent to pipes and vessels containing flammable, oxidizing, corrosive and other hazardous materials
- vii. In fire-fighting lobby, fire command centers, smoke stop lobbies, fire pump rooms, fire-fighting water tank rooms, sprinkler control valve rooms, fire fighting riser ducts, areas of refuge, protected corridors, protected staircases, bedrooms and other occupied area etc.

3.2. Proper metal pipe sleeves shall be installed for the gas pipes running in enclosed, unventilated areas or basement floor, and at least one end exposed directly to the exterior open safe space (it may be used to facilitate the gas leak detection system).

3.3. Gas pipe running vertically shall be enclosed within a protected and dedicated riser shaft & be fully fire separated from other Mechanical & Electrical or Service risers. Ventilation opening shall be provided for such gas riser.

4. List of Items to be included in the Plan Submission

4.1. Endorsement on this guideline, NFPA 58, NFPA 54, other relevant and approved standards and the Fire Code.

4.2. Key plan, Location and site plan associated with the LPG installation.

4.3. Detailed plan and elevation views associated with the LPG installation showing the following:

- i. Location and number of cylinders as well as quantity in kilograms.
- ii. Housing for the LPG cylinders, e.g. cabinets, fencing.
- iii. Location of ancillary fittings, e.g. vaporizer, 1st stage regulator, emergency shut off valves, change over valve, remote cable pull, knock out pot and pipe entry.



- iv. Hydrant location, fire engine access way, source of ignition, boundary line, building line, internal roads and parking area.
- v. Location of exits, staircases, details of horizontal openings (e.g. doors, air intakes and windows) and ground openings (e.g. drains, manholes and entrance to basement).
- vi. Fire safety provisions like, hose reel, fire extinguishers, indication of sprinkler protection, gas leak detectors, mechanical ventilation, exhaust systems and fire suppression systems, where applicable. (Fire Protection Plan and Mechanical Ventilation Plan shall be submitted accordingly in addition to the Building Plan submission.)
- vii. Hazard sign as indicated in **ANNEX D** and other relevant information associated with the LPG installation.

5. Material Approval

- 5.1.** All the Materials, Systems, Assemblies, equipment, Products and Accessories, referred to in this chapter with respect to Life Safety, Fire Safety and Emergency Services shall be Listed, Approved and Registered by the Civil Defence Material Approval Department.
- 5.2.** The above requirement applies to all the products with or without international listing, registration or approval.

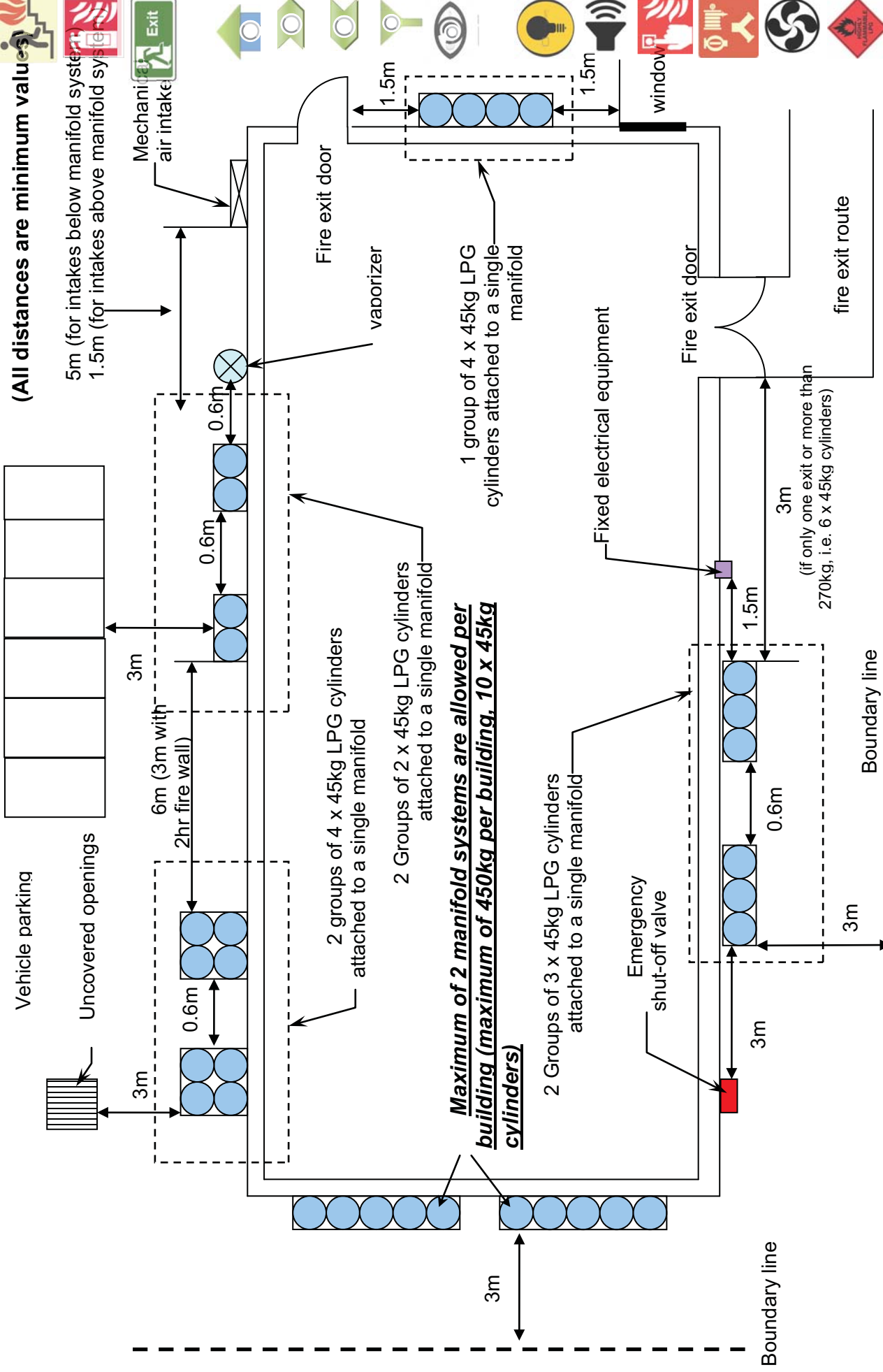
6. Further References

- 6.1.** The following International Codes and Standards were referred, studied and consulted for this chapter. Further details where applicable can be referred to in these Codes and Standards. Also see **XV. ACKNOWLEDGEMENT OF INTERNATIONAL CODES AND STANDARDS.**

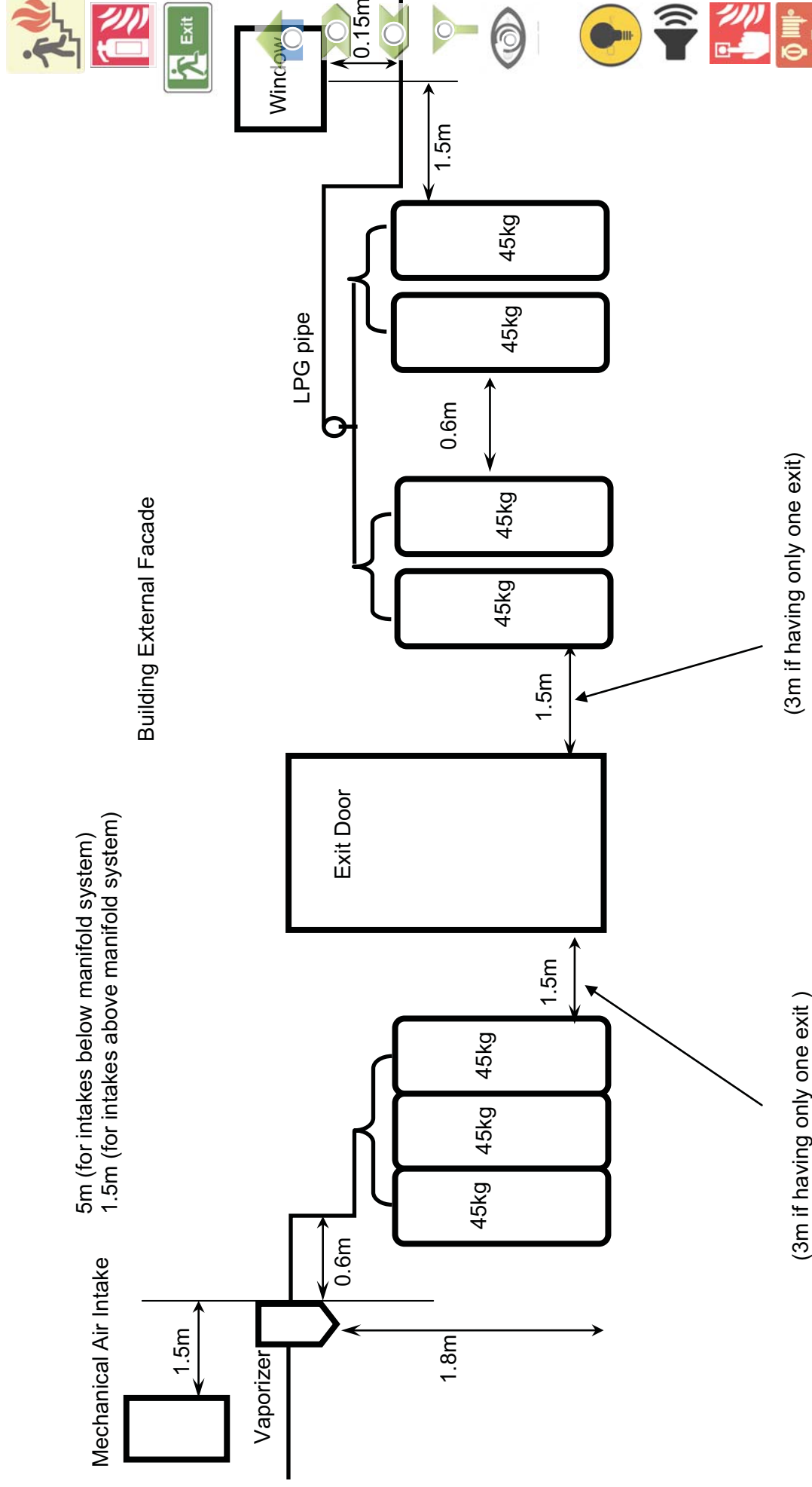
NFPA 54:	ANSI Z223.1–2006, National Fuel Gas Code
NFPA 58:	Liquefied Petroleum Gas Code



ANNEX B - OUTDOOR LPG CYLINDER INSTALLATIONS



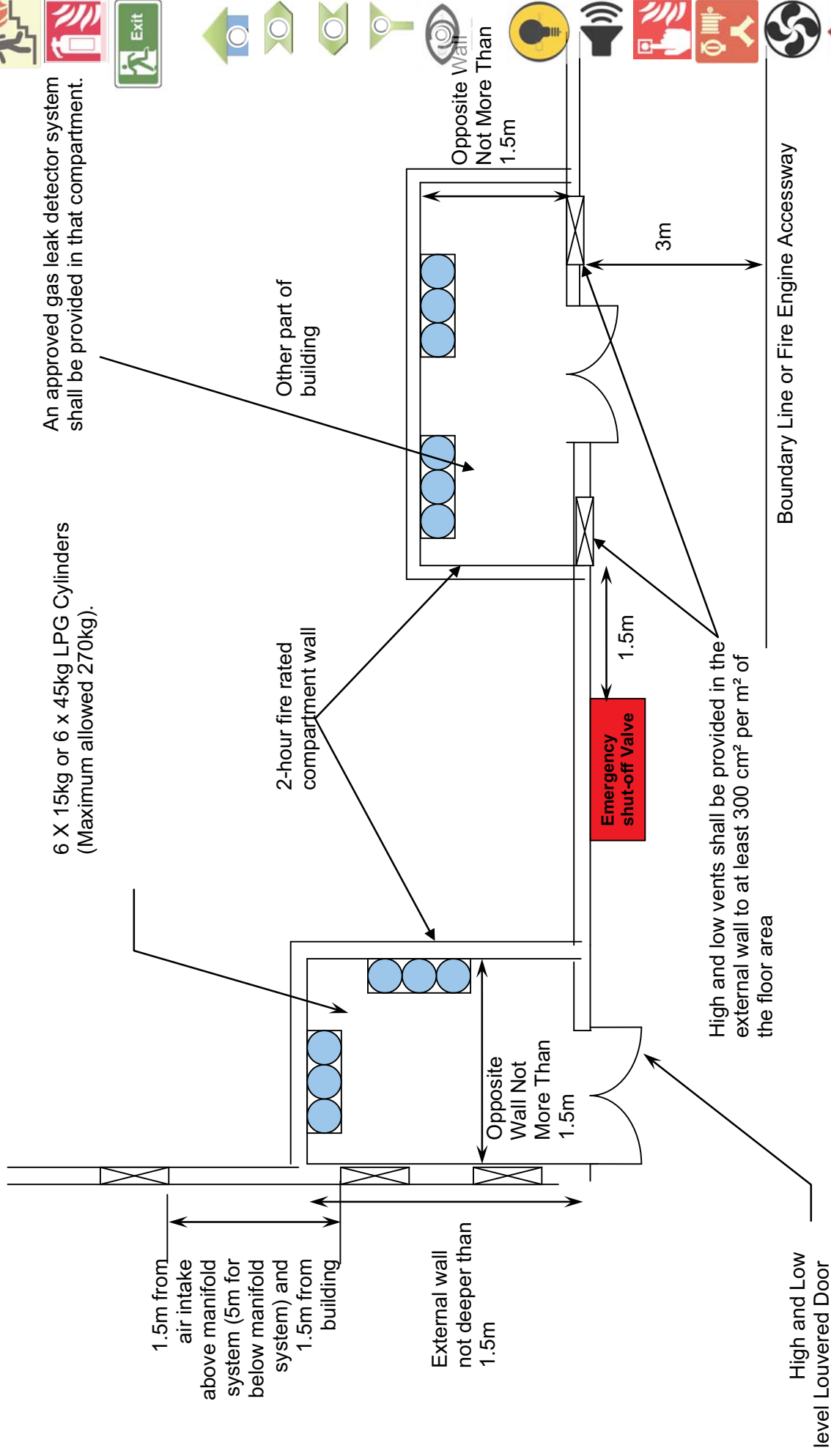
ANNEX B - OUTDOOR LPG CYLINDER INSTALLATIONS



ANNEX B - VARIOUS DISTANCES FOR OUTDOOR LPG CYLINDER INSTALLATIONS

LPG QUANTITY	DISTANCE FROM BOUNDARY	NO. OF BANKS PER MANIFOLD	NO. OF CYLINDERS PER BANK / CLUSTER	NO. OF CYLINDERS PER MANIFOLD	DISTANCE BETWEEN CABINET / CLUSTER	DISTANCE FROM DRAINS, PIT, MANHOLE, OIL TANK BUND WALL, BASEMENT OPENING ETC.	DISTANCE FROM FIRE EXIT ROUTE	HORIZONTAL DISTANCE FROM WINDOWS, DOORS, VENTS, BALANCE FLUE OUTLETS, ETC.	DISTANCE FROM MECHANICAL AIR INTAKE	DISTANCE BETWEEN MANIFOLD SYSTEMS	DISTANCE FROM VEHICLE PARKING LOT
kg	m	no.	no.	no.	m	m	m	m	m	m	m
Less than 270kg	3 min.	2 max.	3 max.	6 max.	0.6 min.	1.5 min.	3 min. (one exit only) 1.5 min. (more than one exit)	1.5 Minimum.	5 min. (intakes below manifold system) 1.5 min. (intakes above manifold system)	3 min. (no fire rated wall) 1.5 min. (with 2-hr fire rated wall)	3.0 Minimum.
270kg to 450kg	3 min.	2 max.	5 max.	10 max.	0.6 min	3 min.	3 min. (one exit only) 1.5 min. (more than one exit)	1.5 Minimum.	5 min. (intakes below manifold system) 1.5 min. (intakes above manifold system)	6 min. (no fire rated wall) 3 min. (with 2-hr fire rated wall)	3.0 Minimum.

ANNEX C INDOOR LPG CYLINDER INSTALLATION IN SEPARATE COMPARTMENT

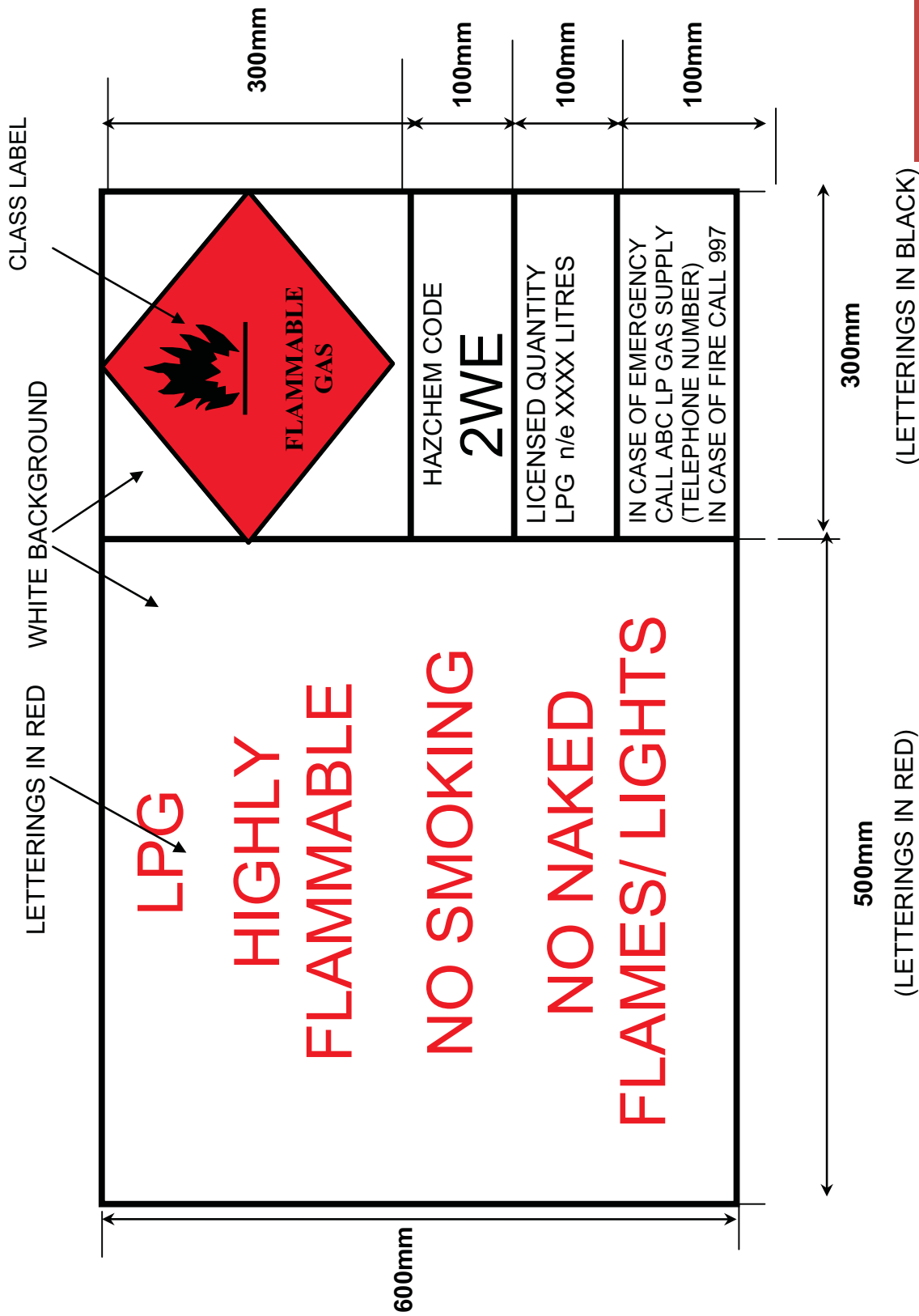


ANNEX C - TECHNICAL DETAILS FOR INDOOR LPG CYLINDER INSTALLATIONS

LOCATION OF LPG	QUANTITY ALLOWED	FIRE RATING OF COMPARTMENT	DISTANCE FROM OPEN FLAME, IGNITION SOURCE	SPRINKLER / GAS LEAK DETECTOR	NATURAL VENTILATION	MECHANICAL VENTILATION	DISTANCE FROM EXITS	MIN. DIST. OF DISCHARGE FROM MECH. AIR INTAKE
	kg	hr	m			m ³ / min	m	m
Separate Compartment	270 max. (6 x 45kg or 6 x 15 kg)	2	3m	Gas leak detector is required together with pipe sleeves and at strategic location where accumulation is possible	a) 300cm ² opening per m ² of compartment floor area b) high and low vents shall be provided c) Compartment not more 1.5m deep from external wall.	0.3 per m ² of compartment floor area (as per NFPA 58)	1.5	1.5 min. (intakes above manifold system)
	Maximum 6 cylinders							5 min. (intakes below manifold system)

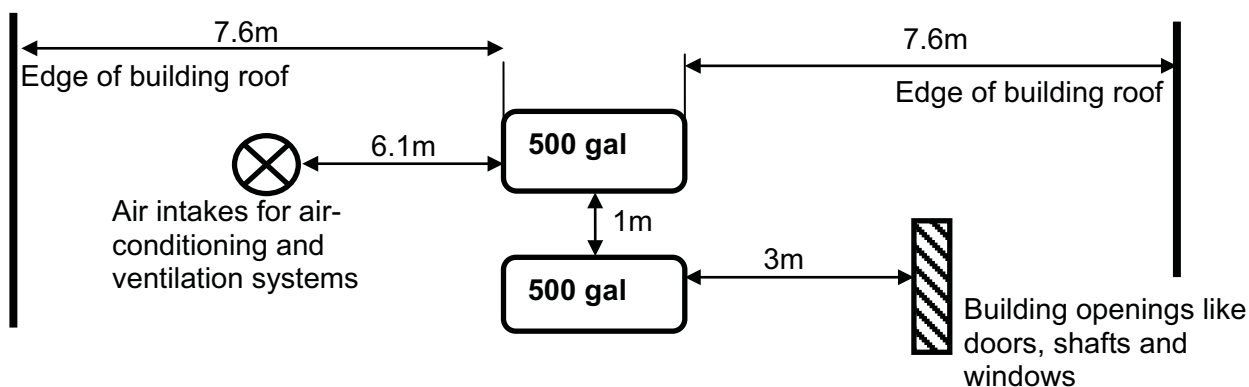


ANNEX D - WARNING SIGN / NOTICE

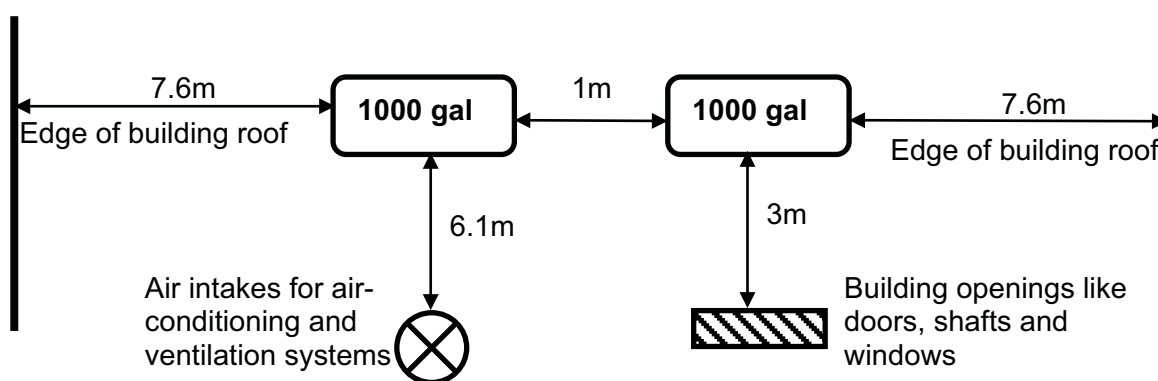


ANNEX E –ROOFTOP CENTRAL LPG TANK INSTALLATION

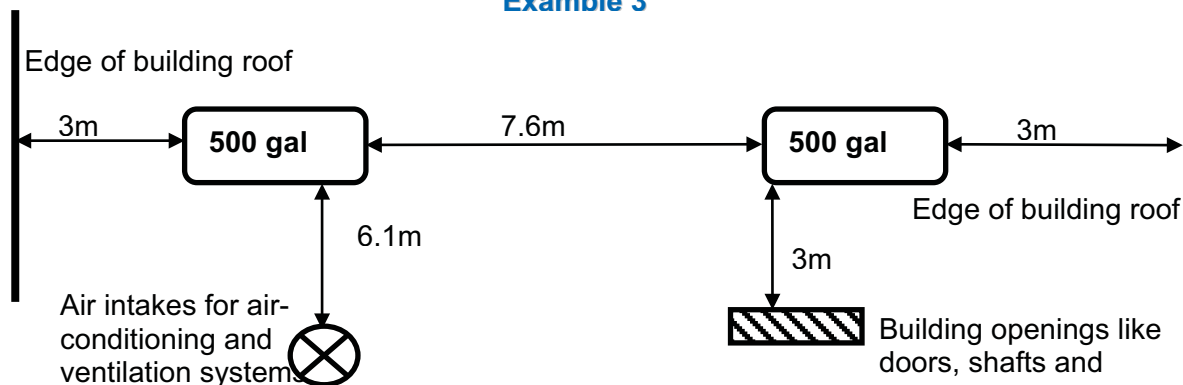
Example 1



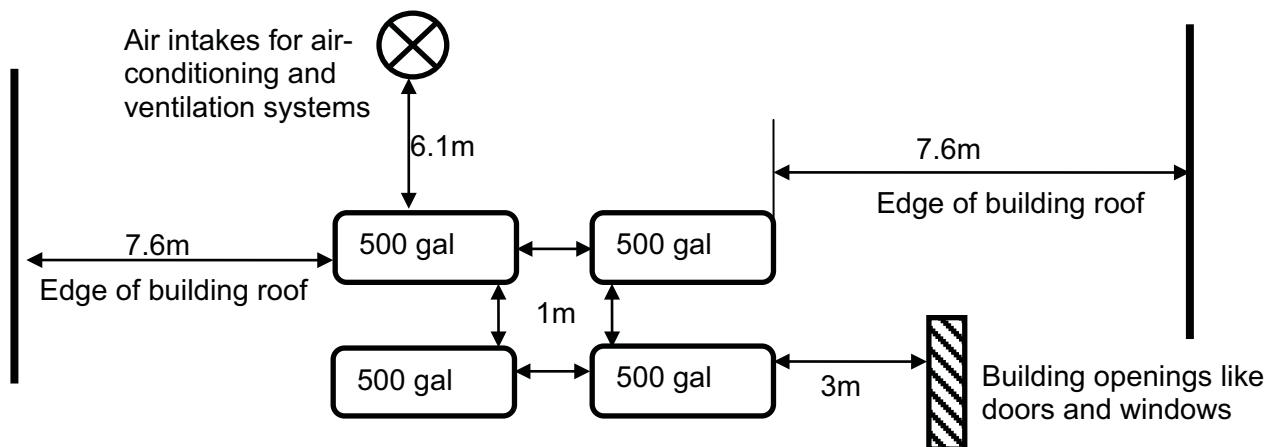
Example 2



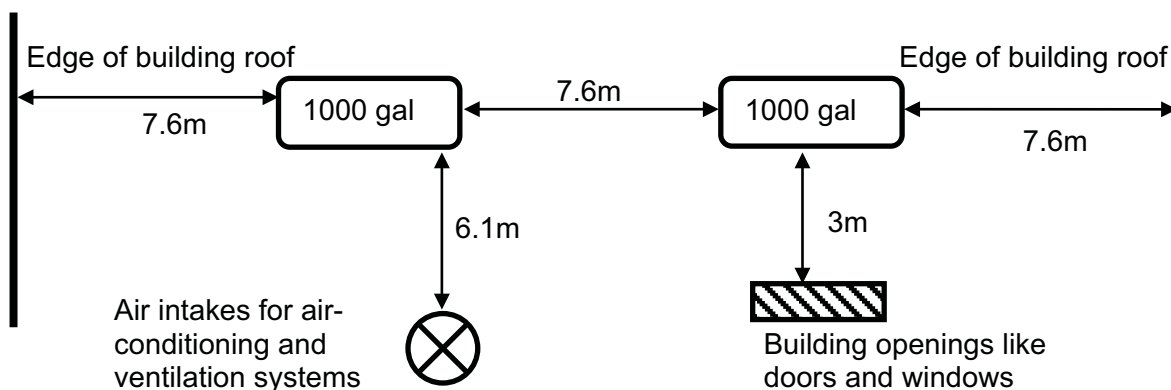
Example 3



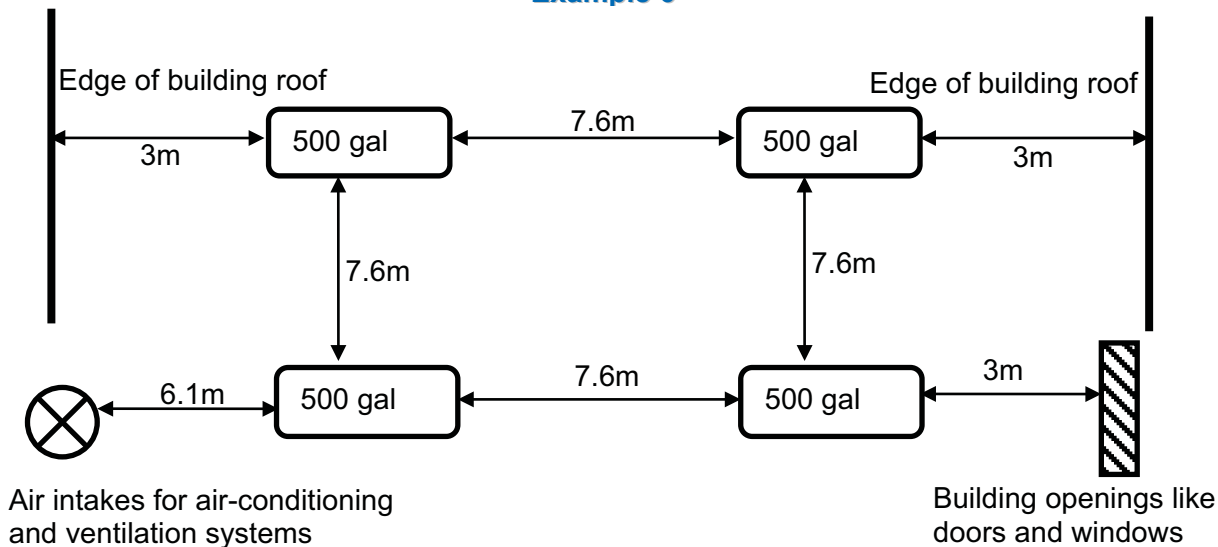
ANNEX E
Example 4



Example 5

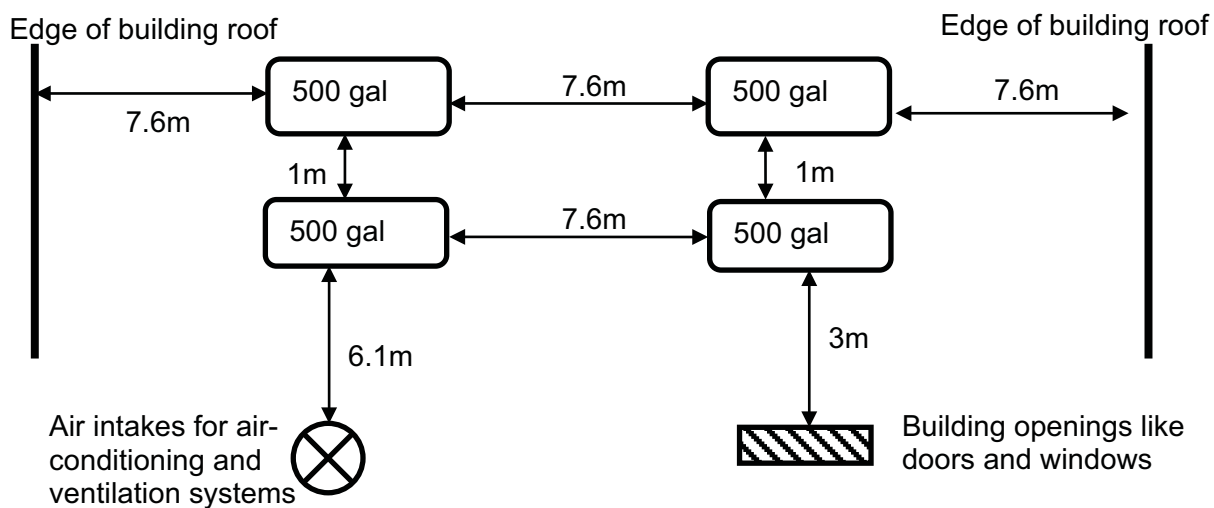


Example 6

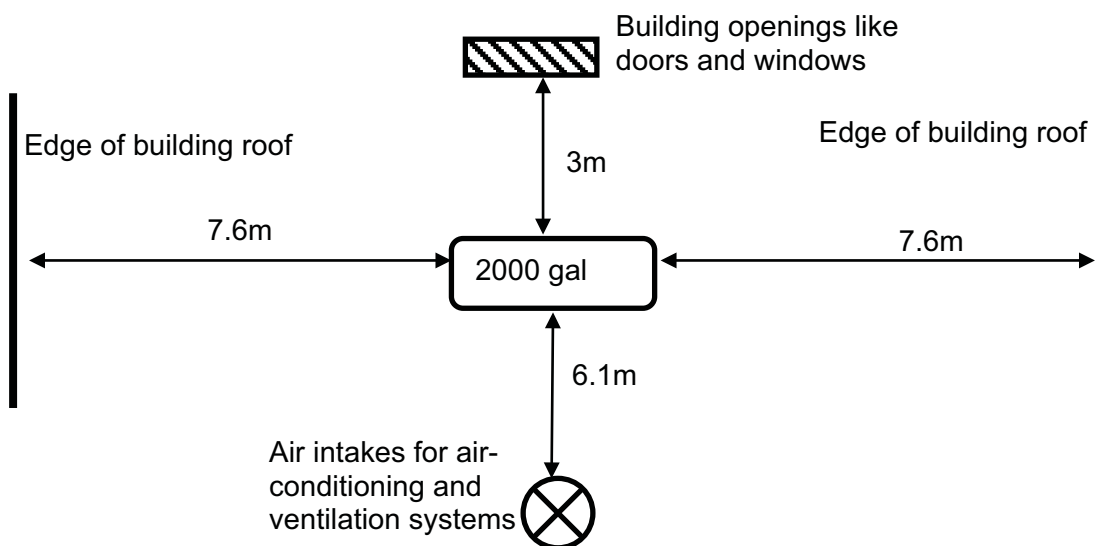


ANNEX E

Example 7



Example 8



CHAPTER 12

FIRE & SAFETY CODES DURING CONSTRUCTION AND MAINTENANCE

1. Policy

- 1.1.** It is the policy of The Civil Defence to ensure that the risk of fire during construction, alteration and demolition operations is minimized in accordance with the requirements of this document.

2. General

- 2.1.** These standards are intended to prescribe minimum safeguards for new building construction and significant building alteration projects in order to provide a reasonable degree of safety to life and property from fire.
- 2.2.** These guidelines are based on the provisions for Fire Safety during building construction as set in National Fire Protection Association (NFPA) 1, 'Fire Prevention Code' and NFPA 241, 'Standard for Safeguarding Construction, Alteration and Demolition Operations' which provide basic measures that shall be followed to minimize and prevent loss.
- 2.3.** This document shall not be construed to be in lieu of any other law or regulation related to construction site safety.
- 2.4.** The general contractor or other designee of the building owner shall be responsible for compliance with these standards.
- 2.5.** When the term "shall" is used in this document, it means a mandatory requirement.
- 2.6.** Alteration activities shall be permitted to require the use of both the demolition and construction activity requirements, as applicable.
- 2.7.** A fire safety program shall be included in all construction, alteration, or demolition contracts, and the right of the owner to administer and enforce this program shall be established, even if the building is entirely under the jurisdiction of the contractor.

3. Fire Protection Plan

- 3.1.** A written Fire Protection plan shall be developed for significant or complex construction projects at the discretion of the Civil Defence. The plan shall be approved by the Civil Defence prior to proceeding past foundation work for new buildings or commencement of demolition work in alteration projects. The written plan shall be consistent with the Fire safety precautions as specified in this standard. The general contractor is responsible for carrying out provisions of the Fire Protection Plan and communication plan shall include the following:
- Procedures for reporting emergencies to the Civil Defence.



- ii. Procedures for emergency notification, evacuation and/or relocation of all persons in the building under construction and on the site.
- iii. Procedures for Hot work operations, management of hazardous materials and removal of combustible debris and maintenance of emergency access roads.
- iv. Floor plans identifying the locations of exits, exit stairs, exit routes and portable fire extinguishers.
- v. Site plans identifying required fire apparatus access roadways and on-site fire hydrants.
- vi. Site plans identifying the designated exterior assembly areas for each evacuation route.
- vii. The name and contact phone number of person(s) responsible for compliance with the Fire Protection Plan.

4. Fire Safety Program

- 4.1.** An overall construction or demolition fire safety program shall be developed. Essential items to be emphasized include the following:

- i. Good housekeeping
- ii. On-site security
- iii. Installation of new fire protection systems as construction progresses
- iv. Preservation of existing systems during demolition
- v. Organization and training of an on-site fire brigade
- vi. Development of a pre-fire plan with the local fire department
- vii. Rapid communication
- viii. Consideration of special hazards resulting from previous occupancies
- ix. Protection of existing structures and equipment from exposure fires resulting from construction, alteration, and demolition operations.

5. Owner's Responsibility for Fire Protection.

- 5.1.** The owner shall designate a person (Program Manager) who shall be responsible for the fire prevention program and who shall ensure that it is carried out to completion.

5.2. Premises identification

- 5.2.1.** The address numbers of the property or project location shall be plainly visible and legible from the street or road fronting the property at the Civil Defence and apparatus access or as otherwise approved.

5.3. Program Manager Responsibilities.

- 5.3.1.** The manager shall be responsible for ensuring that proper training in the use of protection equipment has been provided.
- 5.3.2.** The manager shall be responsible for the presence of adequate numbers and types of fire protection devices and appliances and for their proper maintenance.



- 5.3.3. The manager shall be responsible for supervising the permit system for hot work operations.
- 5.3.4. A weekly self-inspection program shall be implemented, with records maintained and made available.
- 5.3.5. Impairments to the fire protection systems or fire alarm, detection, or communications systems shall be authorized only by the fire prevention program manager.
- 5.3.6. Temporary protective coverings used on fire protection devices during renovations, such as painting, shall be removed promptly when work has been completed in the area.
- 5.3.7. Where there is public fire protection or a private fire brigade, the manager shall be responsible for the development of pre-fire plans in conjunction with the fire agencies.
- 5.3.8. The program manager shall ensure that the general contractor's adequate number of individuals are trained in the proper use of portable fire extinguishers, which are first aid of fire fighting.

5.4. Site Security.

- 5.4.1. Guard service shall be provided where required by the authority having jurisdiction.
- 5.4.2. Where guard service is provided, the guard(s) shall be trained in the following:
 - i. Notification procedures that include calling the Civil Defence and management personnel
 - ii. Knowledge of fire protection equipment
 - iii. Familiarization with fire hazards
 - iv. Use of construction elevators
- 5.4.3. Guards shall be informed of any special status of emergency equipment or hazards.
- 5.4.4. Security fences shall be provided where required by the authority having jurisdiction.
- 5.4.5. Entrances (e.g., doors and windows) to the structure under construction, alteration, or demolition shall be secured where required by the authority having jurisdiction.

5.5. Smoking.

- 5.5.1. Smoking shall be prohibited at or in the vicinity of hazardous operations or combustible/flammable materials. "NO SMOKING" signs shall be posted in these areas.
- 5.5.2. Smoking shall be permitted only in designated areas.



- 5.5.3.** Where smoking is permitted, safe receptacles for smoking materials shall be provided.

5.6. Waste Disposal.

- 5.6.1.** Accumulations of combustible waste material, dust, and debris shall be removed from the structure and its immediate vicinity at the end of each work shift or more frequently as necessary for safe operations.
- 5.6.2.** Rubbish shall not be burned on the premises without first obtaining a permit from the authority having jurisdiction.
- 5.6.3.** Materials susceptible to spontaneous ignition, such as oily rags, shall be stored in a listed disposal container.
- 5.6.4.** When a trash chute is used, an approved safety plan shall be submitted to the authority having jurisdiction.

6. Temporary Construction, Equipment and Storage

- 6.1.** The term temporary shall be defined as the duration of the construction project.

6.2. Temporary Offices and Sheds.

- 6.2.1.** Separation distances between buildings under construction and construction-related structures, such as temporary offices, trailers, sheds, and other facilities for the storage of tools and materials having combustible construction or contents, shall be in accordance with **Table 12.1**.

Table 12.1.: Separation Distances between buildings in construction site

TEMPORARY STRUCTURE EXPOSING WALL LENGTH		MINIMUM SEPARATION DISTANCE	
m	ft	m	ft
6	20	9	30
9	30	11	35
12	40	12	40
15	50	14	45
18	60	15	50
>18	>60	18	60

- 6.2.2.** Detachment between temporary structures, adequate temporary fixed fire protection systems, and portable equipment shall be provided as required by the authority having jurisdiction.
- 6.2.3.** Only safely installed approved heating devices shall be used in temporary offices and sheds.



- 6.2.4.** Clearance shall be provided around stoves, heaters, and all chimney and vent connectors to prevent ignition of adjacent combustible materials.

6.3. Temporary Enclosures.

- 6.3.1.** Only noncombustible panels, flame-resistant tarpaulins, or approved materials of equivalent fire-retardant characteristics shall be used.
- 6.3.2.** Any other fabrics or plastic films used shall be certified as conforming to the requirements of Test Method #2 contained in NFPA 701, Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.
- 6.3.3.** Where used to enclose structures, forming equipment, and similar items, the enclosing material shall be fastened securely or guarded by construction so it cannot be blown by the wind against heaters or other sources of ignition.

6.4. Equipment.

- 6.4.1.** Internal combustion engines and associated equipment, such as air compressors, hoists, derricks, pumps, and similar devices, shall be located so that the exhausts discharge well away from combustible materials.
- 6.4.2.** Where the exhausts are piped outside the structure under construction, alteration, or demolition, a clearance of at least 230 mm (9 in.) shall be maintained between such piping and combustible material.
- 6.4.3.** Internal combustion engines and associated equipment shall be shut down and allowed to cool sufficiently prior to refueling.
- 6.4.4.** Service areas for equipment shall not be located within structures under construction, alteration, or demolition.
- 6.4.5.** Fuel for internal combustion engines shall not be stored within structures under construction, alteration, or demolition, unless otherwise permitted.

6.5. Construction Materials

- 6.5.1.** Construction materials (drop clothes, tarps etc.) shall be non combustible or fire retardant with a maximum flame spread of 25, as tested in accordance with ASTM E-84.
- 6.5.2.** Plastic sheeting shall be fire retardant type.
- 6.5.3.** Wood used in temporary or permanent construction shall be fire retardant pressure impregnated.



- 6.5.4.** All materials used for temporary or permanent construction shall comply with comply with SD410 requirements.

7. Processes and Hazards

7.1. Hot Work.

- 7.1.1.** Hot work includes any work involving operations capable of initiating fires or explosions, including cutting, welding, brazing, soldering, grinding, thermal spraying, thawing pipe, torch applied roofing or any other similar activity. The use of hot work equipment shall be in accordance with the following requirements, including a pre-site inspection, fire watch and post inspection procedures.

7.2. Welding, Cutting, Brazing and other Hot work & open flame or smoke producing operations

- 7.2.1.** Written permission shall be obtained 24 hours in advance of work from the contracting officer's technical representative and building operation manager.
- 7.2.2.** Internal permit shall be issued on a daily basis for all welding, cutting, brazing and other open flame producing operations when it is determined that the work can be done safely at the requested location, combustibles have been separated from the work area, the atmosphere is not flammable and a fire watch is posted for the work period and 30 minutes thereafter.
- 7.2.3.** "Work Permit" culture shall be strictly followed.

7.3. Thermit Welding.

- 7.3.1.** In Thermit welding, the mold shall be dried thoroughly before the charge is ignited and provided with a cover.
- 7.3.2.** Bulk storage of Thermit welding materials shall be maintained in a detached shed at least 15 m (50 ft) from the main buildings.
- 7.3.3.** Storage sheds shall be maintained dry, posted as a "no smoking" area, and kept locked.
- 7.3.4.** Containers for the starting material shall be closed tightly immediately after each use.
- 7.3.5.** The molds shall not be removed until sufficient cooling has taken place in accordance with the manufacturer's published instructions.
- 7.3.6.** Smoking shall not be permitted in areas where Thermit welding material is being used.



7.4. Pre-Site Inspection

An inspection of the hot work site shall be conducted by the general contractor or his/her designee prior to hot work operations to ensure the following.

- 7.4.1. The hot work site is clear of combustibles or that combustibles are protected.
- 7.4.2. Exposed construction is of non combustible materials or that combustible materials are protected.
- 7.4.3. Openings are to be protected.
- 7.4.4. There are no exposed combustibles on the opposite side of the partitions, walls, ceilings, floors etc.
- 7.4.5. Fire extinguishers are available, fully charged and operable.
- 7.4.6. Fire watch personnel are assigned, equipped and trained.

7.5. Fire Watch

- 7.5.1. The sole duty of fire watch personnel shall be to watch for occurrence of fire during and after hot work operations. Individuals designated to fire watch duty shall have fire extinguishing equipment readily available and shall be trained in the use of such equipment. Personnel assigned to fire watch shall be responsible for extinguishing spot fires and communicating an alarm. Hot work conducted in areas with vertical and horizontal fire exposures that cannot be observed by a single individual, shall have additional personnel assigned to fire watches to ensure that all exposed areas are monitored.

7.6. Post-work Inspection

- 7.6.1. The fire watch shall be maintained a minimum of 30 minutes after the conclusion of the work to look out for leftover sparks, slag or smoldering combustibles.

8. Flammable and Combustible Liquids and Flammable Gases.

8.1. Storage.

The following requirements shall apply to storage areas for flammable and combustible liquids and flammable gases

- 8.1.1. Storage areas shall be kept free of weeds and extraneous combustible material.
- 8.1.2. Open flames and smoking shall be prohibited in storage areas.



- 8.1.3. Storage of Class I and Class II liquids shall not exceed 227 L (60 gal) within 15 m (50 ft) of the structure.
- 8.1.4. Storage areas shall be kept free of weeds, debris, and combustible materials not necessary to the storage.
- 8.1.5. Open flames and smoking shall not be permitted in flammable and combustible liquids storage areas.
- 8.1.6. Such storage areas shall be appropriately posted as “No Smoking” areas.
- 8.1.7. Tanks and containers shall be marked with the name of the product and sign,

“FLAMMABLE – KEEP FIRE AND FLAME AWAY”

- 8.1.8. Tanks (i.e. containers in excess of 60 gallons) shall also be labeled

“KEEP 50 FEET (15m) FROM BUILDINGS”

- 8.1.9. Overnight storage of combustible paints and liquids inside or within 50 feet (15m) of a building shall not exceed 10 gallons, unless stored within an approved flammable liquids storage cabinet in a location approved by building management.

8.2. Handling of Flammable and Combustible Liquids at Point of Final Use.

- 8.2.1. At least one portable fire extinguisher (10 pound ABC type or 20-B type) shall be located no less than 10 feet (3m) and no more than 50 feet (15m) from the flammable liquids storage area.
- 8.2.2. Class I and Class II liquids shall be kept in approved safety containers.
- 8.2.3. Metal containers for Class I or Class II liquids shall be in accordance with NFPA 30, 30A requirements or shall be of an approved design. Discharge devices shall not cause an internal pressure on the container. Individual containers shall not be interconnected and shall be kept closed when not in use.
- 8.2.4. Secondary containment or means of spill control, drainage control and diking shall be required for containers and tanks as approved by the Fire Department and if applicable, local hazardous materials program agency.
- 8.2.5. Means shall be provided to dispose of leakage and spills promptly and safely.
- 8.2.6. Class I liquids shall be dispensed only where there are no open flames or other sources of ignition within the possible path of vapor travel.
- 8.2.7. Plans for the installation/use of any aboveground storage tank (i.e. container greater than 60 gallons) shall be submitted to the Civil Defence and if applicable, to local



hazardous material program agency for review and permit prior to proposed tank arriving at the site.

9. Explosive Materials.

- 9.1. The storage, handling, and use of explosive materials shall be in accordance with NFPA 495, Explosive Materials Code and 'Code of Practice for the Management of Dangerous Goods in the Emirates' issued by Dubai Municipality.
- 9.2. All blasting operations shall be under the direct supervision of an individual who is legally licensed to use explosives and who possesses the required permits.

10. Other Combustible Materials.

10.1. Storage

- 10.1.1. Combustible construction materials shall be stored a minimum of 20 feet (6m) from buildings under construction or undergoing remodel, except for
 - i. Materials that are staged for installation on a floor level.
 - ii. When approved by the Civil Defence, materials may be stored in parking garages of Type I construction if the automatic fire sprinkler system is in service and vertical openings are protected.

10.2. Combustible Debris

- 10.2.1. Wood, cardboard, packing material, forms lumber and similar combustible debris shall not be accumulated within buildings. Such debris, rubbish and waste material shall be removed from buildings on a daily basis.

10.3. Oily Rags

- 10.3.1. Oily rags and similar material shall be stored in metal or other approved containers equipped with tight fitting covers.

11. Compressed Gases

11.1. Protection of Gas Containers

- 11.1.1. Gas containers/Cylinders shall be protected as follows.
 - i. combustible materials shall be kept a minimum of 10 feet (3m) from gas containers.
 - ii. Cylinders shall be protected against physical damage.
 - iii. Cylinders shall be stored upright and secured to prevent falling.



- iv. Cylinders shall not be placed near elevators, unprotected platform edges or other areas where they drop more than 2 feet (0.61m)
- v. Cylinders shall not be placed in areas where they may be damaged by falling objects.
- vi. When cylinders are not in use, valve protective caps shall be in place.
- vii. Ropes, chains or slings shall not be used to suspend gas cylinders, unless the cylinder was manufactured with appropriate lifting attachments.

11.2. Separation

- 11.2.1. When stored, gas cylinders shall be separated from each other based on their hazard classes.

11.3. Marking

- 11.3.1. Gas cylinders shall be marked with the name of the contents.

12. Liquefied Petroleum Gas (LP-Gas)

- 12.1. Propane containers maybe used in building under construction or undergoing major renovation as a fuel source for temporary heating for curing concrete, drying plaster and similar applications in accordance with the following.
- 12.2. Heating elements (other than integral heater-container units) shall be located at least 6 feet (1.8m) from any LP-Gas container.
- 12.3. Integral heater-container units specifically designed for the attachment of the heater to the container, or to a supporting standard attached to the container, maybe used provided they are designed and installed so as to prevent direct or radiant heat application to the LP-Gas container.
- 12.4. Blower and radiant type units shall not be directed toward any LP-Gas container within 20 feet (6m).
- 12.5. Heat producing equipment shall be installed with clearance to the combustible in accordance with the manufacturer's installation instructions.
- 12.6. Cylinders shall comply with DOT cylinder specifications and shall be secured in an upright position.
- 12.7. Regulators shall be approved for use with LP-Gas. Fittings shall be designed for at least 250 psi service pressures.
- 12.8. Hose shall be designed for a working pressure of at least 350 psi (unless limited to 5 psi) and shall be a maximum of 6 feet (1.8m) in length.



- 12.9.** Portable heaters shall be equipped with an approved automatic device to shut off the flow of gas to the main burner and to the pilot in the event of flame extinguishment or combustion failure. Portable heaters with an input of more than 50,000 Btu/hr shall be equipped with either a pilot that must be proved before the main burner can be turned on or an approved electronic ignition system.

12.10. Occupied Buildings

- 12.10.1.** In addition to the above, for LPG storage/use in buildings undergoing alteration and that are fully or partially occupied, the following shall also apply.
- 12.10.2.** Specific approval must be obtained from the Civil Defence prior to bringing LP-Gas containers on-site.
- 12.10.3.** The maximum water capacity of individual containers shall be 5-gallon water capacity and number of containers in the building shall not exceed the number of workers assigned to using the LP-Gas.
- 12.10.4.** Containers having a water capacity greater than 2 1/2 pounds (1 quart) shall not be left unattended.

13. Special Equipment

13.1. Motorized Equipment

- 13.1.1.** Internal combustion engines shall not be operated inside buildings, unless the installation is approved by the office of Environmental Management and Safety.
- 13.1.2.** Engines and equipment shall be allowed to cool to ambient temperature before they are refueled.
- 13.1.3.** Motorized equipment, including internal-combustion-powered construction equipment, shall be used in accordance with the following.
- Fuel for equipment shall be stored in an approved area outside of the building.
 - Equipment shall not be refueled while in operation.
 - Equipment shall be located so that exhausts do not discharge against combustible materials.

13.2. Temporary Heating Equipment.

- 13.2.1.** Temporary heating equipment such as LPG fueled, Oil-fired heaters shall be listed and shall be installed, used, and maintained in accordance with the manufacturer's instructions.



- 13.2.2.** Chimney or vent connectors, where required from direct-fired heaters, shall be maintained at least 460 mm (18 in.) from combustibles.
- 13.2.3.** Heating equipment shall be secured properly and kept clear from combustible materials. Refueling operations shall be conducted in approved manner.
- 13.2.4.** Heating devices shall not be used in areas where flammable liquids are being sprayed. Propane and kerosene heaters are prohibited inside buildings. Heating equipment shall not be kept unattended when it is operating.
- 13.2.5.** Heating equipment shall be located a minimum of 3 feet (0.9m) away from combustibles and in an area where it is not likely to overturn.
- 13.2.6.** Temporary heating equipment, where utilized, shall be monitored for safe operation and maintained by properly trained personnel.

13.3. Asphalt and Tar Kettles

- 13.3.1.** Asphalt kettles shall not be located within 20 feet (6.1m) of any combustible material, combustible building surface or building opening.
- 13.3.2.** With the exception of thermostatically controlled kettles, an attendant shall be within 100 feet (30m) of a kettle when the heat source is opening.
- 13.3.3.** Ladders or similar obstacles shall not form a part of the route between the attendance and the kettle. Kettles shall be equipped with tight fitting covers.
- 13.3.4.** Mops and rags soaked with tar have potential to ignite spontaneously and therefore must be thoroughly cleaned and stored away from the structure and combustibles.
- 13.3.5.** A 10 pound ABC-type portable fire extinguisher shall be provided within 30 feet (9.1m) of the kettle. Water extinguishers shall not be used.
- 13.3.6.** A minimum 20-B:C rated portable fire extinguisher shall be located within 30 feet (9.1m) of each asphalt kettle when the heat source is operating.
- 13.3.7.** Minimum 20-B:C rated portable fire extinguishers also shall be located on roofs during asphalt coating operations.

14. Electrical Devices

- 14.1.** All construction-operation electrical wiring and equipment for light, heat, or power purposes shall be in accordance with the applicable provisions of NFPA 70, National Electrical Code.



- 14.2.** Electrical devices shall be maintained in a safe condition.
- 14.3.** Extension cords shall be maintained free from damage.
- 14.4.** Damaged equipment and cords shall be removed from service until rendered safe.
- 14.5. Temporary Wiring.**
- 14.5.1.** All branch circuits shall originate in an approved power outlet or panel board.
- 14.5.2.** Conductors shall be permitted within multiconductor cord or cable assemblies or as open conductors.
- 14.5.3.** All conductors shall be protected by overcurrent devices rated for the ampacity of the conductors.
- 14.5.4.** Runs of open conductors shall be located where the conductors are not subject to physical damage, and the conductors shall be fastened at intervals not exceeding 3 m (10 ft).
- 14.5.5.** Each branch circuit that supplies receptacles or fixed equipment shall contain a separate equipment grounding conductor where run as an open conductor.
- 14.6. Lighting.**
- 14.6.1** Temporary lights shall be equipped with guards to prevent accidental contact with the bulb unless the construction of the reflector is such that the bulb is deeply recessed.
- 14.6.2** Temporary lighting fixtures, such as quartz, that operate at temperatures capable of igniting ordinary combustibles shall be fastened securely so that the possibility of their coming in contact with such materials is precluded.
- 14.6.3** Temporary lights shall be equipped with heavy-duty electrical cords with connections and insulation maintained in safe condition.
- 14.6.4** Temporary lights shall not be suspended by their electrical cords unless such cords and lights have been designed for that purpose.
- 14.6.5** Splices shall have insulation equivalent to that of the cable.
- 14.6.6** Temporary wiring shall be removed immediately upon the completion of the construction or purpose for which the wiring was installed.



15. Fire Protection

15.1. Installation, Testing, and Maintenance.

- 15.1.1.** All the required Fire Alarm, Communication, Fire Fighting and Fire Extinguishing Systems are installed, tested and maintained according to applicable NFPA regulations to ensure the readiness and operability of the systems.

15.2. Hydrants.

- 15.2.1.** The Hydrants either temporary or permanent in nature shall be installed based on the size and hazard evaluation of the construction site, confirming to applicable NFPA standards.
- 15.2.2.** Free access from the street to fire hydrants and to outside connections for standpipes, sprinklers, or other fire extinguishing equipment, whether permanent or temporary, shall be provided and maintained at all times.
- 15.2.3.** Protective pedestrian walkways shall not be constructed so that they impede access to hydrants.
- 15.2.4.** No material or construction shall interfere with access to hydrants, Siamese connections, or fire extinguishing equipment.

15.3. Standpipes.

- 15.3.1.** The standpipes shall be installed when the progress of construction is not more than 35 feet (10.7m) in height above the lowest level of Civil Defence.
- 15.3.2.** Standpipes shall be provided with fire department hose connections and outlets at accessible locations adjacent to usable stairs.
- 15.3.3.** The standpipe system shall be extended as construction progresses to within one floor of the highest point of construction having secured decking or flooring.
- 15.3.4.** Each floor shall be provided with 2 ½ in. (64mm) valve outlet for Civil Defence use. Where construction height requires installation of a Class III standpipe, fire pumps and water main connections shall be provided to serve the standpipe.
- 15.3.5.** In all new buildings in which standpipes are required or where standpipes exist in buildings being altered or demolished, such standpipes shall be maintained in conformity with the progress of building construction in such a manner that they are always ready for use.



15.3.6. On permanent Type II and Type III standpipes, hose and nozzles shall be provided and made ready for use as soon as the water supply is available to the standpipe.

15.3.7. In combined systems where occupant hose is not required, temporary hose and nozzles shall be provided during construction.

15.4. Standpipe Installations in Buildings Under Construction.

15.4.1. Where required by the authority having jurisdiction, in buildings under construction, a standpipe system, either temporary or permanent in nature, shall be installed.

15.4.2. The standpipes shall be provided with conspicuously marked and readily accessible Civil Defence connections on the outside of the building at the street level and shall have at least one standard hose outlet at each floor.

15.4.3. The pipe sizes, hose valves, hose, water supply, and other details for new construction shall be in accordance with engineering judgment for adequate Fire fighting.

15.4.4. The standpipes shall be securely supported and restrained at each alternate floor.

15.4.5. At least one approved hose valve for attaching Civil Defence hose shall be provided at each intermediate landing or floor level in the exit stairway, as determined by the authority having jurisdiction.

15.4.6. Valves shall be kept closed at all times and guarded against mechanical injury.

15.4.7. Hose valves shall have NH standard external threads for the valve size specified in accordance with NFPA 1963, Standard for Fire Hose Connections.

15.4.8. Where Civil Defence connections do not conform to NFPA 1963, the authority having jurisdiction shall designate the connection to be used.

15.4.9. The standpipes shall be extended up with each floor and shall be securely capped at the top.

15.4.10. Top hose outlets shall be not more than one floor below the highest forms, staging, and similar combustibles at all times.

15.4.11. Temporary standpipes shall remain in service until the permanent standpipe installation is complete.



15.5. Fire Extinguishers

- 15.5.1.** Portable Fire Extinguishers shall be provided and shall be mounted on a wall or post at each usable stairway and such that the travel distance to any extinguisher does not exceed 75 feet (23m). Mounting height to the top of the extinguisher shall not exceed 5 feet (1.5m). Extinguishers shall not have less than a 2A10BC rating or as otherwise directed by the Civil Defence.
- 15.5.2.** Wherever a toolhouse, storeroom, or other shanty is located in or adjacent to the building under construction or demolition, or where a room or space within that building is used for storage, a dressing room, or a workshop, at least one approved extinguisher shall be provided and maintained in an accessible location.
- 15.5.3.** At least one approved fire extinguisher also shall be provided in plain sight on each floor at each usable stairway as soon as combustible material accumulates.
- 15.5.4.** Suitable fire extinguishers shall be provided on self-propelled equipment.
- 15.5.5.** Free access to permanent, temporary, or portable first aid Civil Defence shall be maintained at all times.

15.6. Area Separation Walls

- 15.6.1.** When area separation walls are required, the construction shall be completed (with all opening protected) immediately after the building is sufficiently weather-protected at the location of the wall(s).

15.7. Fire Sprinkler Systems

- 15.7.1.** Where automatic Fire Sprinkler systems are required to be installed in new buildings, the system shall be placed in service as soon as possible.
- 15.7.2.** Immediately upon the completion of sprinkler pipe installation on each floor level, the piping shall be hydrostatically tested and inspected. After inspection approval from the Civil Defence, each floor level of sprinkler piping shall be connected to the system supply riser and placed into service.
- 15.7.3.** For system activation notification, an exterior alarm bell can be installed and connected to the sprinkler water flow device prior to installation of the monitoring system.
- 15.7.4.** For buildings equipped with fire sprinkler systems that are undergoing alterations, the sprinkler system(s) shall remain in service at all times except when system modifications are necessary. Fire sprinkler systems undergoing modifications shall be returned to service at the end of each workday unless otherwise approved by the fire department. The general



contractor or his/her designee shall check the sprinkler control valve(s) at the end of each work day to confirm that system has been restored to service.

- 15.7.5.** Where sprinklers are required for safety to life, the building shall not be occupied until the sprinkler installation has been entirely completed and tested so that the protection is not susceptible to frequent impairment caused by testing and correction, unless otherwise permitted by
- 15.7.6.** The provision of 15.7.5 shall not prohibit occupancy of the lower floors of a building, even where the upper floors are in various stages of construction or protection, provided the following conditions are satisfied:
- The sprinkler protection of the lower occupied floors is completed and tested.
 - The sprinkler protection of the upper floors is supplied by entirely separate systems and separate control valves so that the absence or incompleteness of protection in no way impairs the sprinkler protection of the occupied lower floors.
 - Where the sprinkler protection is regularly turned off and on to facilitate connection of newly completed segments, the sprinkler control valves shall be checked at the end of each work shift to ascertain that protection is in service.

15.8. Water Supply.

- 15.8.1.** A water supply for fire protection, either temporary or permanent, shall be made available as soon as combustible material accumulates.
- 15.8.2.** There shall be no delay in the installation of fire protection equipment.
- 15.8.3.** Where underground water mains and hydrants are to be provided, they shall be installed, completed, and in service prior to construction work.
- 15.8.4.** No minimum water supply can be specified due to the wide range of construction types, sites, and sizes. However, unless combustibles are essentially nonexistent in the completed structure and occupancy, a minimum of 1893 L/min (500 gpm) should be provided. In most instances, the required supply is greater, and authorities having jurisdiction should be consulted.

15.9. Fire Alarm System

- 15.9.1.** Fire alarm systems shall be maintained operational at all times during building alterations. When an alteration required modifications to a portion of the fire alarm system, the portion of the system requiring work shall be isolated and the remainder of the system shall be kept in service whenever practical. When it is necessary to shut down an entire fire alarm system, a



fire watch or other mitigation approved by the fire department shall be implemented by the general contractor until the system is returned to full service.

16. Telephone & Communication

16.1. Fire Alarm Reporting.

- 16.1.1.** There shall be a readily available public fire alarm box near the premises, telephone service to the responding Civil Defence, or equivalent facilities.
- 16.1.2.** Instructions shall be issued for the immediate notification of the Civil Defence in the case of a fire. Where telephone service is employed, the Civil Defence number (997) and site address shall be conspicuously posted near each telephone.

17. Civil Defence Access & Parking

- 17.1.** All construction sites shall be accessible by Civil Defence apparatus by means of roadways having an all-weather driving service of not less than 20 feet (6.1m) of unobstructed width.
- 17.2.** The roads shall have the ability to withstand the live loads of fire apparatus and have a minimum 4.5m of vertical clearance.
- 17.3.** Dead end fire access roads in excess of 150 feet (46m) in length shall be provided with approved turnarounds.
- 17.4.** A suitable location at the site shall be designated as a command post and provided with plans, emergency information, keys, communications, and equipment, as needed.
- 17.5.** The person in charge of fire protection shall respond to the location command post whenever fire occurs.
- 17.6.** Where access to or within a structure or an area is unduly difficult because of secured openings or where immediate access is necessary for life-saving or fire-fighting purposes, the authority having jurisdiction shall be permitted to require a key box to be installed in an accessible location.
- 17.7.** Access for use of Civil Defence apparatus shall be provided to the immediate job site at the start of the project and maintained until completion.
- 17.8.** The requirements of 17.1 through 17.7 shall be permitted to be modified where, in the opinion of the Civil Defence, fire-fighting or rescue operations would not be impaired by such modification.



- 17.9.** The required width of access roadways shall not be obstructed in any manner, including obstruction by parked vehicles.
- 17.10.** Signs or other appropriate notices, or both, prohibiting obstruction shall be permitted to be required and shall be maintained.
- 17.11.** The access roadway shall be extended to within 46 m (150 ft) of all portions of the exterior walls of the first story of any building.
- 17.12.** Where an access roadway cannot be provided, an approved fire protection system or systems shall be provided as required and approved by the authority having jurisdiction.
- 17.13.** Where a bridge is required to be used as access, it shall be constructed and maintained using design live loading sufficient to carry the imposed loads of the fire apparatus.

18. Means of Egress Components

18.1. Means of Egress.

- 18.1.1.** Egress routes for staff and construction personnel shall be kept clear and protected from debris, tripping hazards, falling objects and other obstacles at all times.
- 18.1.2.** If a means of egress must be closed, alternative routes complying with the NFPA 101, Life Safety Code, shall be provided.

18.2. Minimum number of exits

- 18.2.1.** All new buildings under construction shall have at least one unobstructed exit. All exits shall be identified in the Fire Protection Plan.
- 18.2.2. Multi-Story Buildings**
 - i.** Each level above the first story in new multi-story buildings shall be provided with at least two usable exit stairs after the floor decking is installed. The stairways shall be continuous and discharge to grade level.
 - ii.** Stairways serving more than two floor levels shall be enclosed (with openings adequately protected) after exterior walls/windows are in place. Exit stairs in new and in existing, occupied buildings shall be lighted and maintained clear of debris and construction materials at all times with the exception as follows.
 - iii.** For new multi-story buildings, one of the required exit stairs may be obstructed on not more than two contiguous floor levels for the



purposes of stairway construction (i.e. installation of gypsum board, painting, flooring etc)

18.3. Stairs.

- 18.3.1.** In all buildings over one story in height, stairway with sufficient width shall be provided that is in usable condition at all times.
- 18.3.2.** This stairway shall be extended upward as each floor is installed in new construction and maintained for each floor still remaining during demolition.
- 18.3.3.** The stairway shall be lighted.
- 18.3.4.** During construction, the stairway shall be enclosed where the building exterior walls are in place.
- 18.3.5.** All exit stairs shall be provided with stair identification signs to include the floor level, stair designation, and exit path direction as required to provide for safe egress.

18.4. Hoists and Elevators.

- 18.4.1.** Where hoists and elevators provide the only efficient means of transporting hose and other cumbersome fire-fighting equipment to upper floors, they shall be available to the Civil Defence whenever necessary.

19. Assembly Points

- 19.1.** Designated exterior assembly points shall be established for all construction personnel to relocate to upon evacuation. The assembly points shall also be identified in Fire Protection Plan.

20. Vehicle Parking.

- 20.1.** All vehicles shall be parked a minimum of 20 feet (6.1m) from new buildings under construction with following exceptions.
- 20.2.** Vehicles that are parked temporarily for loading/unloading or other construction related operations. However such vehicles shall not be left unattended.
- 20.3.** Private vehicles maybe parked in parking garages of construction site if the automatic fire sprinkler system is in service and vertical openings are protected.



21. Safeguarding Construction and Alteration Operations

21.1. Scaffolding, Shoring, and Forms.

- 21.1.1.** Accumulations of unnecessary combustible forms or form lumber shall be prohibited.
- 21.1.2.** Combustible forms or form lumber shall be brought into the structure only when needed.
- 21.1.3.** Combustible forms or form lumber shall be removed from the structure as soon as stripping is complete.
- 21.1.4.** Those portions of the structure where combustible forms are present shall not be used for the storage of other combustible building materials.
- 21.1.5.** During forming and stripping operations, portable fire extinguishers or charged hose lines shall be provided to protect the additional combustible loading adequately.

21.2. Construction Material and Equipment Storage.

- 21.2.1.** Temporary storage of equipment to be installed, combustible construction materials, or combustible packing materials shall not be permitted in unprotected structures under construction or alteration unless authorized by the authority having jurisdiction.
- 21.2.2.** Storage shall not be permitted in protected structures until protection is in service.
- 21.2.3.** Yard storage of equipment to be installed or combustible construction materials shall not be stored closer than 9 m (30 ft) from the structure under construction or alteration.

21.3. Permanent Heating Equipment.

- 21.3.1.** The permanent heating equipment for a new building shall be installed and put into operation as soon as practicable.

21.4. Gas.

- 21.4.1.** The installation of gas piping for construction purposes, or modifications to existing gas piping, gas utilization equipment, or accessories, shall be performed only by a qualified agency.
- 21.4.2.** All such work shall be in accordance with NFPA 54, National Fuel Gas Code.



21.4.3. All modifications to existing gas piping systems shall be performed with the gas turned off.

21.4.4. Hot taps shall be permitted to be made, provided they are installed by a trained and experienced crew utilizing equipment specifically designed for such purpose.

21.5. Building Separation Walls.

21.5.1. Fire Cutoffs.

- i. Fire walls and exit stairways, where required for the completed building, shall be given construction priority for installation.
- ii. Fire doors with approved closing devices and hardware shall be installed as soon as is practicable and preferably before combustible material is introduced.
- iii. Fire doors, after installation shall not be obstructed from closing.

21.5.2. Temporary Separation Walls.

- i. Protection shall be provided to separate an occupied portion of the structure from a portion of the structure undergoing alteration, construction, or demolition operations when such operations are considered as having a higher level of hazard than the occupied portion of the building.
- ii. Walls shall have at least a 1-hour fire resistance rating.
- iii. Opening protectives shall have at least a 45-minute fire protection rating.
- iv. Nonrated walls and opening protectives shall be permitted when an approved automatic sprinkler system is installed.

21.6. Fire Protection During Construction.

21.6.1. The provisions of Section 15 shall apply.

22. Safeguarding Roofing Operations

22.1. Asphalt and Tar Kettles.

22.1.1. Asphalt and tar kettles shall not be located on roofs.



- 22.1.2.** A lid that can be closed by means of gravity shall be provided on all roofing kettles.
- 22.1.3.** The tops and covers of all kettles shall be close-fitting and constructed of steel having a thickness of not less than No. 14 manufacturer's standard gauge [2 mm (0.075 in.)].
- 22.1.4.** Used roofing mops and rags shall be cleaned of excessive asphalt and stored away from the building and combustible materials.
- 22.1.5.** Discarded roofing mops and rags shall not be in contact with combustibles.
- 22.1.6.** Kettles shall be constantly attended when in operation by a minimum of one employee knowledgeable of the operations and hazards. The employee shall be within 7600 mm (300 in.) of the kettle and have the kettle within sight.
- 22.1.7.** 22.1.7 Roofing kettles shall not block exits, means of egress, gates, roadways, or entrances. In no case shall kettles be closer than 3000 mm (120 in.) from exits or means of egress.

22.2. Single-Ply and Torch-Applied Roofing Systems.

22.2.1. General.

- i.** Single-ply and torch-applied roofing systems shall be installed using extreme caution.
- ii.** Torches or hot-air guns used to secure roofing membranes shall be used in accordance with the manufacturer's recommendations.
- iii.** In order to prevent smoking or ignition of roofing membranes, they shall not be overheated.

22.3. Openings, Penetrations, and Flashings.

- 22.3.1.** Caution shall be used where working near roof openings, penetrations, or flashings.
- 22.3.2.** The flame of the torch shall not come in direct contact with wood nailers, cant strips, or metal flashing.
- 22.3.3.** Small torches shall be used to heat the underside of the membrane at a distance from these areas before securement.
- 22.3.4.** Hot trowels shall be used to feather seams at laps and flashings.



22.3.5. The torch shall not be used in areas where the flame impingement cannot be fully viewed.

22.3.6. Open flames shall not be left unattended.

22.4. Flame Contact Protection.

22.4.1. The torch flame shall not be applied to a combustible substrate for the membrane.

22.4.2. Base ply shall be used to cover wooden decks, combustible insulation (such as foam plastic, kraft-faced glass fiber, or wood fiber), small crevices, cant strips, plastic fastener plates, or any other combustible surface.

22.4.3. Base ply shall be permitted to consist of either glass fiber felts or minimum 18 kg (40 lb) organic felts.

22.4.4. Torch flames shall not come in contact with exposed plastic roofing cement.

22.4.5. Installation.

- i. The installation of torch-applied roofing and, in some cases, single-ply roofing systems is hot work and shall comply with Section 5.1, except where otherwise noted.
- ii. Torch-applied roofing shall be exempt from the requirement in NFPA 51B, Standard for Fire Prevention During Welding, Cutting, and Other Hot Work, that combustibles shall be kept 11 m (35 ft) from hot work, commonly referred to as the "35 Foot Rule."

22.5. Personal Protection.

22.5.1. Protective clothing and personal protective equipment shall be worn by installers.

22.6. Equipment.

22.6.1. Proper equipment shall be used to heat roofing membranes.

22.6.2. Torches shall be equipped with a pilot adjustment, a flame height adjustment, a minimum of 7600 mm (300 in.) to a maximum of 15 m (50 ft) of listed hose, a pressure gauge, and a regulator.

22.6.3. A spark igniter shall be used.

22.6.4. Torch trolleys and multiple torch head machines shall be equipped with listed safety valves.



22.7. Equipment Inspection.

- 22.7.1.** Equipment shall be inspected thoroughly and repaired or replaced as needed prior to use.

22.8. Fuel Gas Cylinders.

- 22.8.1.** Fuel gas cylinders shall not be hoisted by their valves.
- 22.8.2.** Straps placed around the cylinders shall be utilized.
- 22.8.3.** Carts used to transport fuel gas cylinders shall be stable.
- 22.8.4.** Safety caps shall be attached to all fuel gas cylinders and installed on the valves whenever cylinders are not in use.
- 22.8.5.** The fuel gas cylinder shall be sized for the torch used.

22.9. Frost Buildup.

- 22.9.1.** If frost buildup occurs on fuel gas cylinders and the rate of vapor withdrawal is no longer adequate for operating conditions, the cylinder shall not be placed on its side or heated with the torch flame.
- 22.9.2.** The hose shall be disconnected and a larger cylinder used.

22.10. Fire Extinguishers for Roofing Operations.

- 22.10.1.** There shall be at least one portable fire extinguisher having a rating of not less than 20-B no closer than 5 feet (1500 mm) and no more than 25 feet (7600 mm) of horizontal travel distance from every kettle at all times while such kettle is in operation.
- 22.10.2.** Fire extinguishers shall be located in an accessible, visible, or identified location.
- 22.10.3.** There shall be at least one multipurpose 2-A:20-B:C portable fire extinguisher on the roof being covered or repaired, or other fire protection shall be provided as determined by the authority having jurisdiction.
- 22.10.4.** There shall be at least one multipurpose 2-A:20-B:C portable fire extinguisher within 20 feet (6100 mm) of horizontal travel distance from torch-applied roofing equipment.
- 22.10.5.** All kettle operators and torch-applied roof installers shall be trained in the use of fire extinguishers.



22.11. Fuel for Roofing Operations.

- 22.11.1.** Fuel containers, burners, and related appurtenances of roofing equipment in which liquefied petroleum gas is used for heating shall comply with all the applicable requirements of NFPA 58, Liquefied Petroleum Gas Code.
- 22.11.2.** Fuel containers having capacities greater than 0.45 kg (1 lb) shall be located at least 10 feet (3000 mm) from the burner flame or at least 2 feet (600 mm) there from where properly insulated from heat or flame.
- 22.11.3.** Solid fuel or Class I liquids shall not be used as fuel for roofing kettles.
- 22.11.4.** LP-Gas cylinders shall be secured to prevent accidental tip over.
- 22.11.5.** Where in the opinion of the authority having jurisdiction, there is danger of physical damage to the fuel containers, protection shall be provided.

23. Safeguarding Demolition Operations**23.1. General.**

- 23.1.1.** In addition to the specific requirements of this chapter, the provisions of Section 1 through 18 shall be followed, as applicable, for all demolition operations.

23.2. Special Precautions.

- 23.2.1.** Special precautions shall be taken where demolition work is performed in areas where floors are soaked with oil or other flammable liquid; where dust accumulations are present; or where combustible insulation is present in floors, walls, or ceilings/roofs where hot work is being performed. In these situations, charged hose lines of an adequate number and size shall be provided.
- 23.2.2.** Flammable and combustible liquids shall be drained from tanks and machinery reservoirs in a safe manner and removed from the building immediately. Particular attention shall be paid to the removal of residue and sludge accumulations if hot work operations are involved.

23.3. Smoking.

- 23.3.1.** Smoking shall be prohibited throughout the demolition areas.

23.4. Demolition Using Explosives.

- 23.4.1.** If explosives are used in demolition work (implosion), hose lines [at least two of 38 mm (1.5 in.) diameter or one 64 mm (2.5 in.) diameter] shall be



provided in the immediate vicinity of the demolition site during the actual detonation.

- 23.4.2.** The required hose lines shall be of sufficient length to be capable of extinguishing any small fire anywhere on the demolition site after detonation.

23.5. Gas.

- 23.5.1.** Prior to demolition, gas supplies shall be turned off and capped at a point outside the building.
- 23.5.2.** Gas lines within the building shall be purged after capping unless otherwise permitted by the authority having jurisdiction.

23.6. Fire Cutoffs.

- 23.6.1.** Vertical and horizontal cutoffs shall be retained until razing operations necessitate their removal as permitted by the authority having jurisdiction.
- 23.6.2.** Fire doors shall be closed at the end of each working day.

23.7. Fire Protection During Demolition.

- 23.7.1.** The provisions of Chapter 15 shall apply in addition to the specific requirements of this section.
- 23.7.2.** System Operation. Where a building is equipped with sprinklers, the sprinkler protection shall be retained in service as long as the condition requiring the use of sprinklers exists.

23.8. Sprinkler Control Valves.

- 23.8.1.** The operation of sprinkler control valves shall be permitted only by properly authorized personnel and shall be accompanied by the notification of designated parties.
- 23.8.2.** Where the sprinkler protection is regularly turned off and on to facilitate removal and capping of segments, the sprinkler control valves shall be checked at the end of each work shift to ascertain that protection is in service.

23.9. Standpipes.

- 23.9.1.** Standpipes shall be maintained in conformity with the progress of demolition activity in such a manner that they are always ready for fire department use.



23.10. Fire Extinguisher.

- 23.10.1.** Fire extinguishing equipment shall be available subject to the authority having jurisdiction.

24. Safeguarding Underground Operations**24.1. General.**

- 24.1.1.** In addition to the specific requirements of this chapter, the provisions of all the chapters shall apply to the underground operations unless otherwise modified by this chapter.
- 24.1.2.** Drainage systems shall be properly designed and installed to remove water from sprinkler discharge and fire hose streams.
- 24.1.3.** Fire safety for existing, operating, fixed guideway underground transportation systems undergoing alteration or renovation shall be in accordance with NFPA 130, Standard for Fixed Guideway Transit and Passenger Rail Systems.
- 24.1.4.** Means of egress for existing, operating, underground structures shall be in accordance with NFPA 101, Life Safety Code.

24.2. Security.

- 24.2.1.** At each aboveground entrance, underground operations shall have a check-in/check-out system, supervised by a qualified individual at all times, that provides an accurate record of each person who is underground.
- 24.2.2.** The location of the check-in/check-out system shall be within 25 feet (7600 mm) of the entrance and shall be easily identified.
- 24.2.3.** Completed or unused sections of the underground facility shall be barricaded, properly marked, and made off limits.
- 24.2.4.** Compartmentation by means of the installation of fire and smoke barriers shall be at intervals that limit the extent and severity of the fire and that provide areas of refuge for occupants.

24.3. Water Supply.

- 24.3.1.** A fire protection water supply system shall be provided.
- 24.3.2.** No minimum water supply can be specified due to the wide range of construction types, sites, and sizes. However, unless combustibles are



essentially nonexistent in the completed structure and occupancy, a minimum of 1893 L/min (500 gpm) should be provided. In most instances, the required supply is greater, and authorities having jurisdiction should be consulted.

- 24.3.3.** A standard fitting with outlet threads compatible with the equipment of the local fire department shall be provided so that travel distance does not exceed 46 m (150 ft).

24.4. Emergency Procedures.

24.4.1. Evacuation Plans.

- i. A written fire prevention, fire suppression, and emergency evacuation plan shall be developed, maintained, and kept current.
- ii. The authority having jurisdiction shall be provided with a copy of the current plan for its review and shall have the opportunity to comment on the plan.
- iii. Special attention shall be given to rescue and smoke-venting procedures, to means of ingress/egress, and to training and orientation of employees and visitors.
- iv. All personnel, including visitors, shall be trained in emergency and evacuation procedures and informed of the hazards prior to going underground.

24.5. Drills.

- 24.5.1.** Underground operations shall conduct disaster and evacuation drills for each shift at least once at the start of underground operations and every 6 months, or more frequently as appropriate.
- 24.5.2.** A record of such drills shall be maintained.

24.6. Fire Detection and Protection Systems.

- 24.6.1.** Fire protection extinguishing equipment applicable to the hazard shall be provided at the head, tail, drive, and take-up pulley areas of belt conveyors and at intervals along belt conveyor lines that shall not exceed 91 m (300 ft).
- 24.6.2.** Belt conveyors installed in underground locations, other than belts that carry the load of the belt on a low-friction metal deck without rollers, shall meet the following minimum requirements:



- i. Conveyor belting shall be approved.
- ii. Entrances in which belt conveyors are installed shall be kept free of accumulations such as muck, debris, and combustibles.
- iii. All belt conveyors shall be equipped with an approved slippage switch system designed to shut down the belt when sliding friction develops between the drive pulley(s) and the belt.
 - i. The slippage switch system shall be tested weekly.
 - ii. On each new installation, the slippage switch system shall be tested before the conveyor is used.

24.6.3. All conveyor belt systems shall be equipped with approved interlock systems that shut down belt conveyors when any conveyor in the system stops or reduces its normal speed or upon activation of any required fire protection system.

24.6.4. Fixed combustible materials such as posts, cribbing, and roof supports shall be either guarded from contact by the belt using metal or located at a distance of at least $\frac{1}{2}$ the width of the belt from any idler or pulley.

- i. An alternate method for minimizing potential frictional ignition is the use of alignment switches at intervals sufficient to prevent the belt from contacting such materials.
- ii. Guarding for machinery in the drive area and at other points along the belt shall be of noncombustible material.

24.6.5. New installations of belt conveyors shall utilize a structure that does not provide a deck between the upper and lower strands of the belt.

24.6.6. Suitable fire extinguishers shall be installed so that travel distance from any one point in a tunnel does not exceed 91 m (300 ft) on a horizontal plane.

24.6.7. Audible and visible alarm and emergency lighting for safe evacuation shall be required.

24.7. Fire Communications Systems.

24.7.1. Two means of communications with the surface shall be available at all times from all areas of the underground facility.

24.7.2. All communications systems shall be tested weekly.



24.8. Electrical.

Electrical cords and plugs shall be heavy duty and suitable for use in damp locations.

24.8.1. Conductors.

- i. Conductors shall be located or guarded so as to be protected from physical damage. Multiconductor portable cable shall be permitted to supply mobile equipment.
- ii. An equipment grounding conductor shall be run with circuit conductors inside the metal raceway or inside the multiconductor cable jacket.
- iii. The equipment grounding conductor shall be permitted to be insulated or bare.
- iv. Oil-filled transformers shall only be used underground where located in a fire-resistant enclosure suitably vented to the outside and surrounded by a dike to retain the contents of the transformers in the event of rupture.

24.8.2. Enclosures.

- i. Bare terminals of transformers, switches, motor controllers, and other equipment shall be enclosed to prevent accidental contact with energized parts.
- ii. Enclosures for use in tunnels shall be raintight, rainproof, or watertight as defined in NFPA 70, National Electrical Code, where necessitated by the environmental conditions.
- iii. Special attention shall be given to maintaining clear access and adequate work space around electrical equipment in accordance with NFPA 70E, Standard for Electrical Safety in the Workplace. Proper housekeeping shall be maintained to avoid fire hazards.
- iv. All nonenergized metal parts of electrical equipment and metal raceways and cable sheaths shall be effectively grounded and bonded to all metal pipes and rails at the portal and at intervals not exceeding 300 m (1000 ft) throughout the tunnel.

24.9. Hazardous Operations and Procedures.

- 24.9.1.** Hot work operations shall be in accordance with NFPA 51B, Standard for Fire Prevention During Welding, Cutting, and Other Hot Work.



- 24.9.2.** A suitable fire extinguisher or other fire control device shall be ready for instant use in any location where hot work is performed.
- 24.9.3.** Acetylene, liquefied petroleum gas (LPG), liquefied oxygen (LOX), and methylacetylene propadiene stabilized gas (MPS) shall be permitted to be used underground only for welding, cutting, and hot work and only if the quality of air is within permitted limits in accordance with the ACGIH Threshold Limit Values and Biological Exposure Indices for 1992–1993.
- 24.9.4.** The quantity of combustible materials to be used underground shall be kept to a minimum. Advance planning shall provide for the use of materials having the most favorable combination of high ignition points, low rates of combustion, and low emissions of smoke and harmful gases.

24.10. Flammable and Combustible Liquids.

- 24.10.1.** Class I flammable liquids shall not be taken, stored, or used underground or within 30 m (100 ft) of a tunnel portal or shaft opening.
- 24.10.2.** Class II and Class III liquids shall be transported and stored in approved closed containers, safety cans, or tanks.
- 24.10.3.** Quantities shall be limited to those necessary for one work shift.
- 24.10.4.** Lubricating oils, greases, and rope dressings taken underground shall be in closed and reclosable approved containers that do not allow the contents to leak or spill.
- 24.10.5.** Oil, grease, and diesel fuel stored underground shall be kept in tightly sealed containers in fire-resistant areas located at least 30 m (100 ft) from shafts and inclines.
- 24.10.6.** Storage areas shall be positioned or diked so that the contents of ruptured or overturned containers cannot flow from the storage area.
- 24.10.7.** Areas within 25 feet (7600 mm) of major electrical installations and unburied tanks for storage of combustible liquids shall be free of transient combustible materials.

24.11. Storage.

- 24.11.1.** No combustible structure shall be erected and no combustible materials shall be stored within 30 m (100 ft) of an access shaft, shaft hoist, or other entry.
- 24.11.2.** Metal containers with self-closing lids shall be provided and used to store combustible waste and debris and shall be removed and taken to the surface daily.



24.12. Equipment.

- 24.12.1.** Less hazardous hydraulic fluids that are listed shall be used in underground machinery and equipment unless the machinery and equipment are protected by an approved fire suppression system or by approved multipurpose fire extinguishers rated at least 4-A:40-B:C.
- 24.12.2.** Wherever self-propelled equipment is used underground, a fire suppression system or a fire extinguisher rated at least 4-A:40-B:C shall be provided on the equipment.

24.13. Ventilation.

- 24.13.1.** Where single-entry shafts/tunnel ventilation systems are used, they shall be reversible from a location outside and in close proximity to the shaft/tunnel.
- 24.13.2.** The ventilation system shall be sufficient for the number of personnel and equipment underground.
- 24.13.3.** Air-sampling logs shall be maintained. Air tests shall be conducted before or after each shift.
- 24.13.4.** Air-sampling logs shall be available to the authority having jurisdiction.
- 24.13.5.** Fan houses, fan bulkheads for main and booster fans, and air ducts connecting main fans to underground openings shall be constructed of noncombustible materials.

25. Requirements for Site Offices (Manufactured Homes/Offices)

- 25.1.** The Life and Fire Safety requirements of Site offices shall be in accordance with NFPA 501, Standard on Manufactured Housing and NFPA 501A, Standard for Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities.
- 25.2. Manufactured Home Site Fire Safety Requirements.**
 - 25.2.1.** Fire separation distances shall comply with local rules or regulations in addition to NFPA 5000, Building Construction and Safety Code.
 - 25.2.2.** Vertical Positioning of Manufactured Homes. Manufactured homes shall not be positioned vertically, stacked with one over the other, in whole or in part, unless the structure is designed and approved for such installation and permitted by the authority having jurisdiction.
- 25.3. Marking of Underground Utility Lines.**



- 25.3.1.** The location of underground electrical cables, gas piping, water piping, and sewer lines that are buried within 1.2 m (4 ft) of the perimeter of the site's largest planned manufactured home shall be indicated by an aboveground sign(s) or underground marker tapes identifying the proximity of the lines.
- 25.3.2.** A plot plan showing the “as built” location of underground utility lines shall be available for installations in multiple-site facilities.

25.4. Manufactured Home Installations.

- 25.4.1.** Installation of all manufactured homes, including the installation of the support system and the connection of structural, electrical, mechanical, and plumbing systems to the site utilities or between sections in the case of multiple-section homes, shall be performed in accordance with printed installation instructions provided by the manufacturer of the home.
- 25.4.2.** All manufactured homes, accessory buildings, structures, and community buildings shall be located and maintained in such a manner that required egress windows or doors are not blocked.

25.5. Fire Detection and Protection Systems.

- 25.5.1.** In addition to the requirements of Sections 1 through Chapter 18, the requirements of NFPA 501, Standard on Manufactured Housing and NFPA 501A, Standard for Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities shall apply.

26. Fire Safety and Evacuation Plan for Building Under Construction or Renovation

- 26.1.** The constructor, general contractor or project manager should develop and implement a fire safety and evacuation plan before work starts. The plan should be in writing and distributed to all workers and sub trades on project, including site visitors. The fire safety and evacuation plan shall include the following:
- i. Procedures for reporting emergencies to Civil Defence.
 - ii. Procedures for emergency notification, evacuation and/or relocation of all persons in the building under construction and on the site.
 - iii. Procedure for hot work operations, management of hazardous materials and removal of combustible debris and maintenance of emergency access roads.
 - iv. Floor plans identifying the locations of exits, exit stairs, exit routes and portable fire extinguishers and fire hose cabinets.
 - v. Site plan identifying the designated exterior assembly areas for each evacuation route.



- vi. Site plan identifying required fire apparatus access roadways and on-site fire hydrants.
- vii. Document and post the name and phone numbers of all personnel responsible for managing the fire safety evacuation plan, including after-hours contact information.
- viii. Appointment of fire warden(s) to ensure that everyone evacuates work areas when a fire alarm is activated.
- ix. Post contact information for the security company that oversees “Hot Work” requirements as part of the fire code. Ensure that all construction employees are made aware of the “Hot Work” requirements.
- x. Evacuation plan of already occupied portion of the building. Ensure evacuation plan for occupied portion and portion under construction or renovation are compatible.
- xi. Records of all fire safety meetings with project management, workers, foremen, subcontractors, suppliers and others who may be on site.
- xii. Records of fire drills involving the existing alarm system or on alternative such as compressed air horns, shouts of “fire” etc. Conduct a post-mortem on response, performance and awareness of personnel.
- xiii. Procedure in notifying the shutdown of a certain fire safety system to Civil Defence and also measures to isolate it from the rest of the system which must be in service.
- xiv. Measures to provide a 24-hour fire watch until the system is fully restored and in service.

27. Material Approval

- 27.1. All the Materials, Systems, Assemblies, equipment, Products and Accessories, referred to in this chapter with respect to Life Safety, Fire Safety and Emergency Services shall be Listed, Approved and Registered by the Civil Defence Material Approval Department.
- 27.2. The above requirement applies to all the products with or without international listing, registration or approval.

28. Further References

- 28.1. The following International Codes and Standards were referred, studied and consulted for this chapter. Further details where applicable can be referred to in these Codes and Standards. Also see **XV. ACKNOWLEDGEMENT OF INTERNATIONAL CODES AND STANDARDS.**
- NFPA 1: Fire Prevention Code
- NFPA 241: Standard for Safeguarding Construction, Alteration and Demolition Operations
- ‘Code of Practice for the Management of Dangerous Goods in the Emirates’ issued by Dubai Municipality



CHAPTER 13

FIRE SAFETY REQUIREMENT FOR MULTI-TENANT (TERRACE TYPE)
WAREHOUSES AND FACTORIES

1. Scope

- 1.1. The scope of this guideline is for multi-tenant, terrace type, group of warehouses and/or factories arranged for multiple usages by multiple owners or that is intended to be rented out.
- 1.2. Storage occupancies where extra hazardous and explosive materials are stored and in factories or industries where hazards exist in manufacturing, processing, extracting, coating and treating activities and all the industries identified in Chapter 9, Table 9.3, a fire risk analysis report of the facility prepared by Civil Defence approved consultant shall be furnished for Civil Defence jurisdiction.

2. Definition

2.1. Factories

- 2.1.1. Factories are occupancies in which products are manufactured or in which processing, assembling, mixing, packaging, finishing, decorating, repair operations and similar operations are conducted.

2.2. Warehouse

- 2.2.1. Warehouse is defined as space used for storing various types of goods or materials. It includes warehouses for storing fresh/perishable food products, paper, wood, metal and other materials which are classified as non-hazardous material by the individual Material Safety Data Sheet.

3. Compartment

- 3.1. The size of fire compartment for warehouse and/or factory shall not exceed the maximum allowable dimensions shown in the [Table 13A.1](#) of this guideline, depending on the type of fire protection and configuration of the warehouse and/or factory. Multi-tenanted warehouses and/or factories must have fire compartmentalization between them regardless of sprinkler provision.
- 3.2. Compartmentalization, in respect of size limitation, may be achieved by using fire-rated roller shutter or by other approved means. Localized smoke detector shall be installed to activate the roller shutter. The roller shutter shall also be linked to the building automatic fire alarm system which shall act as a backup for the activation of the shutter. Such localized smoke detection system shall be provided with zone indication on the main fire alarm panel with buzzer sound, however it's activation is not necessary to sound the general fire alarm.



- 3.3. Compartmentalization between the warehouse or factory and loading/unloading area shall be provided, except where the warehouse or factory is a single-storey single-tenant or multi-storey single-tenant per storey type, with the loading/unloading area abutting external space; or the roof over the loading/unloading area abutting external space is not more than 3m.
- 3.4. The compartment size limit stipulated in [Table 13A.1](#) shall include the loading/unloading area if it is not fire compartmented from the warehouse or factory area, unless the entire warehouse or factory including the loading/unloading and covered driveway area is sprinkler protected and provided with smoke control system.
- 3.5. Fire compartmentalization is required between the warehouse or factory and other areas having different type of occupancy.

4. Sprinkler Protection and Fire Fighting Systems.

- 4.1. Automatic sprinkler system complying with NFPA13 shall be provided if the compartment size of the warehouse or factory exceeds the maximum allowable size shown in the [Table 13A.1](#) of this guideline. Only the list of commodities shown in List A is allowed for the exemption of sprinkler in addition to the compartment size.
- 4.2. Sprinkler coverage shall be extended to the areas shielded by access platforms in the high rack storage warehouse or factory. The supporting structures of the platforms shall have the same fire resistant rating as the element of structure of the warehouse.
- 4.3. Private fire hydrants shall be provided with the most remote hydrant pressure of 6.9bar. Hydrants shall be spaced at 100m apart along the fire engine accessway and shall be in accordance with NFPA 24.
- 4.4. Two numbers of hydrants shall be considered to calculate for the hydraulic demand. Fire fighting water shall be provided for 2 hours. Refer to [Figure 13A.1](#), [13A.2](#) and [13A.3](#) for illustrations of requirements.

5. Storage Height Control

- 5.1. Signage shall be provided on the walls of the warehouse or factory (including the loading/unloading area) to control the maximum allowable storage height and to maintain the minimum clearance below the sprinkler heads in accordance with NFPA 13.
- 5.2. A 50mm wide red line shall be drawn around the wall with signage indicated as “No Storage Above This Line”. This sign shall be provided at no more than 30m interval along the red line. The lettering of the sign shall not be less than 100mm.
- 5.3. The storage height limitations shall be clearly indicated on plans. To facilitate such provision, the Approved Consultant shall make known to the owner and the warehouse or factory operator the clearance and height limitations appropriate to the particular warehouse or factory usage.



6. Smoke Control

- 6.1.** The provision of smoke control shall be in accordance with NFPA 204 and NFPA92B or [Table 13A.2](#) of this guideline, whichever stringent, either in a form of smoke vent, smoke purging or engineered smoke control system depending on the fire compartment size and type of fire protection system.

6.2. Smoke Vents

- 6.2.1.** Smoke vents in [Table 13A.2](#) shall be of permanent open type and the effective opening shall comply with [Table 13A.3](#). Smoke vents which are closed shall be designed to be activated automatically during fire mode.
- 6.2.2.** The minimum dimensions of vertical smoke vent shall be 400 mm (length) X 600mm (height) and horizontal smoke vent (roof or ceiling) shall be minimum 0.25 meters square in area.
- 6.2.3.** No area in the warehouse or factory shall be more than the stipulated distance mentioned in [Table 13A.3](#) measured horizontally away from any vertical or horizontal smoke vent.
- 6.2.4.** All smoke vents shall be located at the highest unobstructed level along the perimeter walls of the warehouse or factory.

6.3. Smoke Purging System

- 6.3.1.** Replacement of smoke vents by smoke purging system is allowed provided that the warehouse or factory is sprinkler protected.

6.4. Engineered Smoke Control

- 6.4.1.** Engineered smoke control system shall be provided if the floor area of the compartment is more than 4830m².
- 6.4.2.** The fire size and the engineered smoke control system shall be designed and installed in accordance with the NFPA requirements.



LIST A (Not exhaustive)– Low Hazard Commodities, Materials and related activities Exempted from Sprinkler with regards to Table 13A.1, Figure 13.A1. 13A2 and 13A.3.

LOW HAZARD STORAGE MATERIALS	LOW HAZARD ACTIVITIES/ FACTORIES
1. Alcoholic beverages – up to 12% alcohol in metal, glass or ceramic material.	1. Beverages (nonalcoholic)
2. Appliances like stove, refrigerator – not packaged, no exterior plastic material.	2. Brick and masonry
3. Asbestos.	3. Foundries
4. Batteries – Dry cells, non-lithium, packaged in cartons, filled automobile batteries.	
5. Bottles, Jars – Empty glass, filled with noncombustible liquids or non-combustible powders.	
6. Canned food – In cartons.	4. Gypsum
7. Cans – empty metal.	
8. Cement – in bags.	5. Telecommunications signal processing
9. Chalk and crayons.	6. Telephone exchanges
10. Coffee – canned in carton.	
11. Electric coil	
12. Fertilizers – Bagged, phosphates.	
13. File cabinets – metal, wrap by cardboard.	
14. Fish products – frozen, non-waxed, non plastic packaging, canned, carton.	
15. Frozen food – non-waxed, non-plastic packaging.	
16. Fruit – fresh, non-plastic trays or containers with wood spacers.	
17. Glass and mirrors.	7. Glass products
18. Gypsum board.	
19. Ice-Cream.	8. Ice
20. Meat products – bulk, canned, carton, frozen, non-waxed, non-plastic containers.	
21. Metal desk – with plastic tops and trim.	
22. Metal s.	9. Metal products (fabrication and assembly)
23. Milk and dairy products– waxed or non-waxed paper containers, plastic containers.	
24. Motor – electric	
25. Nuts – canned, carton.	
26. Paint – water based, carton.	
27. Plastic containers – non-combustible liquids or semi-liquid in plastic container less than 5 gal.	
28. Porcelain and pottery.	10. Ceramic
29. Poultry product- canned, carton, frozen, non-waxed, non-plastic containers.	
30. Salt – bagged.	
31. Syrup – drummed metal containers.	
32. Transformer (Non-energized) – dry and oil filled.	
33. Wire – bare wire on metal spools, on wood skids.	
34. Stables, Sheds	
35. Washers and Driers	



7. Material Approval

- 7.1.** All the Materials, Systems, Assemblies, equipment, Products and Accessories, referred to in this chapter with respect to Life Safety, Fire Safety and Emergency Services shall be Listed, Approved and Registered by the Civil Defence Material Approval Department.
- 7.2.** The above requirement applies to all the products with or without international listing, registration or approval.

8. Further References

- 8.1.** The following International Codes and Standards were referred, studied and consulted for this chapter. Further details where applicable can be referred to in these Codes and Standards. Also see **XV. ACKNOWLEDGEMENT OF INTERNATIONAL CODES AND STANDARDS.**

- NFPA 1: Uniform Fire Code
- NFPA 101: Life Safety Code
- NFPA 5000: Building Construction and Building Code



TABLE 13A.1 - SIZE OF FIRE COMPARTMENT

WAREHOUSE AND FACTORY CONFIGURATION		WITH SPRINKLER	WITHOUT SPRINKLER
Single Storey Warehouse and Factory (Multi-tenant)	Maximum Floor Area	Maximum gross area 4830 m ² Maximum area per compartment 900 m ²	Maximum 232 m ² per compartment or Maximum 900 msq gross area (whichever lower)
	Maximum Storage Height	According to NFPA13	3m
Multi-storey warehouse and Factory with mezzanine (Multi-tenant)	Maximum Floor Area	Maximum gross area 3720 m ² Maximum area per compartment 900m ²	Maximum 140 m ² per compartment or 900 msq gross area (whichever lower)
	Maximum Storage Height	According to NFPA13	3m

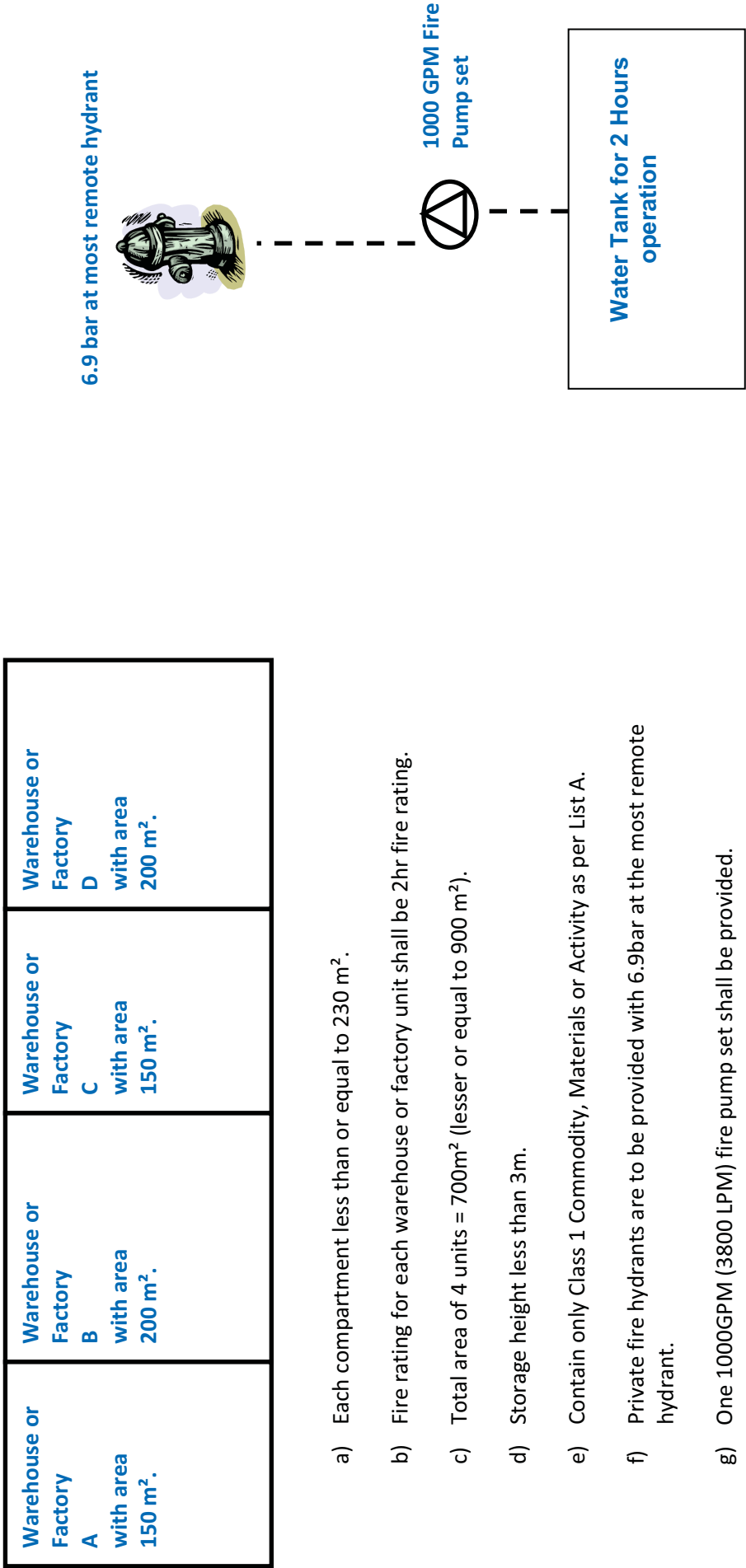
TABLE 13A.2 – SMOKE MANAGEMENT REQUIREMENT

LOCATION OF WAREHOUSE AND FACTORY	COMPARTMENT SIZE	SMOKE CONTROL REQUIREMENT
Aboveground Warehouse and Factory	Up to 230 m ²	Smoke vent based on Table 13A.3
	230 m ² to 2000 m ²	Smoke purging
	2000 m ² to 4830 m ²	Smoke purging or engineered smoke control
	More than 4830 m ²	Engineered smoke control

TABLE 13A.3 – DISTANCE FROM SMOKE VENT

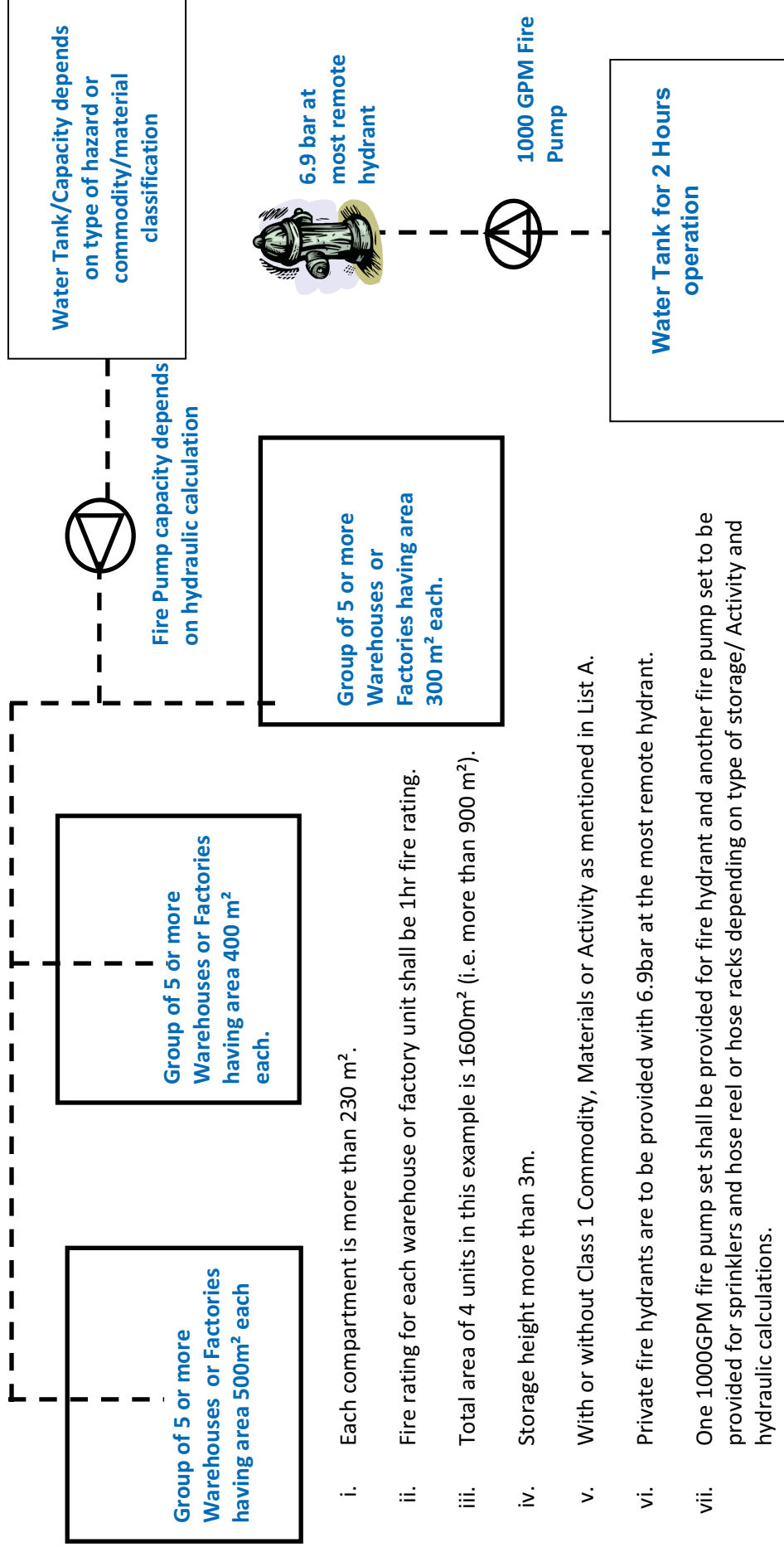
MINIMUM OPENING OF SMOKE VENT BASED ON FLOOR AREA	MAXIMUM DISTANCE FROM ANY PART OF WAREHOUSE TO SMOKE VENT OPENING.
2.5%	12m
5%	15m
10%	18m
15%	21m
20%	24m

Figure 13A.1: Multi-tenant Warehouse or Factory not requiring sprinkler



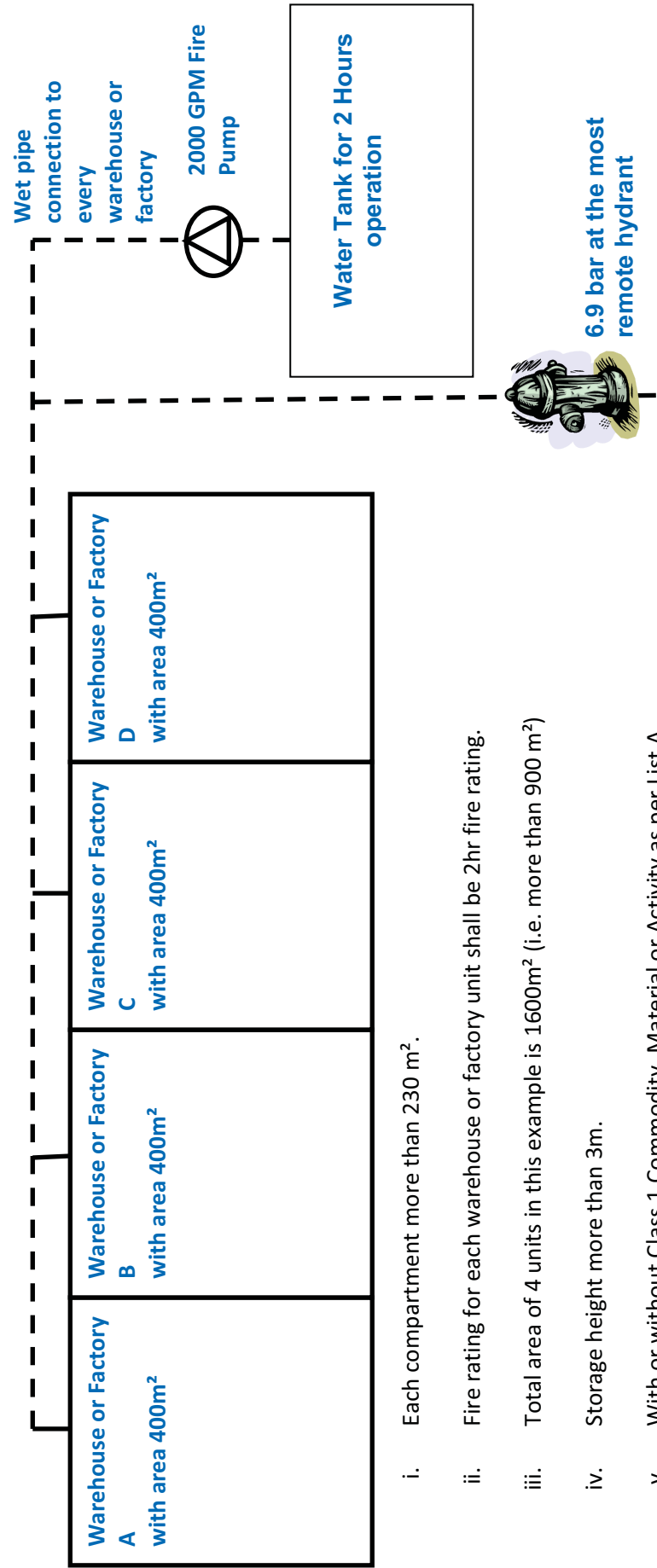
- a) Each compartment less than or equal to 230 m².
- b) Fire rating for each warehouse or factory unit shall be 2hr fire rating.
- c) Total area of 4 units = 700m² (lesser or equal to 900 m²).
- d) Storage height less than 3m.
- e) Contain only Class 1 Commodity, Materials or Activity as per List A.
- f) Private fire hydrants are to be provided with 6.9bar at the most remote hydrant.
- g) One 1000GPM (3800 LPM) fire pump set shall be provided.
- h) Water for fire fighting shall be for 2 hours.
- i) No Sprinklers or landing valves are required.

Figure 13A.2: Multi-tenant Warehouse or Factory requiring sprinkler



- i. Each compartment is more than 230 m².
- ii. Fire rating for each warehouse or factory unit shall be 1hr fire rating.
- iii. Total area of 4 units in this example is 1600m² (i.e. more than 900 m²).
- iv. Storage height more than 3m.
- v. With or without Class 1 Commodity, Materials or Activity as mentioned in List A.
- vi. Private fire hydrants are to be provided with 6.9bar at the most remote hydrant.
- vii. One 1000GPM fire pump set shall be provided for fire hydrant and another fire pump set to be provided for sprinklers and hose reel or hose racks depending on type of storage/ Activity and hydraulic calculations.
- viii. Water for fire fighting shall be for 2 hours.
- ix. Landing valves are not required

Figure 13A.3: Multi-tenant Warehouse or Factory with unconfirmed type of storage or to be rented out



- i. Each compartment more than 230 m².
- ii. Fire rating for each warehouse or factory unit shall be 2hr fire rating.
- iii. Total area of 4 units in this example is 1600m² (i.e. more than 900 m²)
- iv. Storage height more than 3m.
- v. With or without Class 1 Commodity, Material or Activity as per List A.
- vi. Minimum 2000 gpm fire pump set to be provided combined with hydrant and provision for Sprinklers.
- vii. 2 hours fire fighting water.
- viii. Wet pipe connection to every warehouse unit for future connection to sprinkler system.
- ix. Landing valves are not required. (Sprinklers need not be provided at the initial stage. Sprinklers should be provided by the tenant based on his Material category or the Activity.

CHAPTER 14

SUBSTATION REQUIREMENTS

1. General

- 1.1. The purpose of a substation building is to protect the equipment installed indoors, with necessary clearances and working space for the safe operation and maintenance of such equipment. This chapter covers the criteria and parameters for the requirements of Construction, Fire Detection and Fire Suppression Systems.
- 1.2. Guidelines of this chapter should be considered in conjunction with respective details and requirements of all other related chapters of this code.
- 1.3. Substation buildings are categorized as critical Industrial Occupancies for Life Safety evaluations and Special purpose Industrial occupancy Hazard Group for Fire Suppression purposes because of the mixed hazard nature of substations.

2. Construction

- 2.1. The Substation building shall be of Fire Resistant construction equivalent to Type I (443).
- 2.2. Every room of the substation shall be a separate Fire Compartment. Battery rooms, Control rooms, Switchgear rooms, cable spreading rooms, Battery charger etc shall be separated from one another by a 2 hour fire rated barrier.
- 2.3. If a structure or building is physically detached from the main building, such building shall be separated by appropriate distance and Fire resistance as per CHAPTER 1. CONSTRUCTION AND COMPARTMENTATION, [Table 1.2](#).
- 2.4. All doors in 2 hour rated fire barriers should be provided with 90 minutes rated fire door assemblies.
- 2.5. All other penetrations through fire barriers or floors and ceilings such as fire dampers, cable trays, piping etc shall be provided with penetration seals (fire stops), or other approved means having a fire protection rating consistent with the designated fire resistance rating of the barrier.
- 2.6. Removable (or Collapsible or foldable) Fire Barriers of appropriate and equivalent fire rating shall be provided when space is required for equipment maintenance, movement or replacement.
- 2.7. Transformer vaults or rooms, Cable spreading rooms, basements and cable tunnels should be provided with adequate fixed drainage arrangement, preferably with fixed sump and piping.
- 2.8. Special precautions should be taken to collect and contain the oil for Oil filled equipment and oil filled transformers by providing Yardstone, Berns, holding tanks or curb around equipment, or pits.



- 2.9. The substation grading must be contoured to permit the oil to flow to an area that will not affect or endanger other equipment or areas.
- 2.10. The discharge from any oil pressure relief device should be directed away from any nearby equipment to prevent from the splashing of flaming oil.
- 2.11. All equipment in the substation, including noncurrent carrying parts of Fire Detection and Protection Systems shall be permanently grounded with appropriate sized grounding conductors and proper terminations.

2.12. Outdoor Oil insulated transformer and Equipment

- 2.12.1. Outdoor oil-insulated transformers should be separated from adjacent structures and from each other by firewalls, spatial separation, or other approved means for the purpose of limiting the damage and potential spread of fire from a transformer failure.
- 2.12.2. Oil-insulated transformers shall be separated from adjacent structures by a 4-hour-rated firewall or by spatial separation in accordance with [Table 14.1](#). Where a firewall is provided between structures and a transformer, it should extend vertically and horizontally as indicated in [Figure 14.1](#)

Table 14.1: Separation distances for outdoor transformers

Table 14.1: Separation distances for outdoor transformers	
TRANSFORMER OIL CAPACITY	MINIMUM SEPARATION WITHOUT FIRE WALL
Less than 500 Gallons	1.5 meters
500 – 2000 Gallons	7.6 meters
More than 2000 Gallons	15 meters



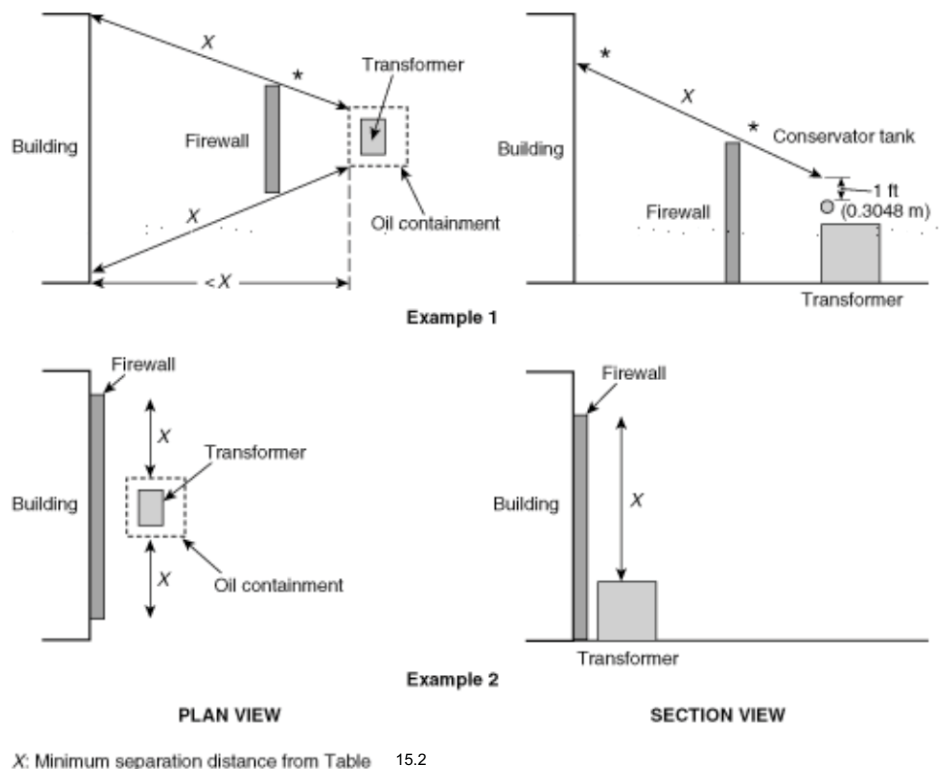


Figure 14.1: Separation distances and Fire wall arrangement for outdoor transformers

2.12.3. As a minimum, the firewall should extend at least 1 ft (0.31 m) above the top of the transformer casing and oil conservator tank and at least 2 ft (0.61 m) beyond the width of the transformer and cooling radiators as shown in **Figure 14.2**.

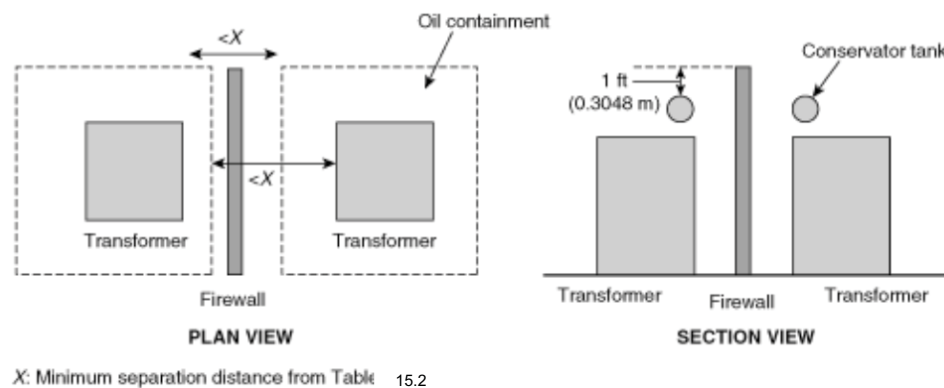


Figure 14.2: Fire wall arrangement for outdoor transformers

2.12.4. For transformers with less than 500 gal (1890 L) of oil and where a firewall is not provided, the edge of the postulated oil spill (i.e., containment basin, if provided) should be separated by a minimum of 5 ft (1.5 m) from the exposed structure to prevent direct flame impingement on the structure.



- 2.12.5.** Power capacitor units located outdoor, which contain a combustible dielectric fluid, should be a minimum of 3m from any structure or building having no fire resistive rating.

2.13. Indoor Oil insulated transformer or Equipment

- 2.13.1.** If possible, only Dry-type (Air cooled) transformers should be considered for indoor installations.
- 2.13.2.** When an oil filled equipment or transformer is installed indoors, it should be installed in transformer /Capacitor vault or room.
- 2.13.3.** Oil-insulated transformers of greater than 100 gal (379 L) oil capacity installed indoors should be separated from adjacent areas by fire barriers of 4-hour fire resistance rating.
- 2.13.4.** Transformers having a rating greater than 35 kV, insulated with a less flammable liquid or nonflammable fluid, and installed indoors should be separated from adjacent areas by fire barriers of 3-hour fire resistance rating.
- 2.13.5.** Capacitor units located indoors, which contain flammable dielectric fluid, should be separated from adjacent areas by a 4 hour fire-rated barrier.
- 2.13.6.** To minimize the structural and mechanical damage from an explosion of indoor oil filled equipment or transformer, explosion relief and venting devices should be installed.

3. Fire Access

- 3.12.** Fire Access way, means and turning facilities shall be provided according to CHAPTER 2. FIRE ACCESS.
- 3.13.** Minimum of 4m wide clear access shall be ensured for the Fire Apparatus to reach the Substations, specially in remote and rural areas.

4. Means of Egress

- 4.12.** Minimum of 2 exits, located at diagonally opposite ends shall be provided.
- 4.13.** Basements, Cable spreading areas shall be provided with minimum 2 exits, located at opposite ends and discharging directly outside at the ground floor.
- 4.14.** Basements, Cable spreading areas shall have a maximum travel distance of 23 m to the exit without any dead ends.
- 4.15.** Control rooms, Battery rooms, Offices, Switchgear rooms etc shall have a maximum travel distance of 60m without any dead ends.
- 4.16.** Common path in a substation building shall not exceed 15m.



- 4.17. Relay and Control Panels, equipment, batteries etc shall be arranged with minimum clearance of 1525mm between the row of panels/ equipment etc and from wall.

5. Doors

- 5.12. Panic Hardware shall be provided on all doors, overriding any exterior lock or padlock to allow egress from inside the building.

6. Portable Fire Extinguishers

- 6.12. Portable Fire Extinguishers shall be provided as per Table 14.2.

Table 14.2: Portable Fire Extinguishers for Substation

LOCATION	TYPE OF EXTINGUISHERS TO BE PROVIDED AS A SET	MAXIMUM TRAVEL DISTANCE TO NEAREST EXTINGUISHER SET
Offices	- Water Type, 9 Ltrs - CO2, 2 Kg	15 m
Common Circulation Areas Corridors, Lobby's, Passage ways	- Water Type, 9 Ltrs - CO2, 5 Kg	22.5 m
Electrical Rooms, Telephone Rooms, Control Rooms, Switchgear Rooms, RMU Room and Other service rooms	- Dry Powder Type, 4.5 Kg - CO2, 5 Kg	9 m
Transformer Room, Capacitor Rooms	- Dry Powder Type, 4.5 Kg - CO2, 5 Kg - Dry Powder Trolley Type, 25 Kg per transformer	9 m
HV / LV Room	- Dry Powder Type, 4.5 Kg - CO2, 5 Kg - CO2 Trolley Type, 12 Kg near exit	9 m

7. Exit Signs

- 7.12. Exit Signs and Directional Signs shall be provided throughout the substation building in accordance with CHAPTER 5. EXIT SIGNS of this code.
- 7.13. Photoluminescent Exit Signs and Directional Signs should be provided for basements, exit passages and equipment.



- 7.14.** Adequate WARNING signs regarding electric shocks, thermal shock impacts, use of inappropriate Fire Extinguishing media, precise identification of breaching inlets for particular water system etc shall be provided throughout the facility.

8. Emergency and Exit Lighting

- 8.12.** Emergency and Exit Lighting shall be provided throughout the substation building in compliance with CHAPTER 6. EMERGENCY AND EXIT LIGHTING.
- 8.13.** All Emergency Lighting System should be wired for FAULT and LOW BATTERY monitoring of all individual luminaries.

9. Fire Detection and Fire Protection System

- 9.12.** Acceptable Fire Detection and Protection systems shall be as per the [Table 14.3](#). And the design criteria shall be as per CHAPTER 8. FIRE DETECTION SYSTEMS and CHAPTER 9. FIRE PROTECTION SYSTEMS of this Code.
- 9.13.** The Main power supply to the entire substation including the Transformer feeder shall be shutoff upon the Detection of Smoke, Heat or Flame.

Table 14.3 Acceptable Fire Detection and Fire Protection Systems for Substation

LOCATION	FIRE DETECTION REQUIREMENTS	FIRE PROTECTION REQUIREMENTS
Battery Charger Room	• Early Warning Smoke Detection System • Point Type Smoke Detection System	• Inert Gas Suppression System • Chemical Gas Suppression System • Pre-action Sprinkler System
Battery Room	• Combination of Explosion proof Flame and Heat Detection	• Inert Gas Suppression System • Chemical Gas Suppression System
Cable Spreading Room	• Early Warning Smoke Detection System for the room And Linear Heat Sensing System for cables/treys	• Water Spray System (Actuation shall be only through Linear Heat Sensing System)
Cable trenches	• Early Warning Smoke Detection System for the trenches And Linear Heat Sensing System for cables/treys	• Inert Gas Suppression System • Chemical Gas Suppression System (Activation of Gas suppression shall be only through linear Heat Sensing system)



LOCATION	FIRE DETECTION REQUIREMENTS	FIRE PROTECTION REQUIREMENTS
Cable Tunnel	• Early Warning Smoke Detection System for the tunnel And Linear Heat Sensing System for cables/treys	• Water Spray System (Actuation shall be only through Linear Heat Sensing System)
Capacitor Room	• Point Type Smoke Detection System	• Inert Gas Suppression System • Chemical Gas Suppression System
Ceiling Void	• Early Warning Smoke Detection System • Point Type Smoke Detection System	• Inert Gas Suppression System • Chemical Gas Suppression System • Pre-action Sprinkler System
Communication Room	• Early Warning Smoke Detection System • Point Type Smoke Detection System	• Inert Gas Suppression System • Chemical Gas Suppression System
Control room	• Early Warning Smoke Detection System • Point Type Smoke Detection System	• Inert Gas Suppression System • Chemical Gas Suppression System • Pre-action Sprinkler System
Floor Void	• Early Warning Smoke Detection System • Point Type Smoke Detection System	• Inert Gas Suppression System • Chemical Gas Suppression System
LV and MV Room	• Early Warning Smoke Detection System • Point Type Smoke Detection System	• Inert Gas Suppression System • Chemical Gas Suppression System
Offices	• Early Warning Smoke Detection System • Point Type Smoke Detection System	• Automatic Sprinkler System • Inert Gas Suppression System • Chemical Gas Suppression System
RMU Room	• Early Warning Smoke Detection System • Point Type Smoke Detection System	• Inert Gas Suppression System • Chemical Gas Suppression System
Switchgear Room	• Early Warning Smoke Detection System	None
(Oil filled) Transformer Room	• Multisensor Detection System	• Water Spray System



LOCATION	FIRE DETECTION REQUIREMENTS	FIRE PROTECTION REQUIREMENTS
(Oil filled) Transformer Vault	- Heat Detection System - UV Flame Detection System for outdoor transformers	Water Spray System
HVAC Room	Point Type Smoke Detection System	Automatic Sprinkler System
Relay Room	Early Warning Smoke Detection System	None
Substation Yard	None	Yard Hydrant System (With one Hydrant consideration for Water demand calculation)
Fire Pump Room	Heat Detection System	Automatic Sprinkler System

- 9.14.** An emergency communication system should be provided throughout the Substation to establish quick communication assistance in the event of fire.
- 9.15.** Wet Riser System shall be provided throughout the Substation building.
- 9.16.** A single Fire Pumpset can serve the entire Fire water system loop for both Yard Hydrant Network and Fixed Fire Water Systems.
- 9.17.** Fire Water Reserve shall be for 2 hour operation.
- 9.18.** Breeching inlets for the Transformer Water Spray System shall be located as far away as possible from the Transformers, preferable at 12 m.
- 9.19.** Main Breeching inlet for the substation network shall be located outside the yard near the entrance.

10. Ventilation and Smoke Control System

- 10.12.** Control room, cable spreading rooms and switchgear room should be provided with smoke venting systems.
- 10.13.** All basements should have smoke extraction systems.
- 10.14.** Battery rooms should be provided with ventilation to limit the concentration of hydrogen to 1 percent by volume.
- 10.15.** Fire dampers shall be provided at locations where ducts and outlets pass through fire rated walls, partitions and floors.



11. Material Approval

11.1. All the Materials, Systems, Assemblies, equipment, Products and Accessories, referred to in this chapter with respect to Life Safety, Fire Safety and Emergency Services shall be Listed, Approved and Registered by the Civil Defence Material Approval Department.

11.2. The above requirement applies to all the products with or without international listing, registration or approval.

12. Further References

12.1. The following International Codes and Standards were referred, studied and consulted for this chapter. Further details where applicable can be referred to in these Codes and Standards. Also see **XV. ACKNOWLEDGEMENT OF INTERNATIONAL CODES AND STANDARDS.**

- NFPA 1: Uniform Fire Code
- NFPA 101: Life Safety Code
- NFPA 5000: Building Construction and Safety Code
- NFPA 850: Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations
- NFPA 75: Standard for the Protection of Information Technology Equipment
- NFPA 76: Standard for the Fire Protection of Telecommunications Facilities



CHAPTER 14

ACCESSIBILITY GUIDELINES FOR THE DISABLED

The following guidelines are extracted from NFPA 5000, Building Construction and Safety Code, Chapter 12 Accessibility, 2009 Edition; the NFPA 101, Life Safety Code; the International Building Code, Chapter 11 Accessibility, 2006 Edition, and the American National Standard ICC/ANSI A117.1, 2009.

1. Purpose

The provisions for Americans with Disabilities Act Guidelines (ADAG) control the design and construction of facilities for accessibility and usability to the physically disabled persons. Physical disability, or *severe mobility impairment*, is the “the ability to move to stairs but without the ability to use the stairs.”

ANSI A117.1 defines the technical criteria as to “make sites, facilities, buildings and elements accessible to and usable by people with such physical disabilities as the inability to walk, difficulty walking, reliance on walking aids, blindness and visual impairment, deafness and hearing impairment, incoordination, reaching and manipulation disabilities, lack of stamina, difficulty interpreting and reacting to sensory information, and extremes of physical size.”

2. Scope

All areas of newly designed and newly constructed buildings and facilities and altered portions of existing buildings and facilities shall comply with these requirements. [12.1.1, NFPA 5000]

The scope is broadly inclusive of all aspects of construction that affect the ability of disabled people to approach, enter, and utilize a facility. The term “facility” includes not only the building and structures, but also the site on which they are located. Features of a site, such as parking areas and paths of travel from a public way to a structure, affect accessibility and are, therefore, within the scope.

3. Applicability and Adoption

The local authorities in the UAE have already adopted and enforced the American National Fire Protection Association Life Safety Codes (NFPA), and the International Building Code (IBC).

The local Authority Having Jurisdiction (AHJ), represented by the Civil Defence, may provide scoping provisions to specify the extent to which ADA technical criteria apply. In the case such provision is not available, or the AHJ has not adopted or enforced certain ADA requirements, the building design and construction should conform to ADA provisions stated herein and detailed in the referenced codes and standards.



4. Referenced Codes and Standards

- 4.1 NFPA 101, Life Safety Code, 2009, Subsection 7.5.4 Accessible Means of Egress.
- 4.2 NFPA 500, Building Construction and safety Code, 2009, Chapter 12 Accessibility
- 4.3 American National Standard ICC/ANSI A117.1 Accessible and Usable Buildings and Facilities, 2003
- 4.4 International Building Code, Chapter 11 Accessibility, 2009.

5. Permitting and Inspection

Per 1.7.6.5.2.1, NFPA 5000: Issuing a permit (or NOC- No Objection Certificate in the UAE) or approval of construction documents by the authority having jurisdiction (Civil Defence) shall not be construed to be a permit for, or an approval of, any violation of any of the provisions of this code. As such, the Architect is responsible for compliance with the applicable codes.

The authority having jurisdiction shall reserve the right to inspect the building or structure, for which an application for permit has been received, at any time during construction and/or prior to issuing the permit or NOC.

6. General Exceptions

Per 12.3, NFPA 5000 and 1103.2, IBC-2006, the following sites, buildings, facilities, and elements are exempt from ADA requirements. Refer to the corresponding section for more information. They shall include:

- Existing Buildings.
- Construction Sites.
- Raised Areas.
- Limited Access Spaces.
- Machinery and Equipment Spaces.
- Single Occupant Structures.
- Detention and Correctional Facilities.
- Residential Facilities.
- Employee Work Areas.
- Raised Refereeing, Judging, and Scoring Areas.
- Water Slides.
- Animal Containment Areas.
- Raised Boxing or Wrestling Rings.
- Raised Diving Boards and Diving Platforms.



7. Minimum Requirements and Provisions

The minimum requirements and provisions for design and construction are summarized by the following categories and subcategories of site and building elements, components, and services.

The designer shall further refer to the detailed technical criteria and information pertaining to each category and applicable to the project under consideration.

It is to be noted that Compliance Alternatives [103, ICC/ANSI A117.1] and Exceptions to the requirements [per reference Chapter or Section] are commonly acceptable. Additional cultural requirements in the UAE may exempt, for example the requirement for Tactile Signage for the blind and visually impaired persons because they will always be accompanied by a person who is not disabled.

7.1 General Site and Building Elements

(Parking spaces, passenger loading zones and bus stops, stairways, handrails, and windows) Refer to Chapter 5, ICC/ANSI A117.1; 12.8, 12.9, 12.29, and 12.10, NFPA 5000; and 1106 and 1109, IBC.

7.2 Accessible Means of Egress

Refer to 7.5.4, NFPA 101; 12.7, NFPA 5000; and 1007 & 1105, IBC.

7.3 Accessible Routes

(Walking surfaces, doors and doorways, ramps, elevators, and platform lifts) Refer to 12.6, NFPA 5000; Chapter 4, ICC/ANSI A117.1; and 1007.2.1, 1010 & 1104, IBC.

7.4 Area of Refuge

Refer to 7.2.12, NFPA 101; 11.2.12, NFPA 5000; and 1007.6, IBC.

7.5 Building Blocks

(Floor surfaces, changes in level, turning space, clear floor space, knee and toe clearances, protruding objects, reach ranges, and operable parts) Refer to 12.4, 12.5, NFPA 5000; Chapter 4, ICC/ANSI A117.1; and Section 1104, IBC.

7.6 Plumbing Elements and Facilities

(Drinking fountains, kitchens and kitchenettes, toilet and bathing rooms, water closets and toilet compartments, urinals, lavatories and sinks, bathtubs, shower compartments, grab bars, seats, and washing machines and clothes dryers) Refer to Chapter 6, ICC/ANSI A117.1; 12.11, 12.12, 12.13, and 12.14, NFPA 5000; and Section 1109, IBC.



7.7 Communication Elements and Features

(Fire alarms, signs and signage, telephones, detectable warnings, assistive listening systems, automatic teller machines, and 2-way communicating systems) Refer to Chapter 7, ICC/ANSI A117.1; 12.15, 12.16, 12.17, 12.19, 12.20, 12.28, and 12.30, NFPA 5000; and E106, 1110, IBC.

7.8 Special Rooms and Spaces

(Assembly areas, dressing, fitting, and locker rooms; kitchens and kitchenettes, transportation facilities, holding cells and housing cells, and judicial facilities/ courtrooms) Refer to Chapter 8, ICC/ANSI A117.1; 12.12, 12.18, 12.21, 12.22, and 12.31, NFPA 5000; and 1108.2, 1108.4, 1109.10, 1109.12.1, and E109, IBC.

7.9 Built-In Furnishings and Equipment

(Dining surfaces and work surfaces, benches, sales and service counters, service facilities, and storage facilities) Refer to Chapter 9, ICC/ANSI A117.1; 12.25, 12.26, 12.22, and 12.27, NFPA 5000; and 1108.2.8, 1108.3, 1109.8, and 1109.12, IBC.

7.10 Dwelling Units, Sleeping Units, and Residential Facilities

(Accessible units, types A & B units, and units with accessible communication features) Refer to Chapter 10, ICC/ANSI A117.1; 12.33, NFPA 5000; and 1107, IBC.

7.11 Hotels, Swimming Pools, Spas, Saunas, and Steam Rooms

Refer to 12.24, 12.42, and 12.41, NFPA 5000.

7.12 Exercise Machines and Equipment, and Play Areas

Refer to 12.36, and 12.40, NFPA 5000.

7.13 Depositories, Vending Machines, Change Machines, Mail Boxes, and Fuel Dispensers

Refer to 12.28, NFPA 5000.

For other facility and building types such as healthcare, detention and correctional facilities, amusement rides, recreational boating facilities, golf facilities, and airports, refer to 12.23, 12.32, 12.34, 12.35, and 12.38 of NFPA 500; and 1103.2.13, 1107.5.5, 1108.4.2, 1109.14, and E110, IBC.



CHAPTER 16

SPECIFICATION FOR LIFE SAFETY ALARM MONITORING

Category – 1

Civil Defence has made a commitment to enhance Life Safety and National Security in UAE by implementing a 24x7x365 Remote Monitoring System (RMS).

RMS will detect and report alarms in real time from Fire and Fire Fighting Systems, Lift and Gas detection systems in residential, domestic, commercial and industrial buildings.

The project includes the entire UAE and covers every type of buildings right from Warehouses to high rise buildings. Project will be using state of the art technology (M2M) to automatically send alarm signals in case of emergency. Information including exact details on alarm location and status will be provided to DCD for immediate response.

The buildings/sheds are divided into different categories. The specifications for Buildings/sheds falling within Category 1 are as follows:

Buildings with gross area less than 5000 sq ft and with any of the following parameters and having a fire alarm panel are specified as Category-1

- Single Room Commercial Establishments
- Single Storey Buildings
- Double Storey Buildings

Basement of the building will also considered as a floor.

Small industrial sheds (e.g. Warehouse/factories etc.) Less than 5000 sq ft without hazardous material storage.

Subscriber should provide a single Interface Panel for interfacing to the Civil Defence monitoring panel. The Interface Panel shall have the following capability.

- Separate Volt free contacts (VFC) for the following points. The state of the VFC should ideally be Closed (NC) during normal condition and Open (NO) during alarm condition.
 - Common Fire Alarm within the building
 - Common Fire Alarm System Fault.



- Proper terminals for connectivity.
- 230VAC power supply terminals within the interface panel.
- Proper electrical earth.
- Interface panel should be located next to proposed place of installation of Civil Defence alarm panel.
- Containment till the Location of Civil Defence alarm panel.

Interface Panel Location

The Interface Panel should be located next to the Civil Defence Alarm Panel location. The location shall be based as per following

- There shall be excellent GPRS signal coverage at the location.
- The location should be on any floor on or above the ground floor.
- Location shall be within the building and not outside
- The panel shall be easily accessible

Civil Defence Panel Location

Proper space shall be provided for the Civil Defence Panel Location within the building as per the following

- A minimum space of 800mm X 800mm X 500mm shall be provided.
- The space shall be provided on the wall at least 1.5 mtrs above floor level
- The space shall be provided next to the Interface Panel within a maximum distance of 2 mtrs.
- The location shall have excellent GPRS signal coverage.

Important Information

- (a) All Contractors/Building Owners to subscribe at DCD counter.
- (b) Survey will be conducted within 7 working days of date of subscription.
- (c) Building category will be decided after survey.
- (d) The subscriber will need to rectify all snags identified during survey within 48 hrs.
- (e) Subscriber will make the payments at DCD cash counter.
- (f) For multi-tenanted industrial sheds/building with common fire alarm panel, the subscription charges will be borne by the owner. Tenant need to produce the photocopy of the receipt towards payments of subscription charges, duly endorsed by the owner. Owner's endorsement will be considered as acceptance of owner towards tenant's area being covered by the centralized fire alarm system.
- (g) Individual tenants with their own fire alarm system will pay for the subscription charges as per determined category.



- (h) It is mandatory that Industrial sheds with hazardous materials should have a separate panel for the area of the storage.
- (i) Depending upon the type of material stored, multi tenanted industrial sheds might be required to install a separate Fire alarm panel and it will be at the sole discretion of Civil Defence.

Note:

This document is only a guideline. Depending upon the size, location and utilities of a property, Civil Defence has the discretion of advising the systems to be installed for the safety of life and property. Accordingly the property can consider in a Category at the sole discretion of Civil Defence.

Category - 2

Civil Defence has made a commitment to enhance Life Safety and National Security in UAE by implementing a 24x7x365 Remote Monitoring System (RMS).

RMS will detect and report alarms in real time from Fire and Fire Fighting Systems, Lift and Gas detection systems in residential, domestic, commercial and industrial buildings.

The project includes the entire UAE and covers every type of buildings right from Warehouses to high rise buildings. Project will be using state of the art technology (M2M) to automatically send alarm signals in case of emergency. Information including exact details on alarm location and status will be provided to DCD for immediate response.

The buildings/sheds are divided into different categories. The specifications for Buildings/sheds falling within Category 2 are as follows:

Buildings with gross area less than 5000 sq ft and with any of the following parameters and having a fire alarm panel and a fire water tank are specified as Category-2

- Single Room Commercial Establishments
- Single Storey Buildings
- Double Storey Buildings

Basement of the building will also considered as a floor.



Small industrial sheds (e.g. Warehouse/factories etc.) less than 5000 sq ft and with water tank within a radial distance of 15 meters from the shed area without hazardous material storage.

Subscriber should provide a single Interface Panel for interfacing to the Civil Defence monitoring panel. The Interface Panel shall have the following capability.

- Separate Volt free contacts (VFC) for the following points. The state of the VFC should ideally be Closed (NC) during normal condition and Open (NO) during alarm condition.
 - Common Fire Alarm within the building
 - Common Fire Alarm System Fault.
 - Fire Water Tank Low Level
- Proper terminals for connectivity.
- 230VAC power supply terminals within the interface panel.
- Proper electrical earth.
- Interface panel should be located next to the proposed place of installation of Civil Defence alarm panel.
- Containment till the Location of Civil Defence alarm panel.

Interface Panel Location

The Interface Panel should be located next to the Civil Defence Alarm Panel location. The location shall be based as per following

- There shall be excellent GPRS signal coverage at the location.
- The location should be on any floor on or above the ground floor.
- Location shall be within the building and not outside
- The panel shall be easily accessible

Civil Defence Panel Location

Proper space shall be provided for the Civil Defence Panel Location within the building as per the following

- A minimum space of 800mm X 800mm X 500mm shall be provided.
- The space shall be provided on the wall at least 1.5 mtrs above floor level
- The space shall be provided next to the Interface Panel within a maximum distance of 2 mtrs.
- The location shall have excellent GPRS signal coverage.



Important Information

- (j) All Contractors/Building Owners to subscribe at DCD counter.
- (k) Survey will be conducted within 7 working days of date of subscription.
- (l) Building category will be decided after survey.
- (m) The subscriber will need to rectify all snags identified during survey within 48 hrs.
- (n) Subscriber will make the payments at DCD cash counter.
- (o) For multi-tenanted industrial sheds/building with common fire alarm panel, the subscription charges will be borne by the owner. Tenant need to produce the photocopy of the receipt towards payments of subscription charges, duly endorsed by the owner. Owner's endorsement will be considered as acceptance of owner towards tenant's area being covered by the centralized fire alarm system.
- (p) Individual tenants with their own fire alarm system will pay for the subscription charges as per determined category.
- (q) It is mandatory that Industrial sheds with hazardous materials should have a separate panel for the area of the storage.
- (r) Depending upon the type of material stored, multi tenanted industrial sheds might be required to install a separate Fire alarm panel and it will be at the sole discretion of Civil Defence.

Note:

This document is only a guideline. Depending upon the size, location and utilities of a property, Civil Defence has the discretion of advising the systems to be installed for the safety of life and property. Accordingly the property can consider in a Category at the sole discretion of Civil Defence.

Category - 3

Civil Defence has made a commitment to enhance Life Safety and National Security in UAE by implementing a 24x7x365 Remote Monitoring System (RMS).

RMS will detect and report alarms in real time from Fire and Fire Fighting Systems, Lift and Gas detection systems in residential, domestic, commercial and industrial buildings.

The project includes the entire UAE and covers every type of buildings right from Warehouses to high rise buildings. Project will be using state of the art technology (M2M) to automatically send alarm signals in case of emergency. Information including exact details on alarm location and status will be provided to DCD for immediate response.



The buildings/sheds are divided into different categories. The specifications for Buildings/sheds falling within Category 3 are as follows:

Buildings with gross area above 5000 sq ft and below 15,000 sq ft and with any of the following parameters are specified as Category-3.

- Two Room Commercial Establishments
- Three to Seven Storey Buildings

Basement of the building will also considered as a floor.

Industrial sheds (e.g. Warehouse/factories etc.) Above 5000 sq ft and below 15,000 sq ft (including distance of water tank from shed area) without hazardous material storage

Any Category-3 building/industrial sheds may have the following alarm monitoring systems

- Fire Alarm
- Fire Pumps
- Fire Water Tank Low Level
- Lifts

Subscriber should provide a single Interface Panel for interfacing to the Civil Defence monitoring panel. In the event of a single interface panel not being provided, the building category will be treated as Category 5.

The Interface Panel shall have the following capability.

- Separate Volt free contacts (VFC) for the following points. The state of the VFC should ideally be Closed (NC) during normal condition and Open (NO) during alarm condition.
 - Fire Water Tank Low Level
 - Common Lift Alarm and Fault
 - Common Fire Pump Run Status
 - Common Fire Pump Fault Status
 - Common Fire Alarm within the building
 - Common Fire Alarm System Fault.
- Proper terminals for connectivity.
- 230VAC power supply terminals within the interface panel.
- Proper electrical earth.
- Interface panel should be located next to proposed place of installation of Civil Defence alarm panel.



- Containment till the Location of Civil Defence alarm panel.

Interface Panel Location

The Interface Panel should be located next to the Civil Defence Alarm Panel location. The location shall be based as per following

- There shall be excellent GPRS signal coverage at the location.
- The location should be on any floor on or above the ground floor.
- Location shall be within the building and not outside
- The panel shall be easily accessible

Civil Defence Panel Location

Proper space shall be provided for the Civil Defence Panel Location within the building as per the following

- A minimum space of 800mm X 800mm X 500mm shall be provided.
- The space shall be provided on the wall at least 1.5 mtrs above floor level
- The space shall be provided next to the Interface Panel within a maximum distance of 2 mtrs.
- The location shall have excellent GPRS signal coverage.

Important Information

- (s) All Contractors/Building Owners to subscribe at DCD counter.
- (t) Survey will be conducted within 7 working days of date of subscription.
- (u) Building category will be decided after survey.
- (v) The subscriber will need to rectify all snags identified during survey within 48 hrs.
- (w) Subscriber will make the payments at DCD cash counter.
- (x) For multi-tenanted industrial sheds/building with common fire alarm panel, the subscription charges will be borne by the owner. Tenant need to produce the photocopy of the receipt towards payments of subscription charges, duly endorsed by the owner. Owner's endorsement will be considered as acceptance of owner towards tenant's area being covered by the centralized fire alarm system.
- (y) Individual tenants with their own fire alarm system will pay for the subscription charges as per determined category.
- (z) It is mandatory that Industrial sheds with hazardous materials should have a separate panel for the area of the storage.
- (aa) Depending upon the type of material stored, multi tenanted industrial sheds might be required to install a separate Fire alarm panel and it will be at the sole discretion of Civil Defence.



Note:

This document is only a guideline. Depending upon the size, location and utilities of a property, Civil Defence has the discretion of advising the systems to be installed for the safety of life and property. Accordingly the property can consider in a Category at the sole discretion of Civil Defence.

Category - 4

Civil Defence has made a commitment to enhance Life Safety and National Security in UAE by implementing a 24x7x365 Remote Monitoring System (RMS).

RMS will detect and report alarms in real time from Fire and Fire Fighting Systems, Lift and Gas detection systems in residential, domestic, commercial and industrial buildings.

The project includes the entire UAE and covers every type of buildings right from Warehouses to high rise buildings. Project will be using state of the art technology (M2M) to automatically send alarm signals in case of emergency. Information including exact details on alarm location and status will be provided to DCD for immediate response.

The buildings/sheds are divided into different categories. The specifications for Buildings/sheds falling within Category 4 are as follows:

Buildings with gross area above 15,000 sq ft and below 200,000 sq ft with any of the following parameters are specified as Category-4

- Multiple Room Commercial Establishments
- Eight to Twenty Storey Buildings
- Industrial sheds above 15000 sq ft and below 200,000 sq. ft without hazardous material storage

Basement of the building will also considered as a floor.

Any Category-4 building may have the following alarm monitoring systems

- Addressable based Fire Alarm System with minimum floor wise zoning and open protocol connectivity as described in Section 1.4
- Fire Pumps
- Fire Water Tank Low Level
- Lifts
- Gas Detection



Subscriber should provide a single Interface Panel for interfacing to the Civil Defence monitoring panel. The Interface Panel shall have the following capability. In the event of a single interface panel not being provided, the building category will be treated as Category 5.

- Open Protocol connectivity as described in section 1.4 from Addressable fire alarm panels in the event of Fire Alarm System not being connected to BMS.
- Open Protocol connectivity as described in section 1.4 from buildings having a BMS.
- Separate Volt free contacts (VFC) per fire alarm panel (in case of a networked fire alarm system) for the following points. The state of the VFC should ideally be Closed (NC) during normal condition and Open (NO) during alarm condition.
 - Common Fire Alarm within the building
 - Common Fire Alarm System Fault.
- Separate Volt free contacts (VFC) for the following points in the event of the points not being connected to BMS. The state of the VFC should ideally be Closed (NC) during normal condition and Open (NO) during alarm condition.
 - One alarm point per floor/zone for fire alarm(In case of fire alarm panel not being able to provide open protocols)
 - Fire Water Tank Low Level
 - Individual Lift Alarm
 - Individual Lift Fault
 - Individual Fire Pump Run Status
 - Individual Fire Pump Fault Status
 - Gas Detection System Common Alarm
 - Gas Detection System Common Fault.
 - Common Alarm from specialized Fire Systems.
- Proper terminals for connectivity.
- 230VAC power supply terminals within the interface panel.
- Proper electrical earth.
- Interface panel should be located next to proposed place of installation of Civil Defence alarm panel.
- Containment till the Location of Civil Defence alarm panel.

BMS Requirements

Buildings having a BMS should have the provision to monitor the following points in the building:

- Fire Alarm per floor including basement
- Common Fire Alarm system Fault
- Fire Water Tank Low Level



- Individual Lift Fault
- Individual Lift Passenger Alarms
- Individual Fire Pump Running Status
- Individual Fire Pump Trip Status
- Fire Water Line Low Pressure Alarm
- Gas alarm per zone or floor
- Common Gas Alarm System Fault.
- Common Alarm from specialized Fire Systems

The BMS shall integrate to the Civil Defence Alarm Panel using open protocols as defined below. The BMS shall expose all the above mentioned points as Digital values to the Civil Defence Alarm Panel using any of the open protocols defined below:

Open protocols:

- Bacnet IP
- Bacnet MSTP
- Modbus TCP
- Modbus RTU over three wire RS485 – Proper Modbus registers to be provided for each monitoring point.
- Lonworks

Interface Panel Location

The Interface Panel should be located next to the Civil Defence Alarm Panel location. The location shall be based as per following

- There shall be excellent GPRS signal coverage at the location.
- The location should be on any floor on or above the ground floor.
- Location shall be within the building and not outside
- The panel shall be easily accessible

Civil Defence Panel Location

Proper space shall be provided for the Civil Defence Panel Location within the building as per the following

- A minimum space of 800mm X 800mm X 500mm shall be provided.
- The space shall be provided on the wall at least 1.5 mtrs above floor level
- The space shall be provided next to the Interface Panel within a maximum distance of 2 mtrs.
- The location shall have excellent GPRS signal coverage.



Important Information

- (bb)** All Contractors/Building Owners to subscribe at DCD counter.
- (cc)** Survey will be conducted within 7 working days of date of subscription.
- (dd)** Building category will be decided after survey.
- (ee)** The subscriber will need to rectify all snags identified during survey within 48 hrs.
- (ff)** Subscriber will make the payments at DCD cash counter.
- (gg)** For multi-tenanted industrial sheds/building with common fire alarm panel, the subscription charges will be borne by the owner. Tenant need to produce the photocopy of the receipt towards payments of subscription charges, duly endorsed by the owner. Owner's endorsement will be considered as acceptance of owner towards tenant's area being covered by the centralized fire alarm system.
- (hh)** Individual tenants with their own fire alarm system will pay for the subscription charges as per determined category.
- (ii)** It is mandatory that Industrial sheds with hazardous materials should have a separate panel for the area of the storage.
- (jj)** Depending upon the type of material stored, multi tenanted industrial sheds might be required to install a separate Fire alarm panel and it will be at the sole discretion of Civil Defence.
- (kk)** It is recommended that all buildings falling in category-4 and above should have an addressable fire alarm system installed covering the entire buildup area.

Note:

This document is only a guideline. Depending upon the size, location and utilities of a property, Civil Defence has the discretion of advising the systems to be installed for the safety of life and property. Accordingly the property can consider in a Category at the sole discretion of Civil Defence.

Category - 5

Civil Defence has made a commitment to enhance Life Safety and National Security in UAE by implementing a 24x7x365 Remote Monitoring System (RMS).

RMS will detect and report alarms in real time from Fire and Fire Fighting Systems, Lift and Gas detection systems in residential, domestic, commercial and industrial buildings.

The project includes the entire UAE and covers every type of buildings right from Warehouses to high rise buildings. Project will be using state of the art technology (M2M) to



automatically send alarm signals in case of emergency. Information including exact details on alarm location and status will be provided to DCD for immediate response.

The buildings/sheds are divided into different categories. The specifications for Buildings/sheds falling within Category 5 are as follows:

Buildings with any of the following parameters are specified as Category-5.

- Buildings with gross area above 200,000 sq ft
- Buildings with twenty one floors and more
- Multiple Room Commercial Establishments.
- Industrial sheds with area of more than 200,000 sq ft.
- Industrial Facility with Hazardous material (irrespective of area)
- A building with no or multiple interface panel.(irrespective of area and Floors)

Basement of the building will also considered as a floor.

The cost of installation and monitoring for the Remote Monitoring System (RMS) will be calculated as a combination of category 1 to category 4 depending on the technical feasibility and building specific conditions observed during the survey of the building. Any Category-5 building may have the following alarm monitoring systems:

- Addressable based Fire Alarm System with minimum floor wise zoning and open protocol connectivity as described in Section 1.4
- Fire Pumps
- Fire Water Tank Low Level
- Lifts
- Gas Detection

Subscriber should provide a single Interface Panel for interfacing to the Civil Defence monitoring panel. The Interface Panel shall have the following capability.

- Open Protocol connectivity as described in section 1.4 from Addressable fire alarm panels in the event of Fire Alarm System not being connected to BMS.
- Open Protocol connectivity as described in section 1.4 from buildings having a BMS.
- Separate Volt free contacts (VFC) per fire alarm panel (in case of a networked fire alarm system) for the following points. The state of the VFC should ideally be Closed (NC) during normal condition and Open (NO) during alarm condition.
 - Common Fire Alarm within the building
 - Common Fire Alarm System Fault.



- Separate Volt free contacts (VFC) for the following points in the event of the points not being connected to BMS. The state of the VFC should ideally be Closed (NC) during normal condition and Open (NO) during alarm condition.
 - One alarm point per floor/zone for fire alarm(In case of fire alarm panel not being able to provide open protocols)
 - Fire Water Tank Low Level
 - Individual Lift Alarm
 - Individual Lift Fault
 - Individual Fire Pump Run Status
 - Individual Fire Pump Fault Status
 - Gas Detection System Common Alarm
 - Gas Detection System Common Fault.
 - Common Alarm from specialized Fire Systems.
- Proper terminals for connectivity.
- 230VAC power supply terminals within the interface panel.
- Proper electrical earth.
- Interface panel should be located next to proposed place of installation of Civil Defence alarm panel.
- Containment till the Location of Civil Defence alarm panel.

BMS Requirements

Buildings having a BMS should have the provision to monitor the following points in the building:

- Fire Alarm per floor including basement
- Common Fire Alarm system Fault
- Fire Water Tank Low Level
- Individual Lift Fault
- Individual Lift Passenger Alarms
- Individual Fire Pump Running Status
- Individual Fire Pump Trip Status
- Fire Water Line Low Pressure Alarm
- Gas alarm per zone or floor
- Common Gas Alarm System Fault.
- Common Alarm from specialized Fire Systems

The BMS shall integrate to the Civil Defence Alarm Panel using open protocols as defined below. The BMS shall expose all the above mentioned points as Digital values to the Civil Defence Alarm Panel using any of the open protocols defined below:

Open protocols:



- Bacnet IP
- Bacnet MSTP
- Modbus TCP
- Modbus RTU over three wire RS485 – Proper Modbus registers to be provided for each monitoring point.
- Lonworks

Interface Panel Location

The Interface Panel should be located next to the Civil Defence Alarm Panel location. The location shall be based as per following

- There shall be excellent GPRS signal coverage at the location.
- The location should be on any floor on or above the ground floor.
- Location shall be within the building and not outside
- The panel shall be easily accessible

Civil Defence Panel Location

Proper space shall be provided for the Civil Defence Panel Location within the building as per the following

- A minimum space of 800mm X 800mm X 500mm shall be provided.
- The space shall be provided on the wall at least 1.5 mtrs above floor level
- The space shall be provided next to the Interface Panel within a maximum distance of 2 mtrs.
- The location shall have excellent GPRS signal coverage.

Important Information

- (II) All Contractors/Building Owners to subscribe at DCD counter.
- (mm) Survey will be conducted within 7 working days of date of subscription.
- (nn) Building category will be decided after survey.
- (oo) The subscriber will need to rectify all snags identified during survey within 48 hrs.
- (pp) Subscriber will make the payments at DCD cash counter.
- (qq) For multi-tenanted industrial sheds/building with common fire alarm panel, the subscription charges will be borne by the owner. Tenant need to produce the photocopy of the receipt towards payments of subscription charges, duly endorsed by the owner. Owner's endorsement will be considered as acceptance of owner towards tenant's area being covered by the centralized fire alarm system.
- (rr) Individual tenants with their own fire alarm system will pay for the subscription charges as per determined category.



- (ss) It is mandatory that Industrial sheds with hazardous materials should have a separate panel for the area of the storage.
- (tt) Depending upon the type of material stored, multi tenanted industrial sheds might be required to install a separate Fire alarm panel and it will be at the sole discretion of Civil Defence.
- (uu) It is recommended that all buildings falling in category-4 and above should have an addressable fire alarm system installed covering the entire buildup area.

Note:

This document is only a guideline. Depending upon the size, location and utilities of a property, Civil Defence has the discretion of advising the systems to be installed for the safety of life and property. Accordingly the property can consider in a category at the sole discretion of Civil Defence.

Material Approval

- 1.1. All the Materials, Systems, Assemblies, equipment, Products and Accessories, referred to in this chapter with respect to Life Safety, Fire Safety and Emergency Services shall be Listed, Approved and Registered by the Civil Defence Material Approval Department.
- 1.2. The above requirement applies to all the products with or without international listing, registration or approval.



CHAPTER 17

GUIDELINES FOR CONDUCTING RISK ASSESSMENT (RA) STUDIES

1. General requirements

- 1.1.** Risk Analysis should be based on the various hazard assessment methods outlined in **Table 17.1** (or any other approved method) and should include (but not be limited to) the following:
- As a first step in Risk Assessment, PHA (Preliminary Hazard Analysis) should be carried out followed by detailed examination by other known hazard analysis method such as HAZOP studies. The Risk Assessment Study should evaluate all possible risks arising within the premises/operations and/or off- site due to the operations and recommend necessary mitigation measures.
 - A detailed evaluation of regular/irregular operations, activities, tasks and main installations, including physical-chemical characteristics of materials being stored/handled/processed, quantitative data on amounts, volumes, production/storage conditions etc. should be carried out.
 - Site suitability with regard to wind, flooding etc.
 - FAULT TREE and EVENT TREE analysis should be carried out to provide a graphic description of the accident sequences associated with plant operations and storage.
 - Evaluate/Clarify risks (Frequency, Severity and Probability) using accepted Risk Assessment Technique and Criteria leading to determination of risks to be eliminated or controlled.
 - Accident Consequence Analysis and its effects on human, environment and nearby installations and site should be analyzed.
 - Provide for clarification of risks and identification of those to be eliminated or controlled.
 - Evaluate Fire & Explosion hazard using F & EI Index.
 - Evaluate Fire Protection System, Alarm System and Ventilation.
 - Hazardous materials classification based on internationally accepted standards such as NFPA, U.N. or IMDG code, etc.
 - Hazardous Area Classification and identification with mapping of the proposed facility.
 - Effects of emergency situations/major environmental events such as lightning, flooding,



and acts of mischief or sabotage should be analyzed.

- m. Evaluate occupational health hazards & environmental risks involved in process and operations.
- n. For all of the above, measures should be developed and recommended for technical and organizational protection to bring down risks AS LOW AS REASONABLY PRACTICABLE.
- o. Develop ON SITE & OFF SITE emergency action plan in co-ordination with Civil Defence.
- p. Wherever a risk/operation/situation cannot be managed feasibly, it shall be the duty of the consultant to highlight the same in the report.

2. Outline of Risk Assessment Study Report

- 2.1.** Risk (incorporating Health, Safety & Environment risks) Assessment study report should contain the following information as a minimum. In practice, the depth of the information required on each guideline topic given below depends on each individual project / facility e.g. Size & Nature of operation , Identified Hazards, Accident History ,etc, will vary according to the circumstance of the individual facility.
- a. Background and objective that includes a full description of the proposed project.
 - b. Process Description of the Proposed Project i.e. Basic Operations, Physical and Chemical reactions, Operational Storage etc.
 - c. Information on the installation (e.g. location, plot plan, process flow diagram(PFDs), PID's, personnel on site, local land used and population distribution, etc.).
 - d. Information on details of the plant and machinery including sketches (sectional view) of machinery and schematic of the process involved.
 - e. Information on hazardous substances (e.g. substance name monitoring method, hazards composition of process, MSDS, List of Chemicals, etc.)
 - f. Information required on management system (e.g. responsible person and Quality Control for safety training etc.).
 - g. Information on major accidents (identification of potential major hazard events, process flow diagram, prevention and control systems, emergency procedure meteorological conditions, numbers at risk etc.).
 - h. Information on possible accidents, i.e. Assessment of the possible release of hazardous substances or of energy, Possible dispersion of released substances, Assessment of the effects of the release Size of affected area, health effects, property damage, etc.



- i. Documentation and summary of Codes, Standards and Recommended Practices which have been consulted during the design stage of the project.
- j. Recommendations and Mitigation measures based on risk evaluation.
- k. Prior to final approval of the Risk Assessment Study report, a technical presentation to Civil Defence should be carried out if required/ asked by Civil Defence

Table 17.1 – Working Methods for Hazard Assessment

METHOD	PURPOSE	AIM	WORKING PRINCIPLE
1) Preliminary hazard analysis 2) Matrix diagrams of Interactions 3) Use of checklist	1. Identification of hazards	1. Completeness of safety concept	1. Use of “thinking aids”
4) Failure effect analysis 5) Hazard & operability study			2. Use of “searching aids” in schematic documents
6) Accident sequence analysis (inductive) 7) Fault tree analysis (deductive)	2. Assessment of hazards according to their occurrence frequency	2. Optimization of reliability and availability of safety systems	3. Graphic decision of failure sequences and mathematical calculation of probabilities
8) Accident Consequence analysis	3. Assessment of accident consequences	3. Mitigation of consequences and development of optimum emergency plans	4. Mathematical modeling of physical and chemical process

3. Specific Fire Protection Requirements to be Addressed

- 3.1. Fire hazard identification.
- 3.2. Severity analysis/Fire & Explosion Index (F & EI) and Toxicity Index (TI). Refer to [Table 17.2](#).
- 3.3. Mapping areas of risk / risk contours.
- 3.4. Direct comparison with actuarial data and other risk criteria.



- 3.5. Criteria for assessing maximum release quantity and separation distances / Quantifying dispersion.
- 3.6. Scenario development.
- 3.7. Probability analysis / the chances of fire and explosion.
- 3.8. Risk monitoring (if the risk is acceptable).
- 3.9. Identification of environmental problems that are related to fire protection.
- 3.10. Risk reduction analysis (if the risk is not acceptable) systems & methods and recommendations to prevent and/or reduce them to the acceptable level(s).
- 3.11. Hazard and Operability Study (HAZOP).
- 3.12. Event trees.
- 3.13. Case histories where appropriate.
- 3.14. Compliance with codes, procedures and regulations including manufacturing requirement & management under ASME code for boilers & pressure vessels.
- 3.15. Toxicity relationships.
- 3.16. Damage from fire and radiant heat.
- 3.17. The TNT equivalence.
- 3.18. Primary and secondary blasts relationships.
- 3.19. Top event frequency estimation.
- 3.20. Design & construction procedures.
- 3.21. Maintenance Operations.
- 3.22. Education & Training of staff.
- 3.23. Emergency / Evacuation Plans (on site & off site plans).

4. Guideline notes

- 4.1. The scale that measures severity such as death, injuries, property damage, and areas reached by flames shall be specified.



- 4.2. Calculations specifying the severity measure used for a particular fire shall be included.
- 4.3. Active and passive fire protection measures shall be included.
- 4.4. The consultants shall be solely subject to the laws of the UAE for losses or damages in terms of life and property stemming from design errors, implementation errors, deficiencies of inspections, failure to construct in compliance with the required standards, failure to comply with rules of Professional ethics, failure to use knowledge and experience to the contracting entity, and similar reasons; and successively (severally) liable with the contractors where the consultants have undertaken control and inspection services on works. The consultants shall be caused to complete and compensate for any such losses or damages pursuant to the laws of the UAE.
- 4.5. Civil Defence or any other departments of Civil Defence and their directors, officers and other concerned personnel shall not be held responsible or liable for any such losses or damages, errors, deficiencies and failures on the part of the consultants.
- 4.6. The Material Factor (MF) is derived from the following table:-

**Table 17.2 - Fire & Explosion Index (F&EI) System
Material Factor (MF)**

	$N_F=0$	$N_F=1$	$N_F=2$	$N_F=3$	$N_F=4$
$N_F=0$	1	14	24	29	40
$N_F=1$	4	14	24	29	40
$N_F=2$	10	14	24	29	40
$N_F=3$	16	16	24	29	40
$N_F=4$	21	21	24	29	40

- 4.7. The MF for Combustible Dusts; Combustible Solids; Warehousing/Storage of Goods; Manufacturing, Construction and Other Occupancies are derived from separate tables.
- 4.8. **General Hazards (GH)**
- 4.8.1. General process Hazards are factors that play a primary role in determining the magnitude of a loss incident. The items viz. (i) Chemical Processes (ii) Storage, Handling, Transfer and Manufacturing (iii) Confinement (iv) Access (v) Drainage (vi) Total General Hazards Factor are investigated as contributing hazards.
- 4.9. **Specific Hazards (SH)**
- 4.9.1. The items viz. (i) Quantities of Materials Involved (ii) Pressure Conditions (iii) Toxic Materials Involved (iv) Explosion Potential/ Flammable Range & (v) Total Specific Hazards Factor that indicate existence of specific conditions as a major contributing factor in fire and explosion incidents are investigated.



4.10. Fire and Explosion Index (F&EI)

4.10.1. The F&EI calculation is calculated by giving credit for both general and specific hazards to the materials involved. The formula used is:

$$F\&EI = MF \times (1 + GH) \times (1 + SH)$$

4.10.2. The resulting F&EI values are ranked into four categories:

- 1 - 45 Light Hazard**
- 46 - 60 Moderate Hazard**
- 61 - 95 High Hazard**
- 96 - up Severe Hazard**

4.11. Toxicity Number

4.11.1. The toxicity number (Th) is derived from the NFPA health factor Nh (NFPA 704, 325M or 49). Nh is an integer number ranging from 0 to 4. The five degrees of hazards are related to the protective equipment normally available to fire fighters.

Nh	TH
0	0
1	50
2	125
3	250
4	325

4.12. Penalty Factor

4.12.1. The Penalty Factor (Ts) is the second toxicity parameter used to determine the TI. The Ts value is derived from the 'Threshold Limit Values (TLV)'.

4.12.2. The TLV-values are drawn up by the American Conference of Governmental Industrial Hygienists.

4.12.3. TLV represents a time weighted average (TWA) air concentration to which workers can be exposed during a normal working week without ill effects. TLV is often indicated as a TWA-value, both are the same.

4.12.4. The penalty factor is determined from the table below:



Threshold Limit Values (TLVs)	Penalty Factor (Ts)
<5	125
5-50	75
>50	50

4.13. Toxicity Index (TI)

4.13.1. The Toxicity Index is then calculated from Th and Ts plus the hazard factors of fire & Explosion Index (F&EI). The TI is found from the following formula:

$$TI: \frac{Th + Ts (1 + GH + SH)}{100}$$

4.13.2. The resulting TI values are ranked into three categories:

1-5	Light
6-9	Moderate
10-up	High



CHAPTER 18

SPECIAL STRUCTURES AND OCCUPANCIES

1. General

- 1.1. This chapter briefs out various requirements for special structures such as Membrane structures, Modular houses, Modular offices, Tents, Metro Stations, Amusement structures, Tram stations, Road Tunnels, Robotic Parking structures etc.
- 1.2. Guidelines of this chapter should be considered in conjunction with respective details and requirements of all other related chapters of this code and referenced international standards.
- 1.3. Any structure or special structure to be qualified as 'Temporary Structure' or 'Temporary arrangement' shall be occupied, used or demonstrated for a period less than 6 months from the date of erection or construction.
- 1.4. If any of the structure or special structure is occupied, used or demonstrated for more than a period of 6 months, the structure or special structure shall be considered as a 'Permanent Structure' and hence all the Life Safety and Fire protection requirements shall be as per relevant chapters of this code and other international standards.
- 1.5. The following Construction and Life Safety requirements are mandatory for 'Temporary' as well as 'Permanent' Structures or special structures. The Fire protection requirements are only for 'Permanent' structures or special structures.





CHAPTER 18. SPECIAL STRUCTURES AND OCCUPANCIES

Table 18.1 Construction, Life Safety, Fire and Emergency Systems requirements for Special structures

STRUCTURE	CONSTRUCTION REQUIREMENTS	LIFE SAFETY REQUIREMENTS	FIRE AND EMERGENCY SYSTEMS REQUIREMENTS
18.1.1. Membrane Structures	1. Shall be limited to one story only. 2. There shall be a minimum clearance of 36 in. (915 mm) between the membrane and any equipment, object etc. 3. Area limitation shall be as per Type II construction requirements of Chapter 1. Construction and Compartmentation. 4. Flame spread of all membrane materials exposed within the structure shall be Class A. 5. All membrane structure fabric shall meet the requirements of Test Method 2 contained in NFPA 701, Standard Methods of Fire Tests for Flame Propagation of Textiles and Films. 6. Roof membranes shall have a roof covering classification, as required by the applicable building codes, when tested in accordance with NFPA 256, Standard Methods of Fire Tests of Roof Coverings; ASTM E 108, Standard Test Methods for Fire Tests of Roof Coverings; or UL 790, Test Methods for Fire Tests of Roof Coverings. 7. Air inflated structures shall have not less than two weather proof automatic blower units complete with automatic control, incapable of over pressurization	1. Minimum 2 exits shall be provided. 2. Minimum 3 exits shall be provided if occupant load is 500-1000 3. Minimum 4 exits shall be provided if occupant load is more than 1000. 4. The Commonpath, Dead-ends, travel distances, exit width etc. shall be as per occupancy type and shall comply with Chapter 3. Means of Egress. 5. Cooking facilities, Hazardous material storage areas shall be separated. 6. Containers for liquefied petroleum gases shall be installed not less than 60 in. (1525 mm) from any temporary membrane structure. 7. The ground enclosed by any membrane structure shall not be less than 10 ft (3050 mm) from all flammable or combustible material.	1. If enclosed structure, Fire Alarm System shall be provided as per Chapter 8. Fire Detection and Alarm System. 2. If enclosed structure, Fire fighting system shall be provided as per occupancy type and Table 9.1 of Chapter 9. Fire Protection Systems. 3. Fire Extinguishers shall be provided as per Chapter 4. Portable Fire Extinguishers.

CHAPTER 18. SPECIAL STRUCTURES AND OCCUPANCIES

STRUCTURE	CONSTRUCTION REQUIREMENTS	LIFE SAFETY REQUIREMENTS	FIRE AND EMERGENCY SYSTEMS REQUIREMENTS
	and powered by continuous-rated motors at the maximum power required. 8. Standby power capable of 4 hour backup shall be provided for Air inflated membrane structures. 9. The design, materials, and construction of the membrane structures shall be based on plans and specifications prepared by a licensed architect or engineer knowledgeable in membrane construction. 10. Material loads and strength shall be based on physical properties of the materials verified and certified by an approved testing laboratory.		
18.1.2. Metro Rail and Tram Systems	1. Planning, Construction, Structure, Strength, Materials etc shall be as per NFPA 130. Standard for Fixed Guideway Transit and Passenger Rail Systems. 2. Building construction for all new stations shall be not less than Type I– or Type II– or combinations of Type I– and Type II–approved noncombustible construction. 3. Stairs and escalators regularly used by passengers shall not be required to be enclosed. 4. Ancillary buildings shall be separated from station. All power substations	1. At least two means of egress remote from each other shall be provided from each station platform. 2. Where means of egress routes from separate platforms converge, the subsequent capacity of the egress route shall be sufficient to maintain the required evacuation time from the incident platform. 3. A common path of travel from the platform ends shall not exceed 25 m (82 ft) or one car length, whichever is greater. 4. The maximum travel distance on the	1. Emergency ventilation, based on CFD analysis shall be provided for all enclosed trainway greater than 300 m, underground trainway, if the length is greater than 60 m. 2. Emergency ventilation fans, their motors, and all related components exposed to the exhaust airflow shall be designed to operate in an ambient atmosphere of 250°C (482°F) for a minimum of 1 hour. 3. Operation of the emergency ventilation system components shall be initiated from the central



CHAPTER 18. SPECIAL STRUCTURES AND OCCUPANCIES

STRUCTURE	CONSTRUCTION REQUIREMENTS	LIFE SAFETY REQUIREMENTS	FIRE AND EMERGENCY SYSTEMS REQUIREMENTS
	shall have a fire separation of at least 3 hours from all other occupancies. 5. Electrical control rooms, auxiliary electrical rooms, and associated battery rooms shall have a fire separation of at least 2 hours from all other occupancies. 6. Trash rooms shall have a fire separation of at least 1 hour from all other occupancies. 7. Train control rooms and associated battery rooms shall have a fire separation of at least 2 hours from all other occupancies. 8. All public areas shall have a fire separation of at least 2 hours from nonpublic areas. 9. All station public areas shall have a fire separation of at least 3 hours from all nontransit occupancies. 10. Interior wall and ceiling finish materials, other than textile wall coverings or foam plastic insulation, shall exhibit a flame spread index not exceeding 25 and a smoke developed index not exceeding 450, when tested by NFPA 255 or by ASTM E 84. 11. Perimeter Fire Barriers, Exterior Curtain Wall and Cladding systems shall be 'An Approved System', as per Chapter 1. Construction and	platform to a point at which a means of egress route leaves the platform shall not exceed 100 m (300 ft). 5. Within underground or enclosed trainways, the maximum distance between exits shall not exceed 762 m (2500 ft). 6. The station also shall be designed to permit evacuation from the most remote point on the platform to a point of safety in 6 minutes or less. 7. Cross-passageways shall be permitted to be used in lieu of emergency exit stairways to the surface where trainways in tunnels are divided by a minimum of 2 hour-rated fire walls or where trainways are in twin bores. 8. A minimum clear width of 1200 mm (47 in.) shall be provided along all platforms, corridors, and ramps serving as means of egress. 9. Doors and other openings through the separations shall be 90 minutes fire rated. 10. Power substation door shall be 3 hour fire rated. 11. Where a fire door is required to be open, it shall be automatic closing type.	supervising station. 4. Materials manufactured for use as conduits, raceways, ducts, boxes, cabinets, equipment enclosures, and their surface finish materials shall withstand temperatures up to 500°C (932°F) for 1 hour. 5. Enclosed stations shall be provided with Class I, Type 60 emergency power connected to Emergency lighting, Protective signaling systems, Emergency communication system, Fire command center. 6. Emergency Lighting shall be provided throughout the station as per Chapter 7. 6. Emergency and Exit Lighting. 7. Automatic Fire Detection and Alarm system shall be provided throughout the facility as per Chapter 8. Fire Detection and Alarm System. 8. Voice evacuation/Public Address System shall be provided throughout the station, ancillary buildings as per Chapter 7. Emergency Voice and Communication System. 9. Except for open stations which are remotely located from public spaces, all stations shall be provided with Automatic Sprinkler System with Class III Wet Riser System as per Chapter 9.

CHAPTER 18. SPECIAL STRUCTURES AND OCCUPANCIES

STRUCTURE	CONSTRUCTION REQUIREMENTS	LIFE SAFETY REQUIREMENTS	FIRE AND EMERGENCY SYSTEMS REQUIREMENTS
18.1.4. Road Tunnels	- Construction, Structure, Strength, Materials etc shall be as per NFPA 502. Standard for Road Tunnels, Bridges and Other Limited Access Highways. - The emergency exits shall be enclosed in a minimum 2-hour fire-rated enclosure having a Class A interior finish.	modular housing and offices. - Emergency exits shall be provided throughout the tunnel spaced not more than 300 m (1000 ft) apart. - Reflective or lighted directional signs indicating the distance to the two nearest emergency exits shall be provided on the side walls at distances of no more than 25 m (82 ft) - Where tunnels are divided by a minimum of 2-hour fire-rated construction or where tunnels are in twin bores, cross-passageways between the tunnels shall not be farther than 200 m (656 ft) apart. - An emergency egress walkway with a minimum clear width of 1.12 m (3.6 ft) shall be provided on each side of the cross-passageways. - Walkways shall be continuous the entire length of the tunnel, terminating at surface grade. - Control of hazardous materials shall comply with the requirements of Code of Practice for the Management of Dangerous Goods in the Emirates issued by Dubai Municipality.	- Tunnel associated structures such as substations, transformer rooms, Control rooms, Generator Rooms, Electrical Rooms, Equipment Rooms, Service Rooms shall comply with relevant chapters of this code. - Road Tunnels exceeding 90 m in length, shall be provided with Fire Access, Wet Riser System, Portable Fire Extinguishers, Emergency Lighting as per relevant chapters of this code. Traffic Control Systems, CCTV and Emergency Response procedures shall be provided for tunnels exceeding 90 m in length. - Where tunnel length equals or exceeds 240 m (800 ft) and where the maximum distance from any point within the tunnel to a point of safety exceeds 120 m (400 ft), shall be provided with Fire Access, Automatic Fire Detection system, Wet Riser System, Portable Fire Extinguishers , Emergency Ventilation systems, Emergency Lighting as per relevant chapters of this code. Hydrocarbon Detection system, Telephones, Drainage system, Traffic Control Systems,

CHAPTER 18. SPECIAL STRUCTURES AND OCCUPANCIES

STRUCTURE	CONSTRUCTION REQUIREMENTS	LIFE SAFETY REQUIREMENTS	FIRE AND EMERGENCY SYSTEMS REQUIREMENTS
			CCTV and Emergency Response procedures shall be provided for tunnels exceeding 240 m in length. 4. Where the tunnel length equals or exceeds 1000 m (3280 ft), such tunnels shall be provided with Fire Access, Automatic Fire Detection system, Wet Riser System, Fixed Fire Water Suppression system, Portable Fire Extinguishers, Emergency Ventilation systems, Emergency Lighting, Emergency power supply as per relevant chapters of this code. Hydrocarbon Detection system, Telephones, Drainage system, Traffic Control Systems, CCTV and Emergency Response procedures shall be provided for tunnels exceeding 1000 m in length.
18.1.5. Robotic/ Automatic Car Parking structure	- Construction, Structure, Strength, Materials etc shall be as per NFPA 88A. Standard for Parking structure. - Those parts of parking structures located within, immediately below, attached to, or less than 3000 mm (120 in.) from a building used for any other purpose shall be separated by walls,	- At least two means of egress remote from each other shall be provided which can be Fire Personnel access. - Horizontal walkways for access shall be provided at intervals of 6 m (19.5 ft) vertically and 30 m (98.5 ft) horizontally. - Travel distance from any point to the	Enclosed Robotic and Automated Car parking structure shall be provided with a ventilation system which continuously provides 2 air changes per hour. An engineering analysis based increase in air changes per hour shall be incorporated for the Fire and

CHAPTER 18. SPECIAL STRUCTURES AND OCCUPANCIES

STRUCTURE	CONSTRUCTION REQUIREMENTS	LIFE SAFETY REQUIREMENTS	FIRE AND EMERGENCY SYSTEMS REQUIREMENTS
	partitions, floors, or floor—ceiling assemblies having fire resistance ratings of not less than 2 hours. 3. Offices or other similar spaces that are related to the operation of the parking structure and are less than 300 m² (3000 ft²) in area, other than cashier or attendant booths, shall be separated from parking areas by walls or partitions that resist the passage of smoke. 4. Perimeter Fire Barriers, Exterior Curtain Wall and Cladding systems shall be 'An Approved System', as per Chapter 1. Construction and Compartmentalization.	enclosed exit stair shall not exceed 122 m. 4. The width of stair, width of doors, arrangement of exits, Discharge, doors, swing of doors etc shall be as per Chapter 3. Means of Egress.	smoke scenario. 2. Automatic Fire Detection and Alarm system shall be provided throughout the structure and to cover each level of cars as per Chapter 8. Fire Detection and Alarm System. 3. Automatic Foam Sprinkler System with sprinkler heads to cover each level of cars shall be provided for the structure as per Chapter 9. Fire Protection System. 4. Wet Riser System shall be provided as per Chapter 9. Fire Protection System. 5. Ancillary Buildings shall be provided with Fire suppression systems as per Table 9.2., Chapter 9. Fire protection Systems.
18.1.6. Special Amusement Structure	1. Construction, Structure, Strength, Materials etc of Special Amusement Structure such as haunted house, a roller coaster-type ride within a building, a multilevel play structure within a building, a submarine ride, and similar amusement where the occupants are not in the open air, shall be as per 'Assembly Occupancy' requirements of UAE FIRE AND LIFE	1. Means of Egress shall be as per 'Assembly Occupancy' requirements of Chapter 3. Means of Egress.	1. All special amusement structures greater than 45 m² irrespective of occupant load, shall be provided with Automatic Fire Detection and Alarm system as per Chapter 8. Fire Detection and Alarm System. 2. All special amusement structures greater than 45 m² irrespective of occupant load shall be provided with Automatic Sprinkler System



CHAPTER 18. SPECIAL STRUCTURES AND OCCUPANCIES

STRUCTURE	CONSTRUCTION REQUIREMENTS	LIFE SAFETY REQUIREMENTS	FIRE AND EMERGENCY SYSTEMS REQUIREMENTS
	SAFETY CODE OF PRACTICE, NFPA 101 and NFPA 5000. 2. Interior finish shall be Class A throughout.		with Class III Wet Riser System as per Chapter 9. Fire protection systems. 3. Where the special amusement building required to be sprinklered is movable or portable, the sprinkler water supply shall be by an approved temporary means. 4. When an alarm by sprinkler system or detection system is initiated, illumination in the means of egress shall be increased and Stop any conflicting or confusing sounds and visuals. 5. Exit marking in special amusement buildings shall be of the luminescent, self-luminous, or electroluminescent type.
18.1.7. Tents	1. Tents are allowed only on temporary basis. 2. Tents erected shall not cover more than 75% of the premises. 3. All tent fabric shall meet the requirements of Test Method contained in NFPA 701, Standard Methods of Fire Tests for Flame Propagation of Textiles and Films. 4. There shall be a minimum of 10 ft (3050 mm) between stake lines.	1. Distance between adjacent tents shall be at least 3 m as means of egress. 2. Smoking shall not be permitted in any tent. 3. Containers for liquefied petroleum gases shall be installed not less than 60 in. (1525 mm) from any tent confirming to Chapter 11. Fire Safety Guidelines for LPG. 4. LPG or Fuel Tanks shall be secured in	1. Fire Extinguishers shall be provided as per Chapter 4. Portable Fire Extinguishers.

CHAPTER 18. SPECIAL STRUCTURES AND OCCUPANCIES

STRUCTURE	CONSTRUCTION REQUIREMENTS	LIFE SAFETY REQUIREMENTS	FIRE AND EMERGENCY SYSTEMS REQUIREMENTS
		the upright position and protected from vehicular traffic. 5. Only labeled heating devices shall be used.	

2. Material Approval

- 2.1.
- All the Materials, Systems, Assemblies, equipment, Products and Accessories, referred to in this chapter with respect to Life Safety, Fire Safety and Emergency Services shall be Listed, Approved and Registered by the Civil Defence Material Approval Department.
- 2.2.
- The above requirement applies to all the products with or without international listing, registration or approval.

3. Further References

- 3.1.
- The following International Codes and Standards were referred, studied and consulted for this chapter. Further details where applicable can be referred to in these Codes and Standards. Also see XV. ACKNOWLEDGEMENT OF INTERNATIONAL CODES AND STANDARDS.

- NFPA 1:

Uniform Fire Code

• NFPA 101:

Life Safety Code

• NFPA 5000:

Building Construction and Safety Code

• NFPA 88A:

Standard for Parking Structures

• NFPA 501:

Standard on Manufactured housing

• NFPA 502:

Standard for Road Tunnels, Bridges and Other Limited Access Highways

• NFPA 130:

Standard for Fixed Guideway Transit and Passenger Rail Systems

•

‘Code of Practice for the Management of Dangerous Goods in the Emirates’ issued by Dubai Municipality.



CHAPTER 19

REQUIREMENTS FOR SUBMISSION OF DRAWINGS

1. POLICY

- 1.1. It is the policy of The Civil Defence to ensure that the risk of fire is minimized and to ensure the safety of life and property.
- 1.2. Civil Defence requirements are intended to prescribe minimum guidelines for Design, Construction, Modification & Installation of Buildings, Fire Detection & Protection Systems and Life Safety concerns as per NFPA Standards & Local Regulations.
- 1.3. The Owners, Designers, Consultants, Décor companies & Contractors shall be responsible for compliance with these design standards & code Requirements. The relevant standards and codes that are used as reference shall be stated and declared on the plan.
- 1.4. Project submissions to acquire Civil Defence approval should confirm to the following procedure and standard plan format requirements. Submissions not confirming to these requirements shall not be reviewed.

2. REQUIREMENTS FOR CONSULTANTS

- 2.1. Consultant Office personnel/ Engineer must be Specialized and qualified to represent and discuss their project.
- 2.2. Consultant Office representative must produce his/ her valid Civil Defence Identity card (ID) during an appointment.
- 2.3. Consultant's submissions should comply with Civil Defence requirements for **Consultant's Standard Plans** as per section 3.

3. CONSULTANT'S STANDARD PLANS

- 3.1. All submissions shall confirm to the following requirements.
 - 3.1.1. Drawings should be strictly of A1 size.
 - 3.1.2. Plans should be strictly to 1:100 or 1:150 scale.
 - 3.1.3. All dimensions in the plan should be in Metric (SI) Units. (Meters, Kilograms, Liters...)
 - 3.1.4. Plans should be securely bound. Submission with loose pages shall not be reviewed.
 - 3.1.5. Plans should be printed drawings. Handwritten and hand-drawn submissions shall not be reviewed.



- 3.1.6. Submission should have a cover-page with minimum 150mm X 60mm space for Civil Defence stamping and writing comments.
- 3.1.7. Submission should have detailed floor-wise built-up area calculations.
- 3.1.8. Submission shall consist of plans and designs as follows (Color coded plans shall be appreciated)
 - 3.1.8.1. Built-up area calculations.
 - 3.1.8.2. Setting out plans (Can have suitable scale as applicable)
 - 3.1.8.3. Architectural floor Plans showing Fire rating of Walls, Partitions, Doors & Windows.
 - 3.1.8.4. Travel distances from most remote corners.
 - 3.1.8.5. Maximum diagonal distances of the built-up area.
 - 3.1.8.6. Staircase details.
 - 3.1.8.7. Fire Alarm System layout, Emergency lighting System layout, Exit sign layout & Voice evacuation system layouts with riser diagrams.
 - 3.1.8.8. Fire Fighting System layouts, Fire extinguishers distribution layout, Fire pump and Fire water tank details with riser diagrams.
 - 3.1.8.9. Areas protected by Gas suppression systems shall be shown as per Standard Legends.
 - 3.1.8.10. Smoke control system & Pressurization system layout depicting smoke and fire damper locations and riser diagrams.
 - 3.1.8.11. LPG System tank location, dedicated shafts and layout.
 - 3.1.8.12. Specification of Curtain-wall system, Exterior façade details with approved system numbers and references.
- 3.1.9. Warehouse & Storage project submissions shall have scanned owner's undertaking letter of responsibility, listing the materials used and stored. Type of storage method shall also be described.
- 3.1.10. Industrial, production, processing, manufacturing and factory submissions shall have scanned description of the functional aspect of the facility, rooms and the process flow.
- 3.1.11. A declaration and undertaking letter from consultant shall be furnished which states that the design of fire systems, LPG systems shall be finalized based on detailed calculation based approach from contractor's shop drawings.
- 3.1.12. Each plan shall follow the symbols shown in Civil Defence **Standard Legends** as per **APPENDIX A**. The Civil Defence **Standard Legends** as applicable, shall be shown at the right corner of each page.
- 3.1.13. For approval of modification, revision and alteration of buildings, submission shall have floor-wise "Approved Existing building plans" for reference and "Revised building Plans" in a single bunch with revised areas and revised systems highlighted.



4. REQUIREMENTS FOR DÉCOR COMPANIES

- 4.1. Décor Company personnel/ Engineer must be Specialized and qualified to represent and discuss their project.
- 4.2. Décor Company representative must produce his/ her valid Civil Defence Identity card (ID) during an appointment.
- 4.3. Décor Company submissions should comply with Civil Defence requirements for Décor Company's Standard Plans. Submissions not confirming to these requirements shall be rejected.

5. DÉCOR COMPANY'S STANDARD PLANS

- 5.1. All submissions shall confirm to the following requirements.
 - 5.1.1. Drawings should be strictly of A3 size.
 - 5.1.2. Plan should be strictly to 1:50 or 1:100 scale.
 - 5.1.3. All dimensions in the plan should be in Metric (SI) Units. (Meters, Kilograms, Liters...)
 - 5.1.4. Plans should be printed drawings. Handwritten and hand-drawn submissions shall not be reviewed.
 - 5.1.5. Plans should be securely bound. Submission with loose pages shall be rejected.
 - 5.1.6. Submission should have a cover-page with minimum 150mm X 60mm space for Civil Defence stamping and writing comments.
 - 5.1.7. Submission should have detailed built-up area calculations.
 - 5.1.8. Submission shall consist of plans and designs as follows (Color coded plans shall be appreciated)
 - 5.1.8.1. Setting out plans
 - 5.1.8.2. Architectural Plans showing Fire rating of Walls, Partitions, Doors & Windows.
 - 5.1.8.3. Travel distances from most remote corners.
 - 5.1.8.4. Maximum diagonal distances of the built-up area.
 - 5.1.8.5. Staircase details.
 - 5.1.8.6. Fire Alarm System layout, Emergency lighting System layout, Exit sign layout & Voice evacuation system layouts with riser diagrams.
 - 5.1.8.7. Fire Fighting System layouts with riser diagrams.
 - 5.1.8.8. Fire extinguishers distribution layout.
 - 5.1.9. A declaration and undertaking letter from Décor companies shall be furnished which states that the design of fire systems, LPG systems, kitchen hood protection systems shall be finalized based on detailed calculation based approach from contractor's shop drawings.



5.1.10. Each plan shall follow the symbols shown in Civil Defence **Standard Legends** as per **APPENDIX A**. The Civil Defence **Standard Legends** as applicable, shall be shown at the right corner of each page.

5.1.11. For approval of modification, revision and alteration of buildings, submission shall have floor-wise “Approved Existing building plans” for reference and “Revised building Plans” in a single bunch with revised areas and systems highlighted.

6. REQUIREMENTS FOR CONTRACTING COMPANIES

- 6.1.** Contracting companies must be registered and Civil Defence approved firms.
- 6.2.** Contracting Company personnel/ Engineer must be Specialized and qualified to represent and discuss their project.
- 6.3.** Contracting Company submissions should be based on Civil Defence approved Consultant Design Drawings.
- 6.4.** Contracting Company submissions without Consultant’s stamp & Signature shall not be reviewed.
- 6.5.** Company submissions should comply with Civil Defence requirements for Contracting Company’s Standard Shop drawings as per section 7. Submissions not confirming to these requirements shall be rejected.

7. CONTRACTING COMPANY’S STANDARD SHOP DRAWINGS

- 7.1.** All submissions shall confirm to the following requirements.
 - 7.1.1.** Drawings should be strictly of A1 size.
 - 7.1.2.** Plan should be strictly to 1:100 or 1:150 scale.
 - 7.1.3.** All dimensions in the plan should be in Metric (SI) Units. (Meters, Kilograms, Liters...)
 - 7.1.4.** Plans should be printed drawings. Handwritten and hand-drawn submissions shall not be reviewed.
 - 7.1.5.** Plans should be securely bound. Submission with loose pages shall be rejected.
 - 7.1.6.** Submission should have a cover-page with minimum 150mm X 60mm space for Civil Defence stamping and writing comments.
 - 7.1.7.** Submission shall consist of plans and designs as follows (Color coded plans shall be appreciated)
 - 7.1.7.1.** Fire Alarm System and Voice evacuation system layout with wiring diagrams, riser diagrams, interfacing details & a dedicated page with specific product specifications and schematics (From product manual).



- 7.1.7.2. Emergency lighting System and Exit sign layout with wiring diagrams, riser diagrams, interfacing details & a dedicated page with specific product specifications and schematics (From product manual)
- 7.1.7.3. Fire Fighting System layouts shall include scanned Hydraulic calculations, Hazard identification, Design criteria, Commodity classification, Piping layouts with proposed sizes, Fire pump and Fire water tank details, Suppressing agent tank locations with riser diagrams. A dedicated page shall show product specifications, ratings and schematics. (From product manual).
- 7.1.7.4. Fire extinguishers distribution layout with capacity and specifications from product manual.
- 7.1.7.5. Each plan shall follow the symbols shown in Civil Defence **Standard Legends** as per **APPENDIX A**. The Civil Defence **Standard Legends** as applicable, shall be shown at the right corner of each page.

8. REQUIREMENTS FOR LPG & GAS SUPPRESSION SYSTEM CONTRACTING COMPANIES

- 8.1. LPG & Gas Contracting companies must be registered and Civil Defence approved firms.
- 8.2. LPG & Gas Contracting Company personnel/ Engineer must be Specialized and qualified to represent and discuss their project.
- 8.3. LPG & Gas Contracting Company submissions should be based on Civil Defence approved Consultant Design Drawings.
- 8.4. LPG & Gas Contracting Company submissions shall have Consultant's stamp & Signature.
- 8.5. LPG & Gas Company submissions should comply with Civil Defence requirements for **LPG & Gas Contracting Company's Standard Shop drawings** as per section 9. Submissions not confirming to these requirements shall be rejected.

9. LPG AND GAS BASED FIRE SUPPRESSING SYSTEM CONTRACTING COMPANY'S STANDARD SHOP DRAWINGS

- 9.1. All submissions shall confirm to the following requirements.
 - 9.1.1. Drawings should be strictly of A1 size.
 - 9.1.2. Plan should be strictly to 1:100 or 1:150 scale
 - 9.1.3. All dimensions in the plan should be in Metric (SI) Units. (Meters, Kilograms, Liters...)
 - 9.1.4. Plans should be securely bound. Submission with loose pages shall be rejected.
 - 9.1.5. Submission should have a cover-page with minimum 150mm X 60mm space for Civil Defence stamping and writing comments.
 - 9.1.6. Submission shall have plans and designs as follows (Color coded plans shall be appreciated)
 - 9.1.6.1. Key Plans for the entire floor.
 - 9.1.6.2. If the proposal is for cylinder type LPG, the submission shall furnish scanned copy of building Owner's undertaking letter stating his responsibility not to



allow more than 450 kg of cylinders and not in multiple locations in his building.

- 9.1.6.3. If the proposal is for LPG usage in Industrial applications, the submission shall furnish scanned copy of facility Owner's undertaking letter, stating brief description of the industry and facility with specific application and usage of LPG in the process.
- 9.1.6.4. LPG System layouts shall include LPG Piping layouts in each floor with proposed sizes, LPG tank capacity & location, Filling pipeline layout, Supply point layout, PRDP location and LPG leak detection & alarm system details with riser diagrams. A dedicated page shall show product specifications, ratings and schematics. (From product manual).
- 9.1.6.5. Gas based Fire suppression System layouts shall include scanned Hydraulic and quantity calculations, Hazard identification, Design criteria, Piping layouts with proposed sizes, gas storage tank capacity & location details, respective Fire detection, alarm & actuation system details with riser diagrams. A dedicated page shall show product specifications, ratings and schematics. (From product manual).
- 9.1.6.6. Each plan shall follow the symbols shown in Civil Defence **Standard Legends** as per **APPENDIX A**. The Civil Defence **Standard Legends** as applicable, shall be shown at the right corner of each page.

10. CIVIL DEFENCE STANDARD LEGENDS (See APPENDIX F)



APPENDIX F

10. CIVIL DEFENCE STANDARD LEGENDS

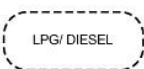
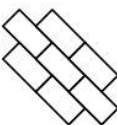
10.1. ARCHITECTURE

CIVIL DEFENCE STANDARD LEGEND FOR ARCHITECTURE

	RCC WALL
	RCC COLUMNS/ PILLARS
	STEEL COLUMNS/ PILLARS
	1 HOUR FIRE RATED WALL
	2 HOUR FIRE RATED WALL
	3 HOUR FIRE RATED WALL
	4 HOUR FIRE RATED WALL
	BLOCK WORK WALL
	GLASS
	STEEL
	GYPSON
	OPENING IN WALL
	OPEN TO SKY
	CONCRETE STANDARD STAIRS
	STEEL STAIRS
	STANDARD DOOR
	FIRE RATED DOOR (X= FIRE RATING, 1 HOUR, 90 MINUTES, 2 HOUR ETC)
	EMERGENCY EXIT DOOR



CIVIL DEFENCE STANDARD LEGEND FOR ARCHITECTURE

	DOUBLE DOOR
	DOUBLE SWING DOOR
	SLIDING DOOR
	WINDOW
	ABOVE GROUND FIRE WATER TANK
	UNDERGROUND FIRE WATER TANK
	ABOVE GROUND LPG/ DIESEL/ STORAGE TANK
	UNDERGROUND LPG/ DIESEL/ STORAGE TANK
	PAVEMENT
	LANDSCAPING AREA
	Smoke barrier wall
	Elevator in noncombustible shaft



10.2. FIRE DETECTION & ALARM SYSTEM

LEGEND:	
SYMBOL	DESCRIPTION
	INTELLIGENT OPTICAL SMOKE DETECTOR WITH STANDARD BASE
	INTELLIGENT HEAT DETECTOR WITH STANDARD BASE
	INTELLIGENT MULTI SENSOR DETECTOR WITH STANDARD BASE
	INTELLIGENT OPTICAL SMOKE DETECTOR WITH SOUNDER
	INTELLIGENT HEAT DETECTOR WITH SOUNDER
	INTELLIGENT MULTI SENSOR DETECTOR WITH SOUNDER
	INTRINSICALLY SAFE SMOKE DETECTOR
	EXPLOSION PROOF SMOKE DETECTOR
	INTRINSICALLY SAFE HEAT DETECTOR
	EXPLOSION PROOF HEAT DETECTOR
	INTRINSICALLY SAFE MULTI SENSOR DETECTOR
	EXPLOSION PROOF MULTI SENSOR DETECTOR
	BEAM DETECTOR-TRANSMITTER
	BEAM DETECTOR-RECEIVER
	LINEAR HEAT DETECTOR
	MANUAL CALL POINT
	MANUAL CALL POINT W/P
	FIRE ALARM SOUNDER OR HORN
	FIRE ALARM SOUNDER OR HORN-W/P
	FIRE ALARM BELL
	FIRE ALARM BELL-W/P
	FIRE ALARM SOUNDER OR HORN WITH FLASER
	FIRE ALARM SOUNDER OR HORN WITH FLASER-W/P
	FIRE ALARM CONTROL PANEL
	FIRE ALARM REPEATER PANEL
	FIRE ALARM MIMIC PANEL
	DUAL INPUT MODULE
	MONITORING MODULE
	DUAL CONTROL RELAY MODULE
	ISOLATOR MODULE
	SOUNDER CONTROL MODULE
	REMOTE INDICATOR
	EXTERNAL POWER SUPPLY UNIT WITH BATTERY



10.3. VOICE EVACUATION SYSTEM

LEGENDS	
SYMBOL	DESCRIPTION
	HORN SPEAKER
	WALL MOUNTED SPEAKER
	WALL MOUNTED SPEAKER WITH STROBE
	CEILING MOUNTED SPEAKER
	CEILING MOUNTED SPEAKER WITH STROBE
	PORTABLE TELEPHONE HAND SET
	FIRE PHONE JACK
	STROBE LIGHT
	STROBE LIGHT-W/P
	VOICE EVACUATION AMPLIFIER
	FIRE TELEPHONE PANEL
	VOICE EVACUATION CONTROL SYSTEM
	END OF LINE RESISTOR



10.4. EMERGENCY LIGHTING & EXIT SIGN SYSTEM

LEGENDS

SYMBOL	DESCRIPTION
	ADDRESSABLE 1x8W EMERGENCY LIGHT, NON MAINTAINED (SURFACE TYPE)
	ADDRESSABLE 1x8W EMERGENCY LIGHT, NON MAINTAINED (RESECCED TYPE)
	ADDRESSABLE 1x8W EMERGENCY LIGHT, NON MAINTAINED W/P
	ADDRESSABLE 1x8W EXIT LIGHT , MAINTAINED
	ADDRESSABLE 1x8W EXIT LIGHT HANGING TYPE SINGLE SIDE,MAINTAINED
	ADDRESSABLE 1x8W EXIT LIGHT DOUBLE SIDE HANGING ARROW,MAINTAINED
	ADDRESSABLE 1x8W EXIT LIGHT MAINTAINED W/P
	CENTRAL BATTERY UNIT
	ADDRESSABLE CENTRAL BATTERY MONITORING PANAL
	DISTRIBUTION BOX
	ADDRESSABLE EMERGENCY/EXIT LIGHT MONITORING CABLE

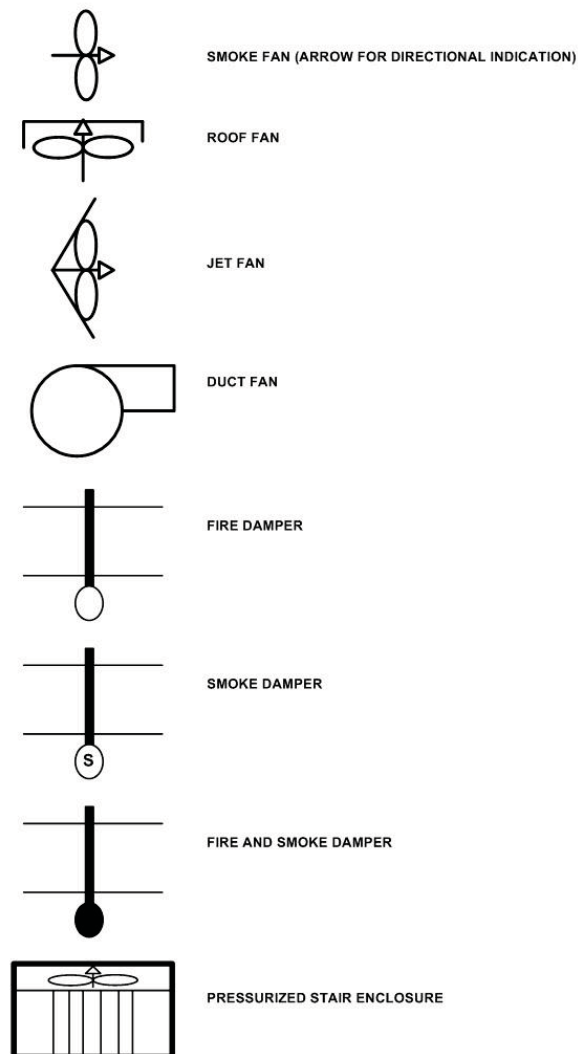
LEGENDS

SYMBOL	DESCRIPTION
	SELF CONTAINED 1x8W EMERGENCY LIGHT, NON MAINTAINED(SURFACE TYPE)
	SELF CONTAINED 1x8W EMERGENCY LIGHT, NON MAINTAINED(RESECCED TYPE)
	SELF CONTAINED 1x8W EMERGENCY LIGHT, NON MAINTAINED W/P
	SELF CONTAINED 1x8W EXIT LIGHT , MAINTAINED
	SELF CONTAINED 1x8W EXIT LIGHT HANGING TYPE SINGLE SIDE,MAINTAINED
	SELF CONTAINED 1x8W EXIT LIGHT DOUBLE SIDE HANGING ARROW,MAINTAINED
	SELF CONTAINED 1x8W EXIT LIGHT MAINTAINED W/P



10.5. SMOKE CONTROL & PRESSURIZATION SYSTEM

CIVIL DEFENCE STANDARD LEGEND FOR SMOKE CONTROL SYSTEM



10.6. WATER BASED FIRE FIGHTING SYSTEM

CIVIL DEFENCE STANDARD LEGEND FOR WATER BASED FIRE SYSTEMS

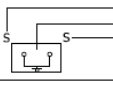
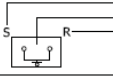
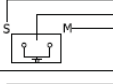
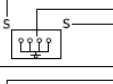
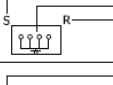
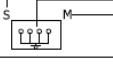
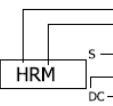
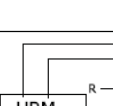
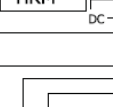
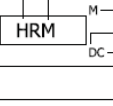
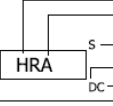
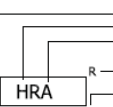
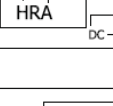
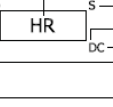
	FIRE PUMP MAIN-ELECTRICAL DRIVEN
	FIRE PUMP-DIESEL DRIVEN
	FIRE PUMP-JOCKEY
	FIRE PUMP CONTROLLER PANEL
	PRESSURE GAUGE
	FIRE WATER MAIN (X= PIPE SIZE)
	GENERAL ISOLATION VALVE
	VALVE IN PIT
	POST INDICATOR VALVE
	OS & Y VALVE
	INDICATING BUTTERFLY VALVE
	CHECK VALVE (ARROW IS DIRECTIONAL)
	Backflow preventer — double check type
	Backflow preventer — reduced pressure zone (RPZ) type
	Pressure regulating valve



	1/2" RECESSED PENDENT SPRINKLER HEAD, K-5.6 (68°C) Q.R.
	3/4" PENDANT SPRINKLER HEAD, K-8.0 (68°C) QUICK RESPONSE
	3/4" RECESSED PENDENT SPRINKLER HEAD (ELO) K-11.2 (68°C) Q. R.
	1/2" CONCEALED SPRINKLER HEAD K-5.6 (68°C) QUICK RESPONSE
	1/2" UPRIGHT SPRINKLER HEAD, K-5.6 (79°C) STD. RESPONSE
	3/4" UPRIGHT SPRINKLER HEAD, K-8 (79°C) STD. RESPONSE
	3/4" UPRIGHT SPRINKLER HEAD K-11.2 (68°C) STD. RESPONSE
	DRY PENDENT SPRINKLER HEAD, K-5.6 (68°C) STD. RESPONSE
	DRY PENDENT SPRINKLER HEAD, K-11.2 (68°C) STD. RESPONSE
	ESFR SPRINKLER HEAD K-25.2, K-16.8, K-14 (74°C)
	1/2" IN-RACK SPRINKLER HEAD K-5.6 (68°C) STD RESPONSE WITH SPRINKLER GUARD & WATER SHIELD
	FOAM SPRINKLER HEAD
	1/2" HORIZONTAL SIDEWALL SPRINKLER HEAD, K-5.6 (79°C).C STD R.
	1/2" HORIZONTAL SIDEWALL SPRINKLER HEAD, K-5.6 (68°C) Q.R.
	1/2" HORIZONTAL SIDEWALL EXTENDED COVERAGE SPRINKLER HEAD, K-5.6 (68°C) Q.R.
	3/4" HORIZONTAL SIDEWALL EXTENDED COVERAGE SPRINKLER HEAD, K-8 (68°C) Q.R.
	ZONAL CONTROL VALVE ASSEMBLY C/W:- BUTTERFLY VALVE, PRESSURE GAUGE, WATER FLOW SWITCH, & TEST&DRAIN VALVE
	AUTO ZONAL CONTROL VALVE ASSEMBLY C/W:- BUTTERFLY VALVE, PRESSURE GAUGE, WATER FLOW CIRCULATOR, & TEST&DRAIN VALVE
	ALARM CHECK VALVE ASSEMBLY
	OS&Y GATE VALVE WITH TAMPER SWITCH
	NON-RETURN VALVE
	SUPERVISORY BUTTERFLY VALVE
	DRAIN VALVE
	AIR RELEASE VALVE
	PRESSURE GAUGE
	DELUGE VALVE
	PRE-ACTION VALVE
	SOLENOID VALVE
	RATIO FLOW CONTROLLER
	BLADDER TANK ASSEMBLY
	ISOLATION VALVE IN VALVE CHAMBER
	FIRE HYDRANT W/ ISOLATION VALVE



CABINET DETAILS

	Ø100x2-WAY BREECHING INLET WITH SURFACE MOUNTED CABINET
	Ø100x2-WAY BREECHING INLET WITH RECESSED TYPE CABINET
	Ø100x2-WAY BREECHING INLET WITH MESONRY TYPE
	Ø150x4-WAY BREECHING INLET WITH SURFACE MOUNTED CABINET
	Ø150x4-WAY BREECHING INLET WITH RECESSED TYPE CABINET
	Ø150x4-WAY BREECHING INLET WITH MESONRY TYPE CABINET
	FIRE HOSE REEL CABINET(SURFACE MOUNTED) CONSISTING: 1 NO. Ø25x30 MTR. LONG MANUAL HOSE REEL W/NOZZLE 1 NO. Ø25 PRESSURE REDUCING VALVE 1 NO. 5 KG CO2 FIRE EXTINGUISHER 1 NO. 6 KG DRY POWDER FIRE EXTINGUISHER
	FIRE HOSE REEL CABINET(RECESSED TYPE) CONSISTING: 1 NO. Ø25x30 MTR. LONG MANUAL HOSE REEL W/NOZZLE 1 NO. Ø25 PRESSURE REDUCING VALVE 1 NO. 5 KG CO2 FIRE EXTINGUISHER 1 NO. 6 KG DRY POWDER FIRE EXTINGUISHER
	FIRE HOSE REEL (MASONARY TYPE CABINET) CONSISTING: 1 NO. Ø25x30 MTR. LONG MANUAL HOSE REEL W/NOZZLE 1 NO. Ø25 PRESSURE REDUCING VALVE 1 NO. 5 KG CO2 FIRE EXTINGUISHER 1 NO. 6 KG DRY POWDER FIRE EXTINGUISHER
	FIRE HOSE REEL CABINET(SURFACE MOUNTED) CONSISTING: 1 NO. Ø25x30 MTR. LONG AUTOMATIC HOSE REEL W/NOZZLE 1 NO. Ø25 PRESSURE REDUCING VALVE 1 NO. Ø25 LOCK SHEILD VALVE 1 NO. 5 KG CO2 FIRE EXTINGUISHER 1 NO. 6 KG DRY POWDER FIRE EXTINGUISHER
	FIRE HOSE REEL CABINET(RECESSED TYPE) CONSISTING: 1 NO. Ø25x30 MTR. LONG AUTOMATIC HOSE REEL W/NOZZLE 1 NO. Ø25 PRESSURE REDUCING VALVE 1 NO. Ø25 LOCK SHEILD VALVE 1 NO. 5 KG CO2 FIRE EXTINGUISHER 1 NO. 6 KG DRY POWDER FIRE EXTINGUISHER
	FIRE HOSE REEL (MASONARY TYPE CABINET) CONSISTING: 1 NO. Ø25x30 MTR. LONG AUTOMATIC HOSE REEL W/NOZZLE 1 NO. Ø25 PRESSURE REDUCING VALVE 1 NO. Ø25 LOCK SHEILD VALVE 1 NO. 5 KG CO2 FIRE EXTINGUISHER 1 NO. 6 KG DRY POWDER FIRE EXTINGUISHER
	FIRE HOSE RACK CABINET(SURFACE MOUNTED) CONSISTING: 1 NO. Ø40 PRESSURE REDUCING ANGLE VALVE 1 NO. Ø40x30 MTR. LONG HOSE & NOZZLE ON RACK 1 NO. 5 KG CO2 FIRE EXTINGUISHER 1 NO. 6 KG DRY POWDER FIRE EXTINGUISHER
	FIRE HOSE RACK CABINET(RECESSED TYPE) CONSISTING: 1 NO. Ø40 PRESSURE REDUCING ANGLE VALVE 1 NO. Ø40x30 MTR. LONG HOSE & NOZZLE ON RACK 1 NO. 5 KG CO2 FIRE EXTINGUISHER 1 NO. 6 KG DRY POWDER FIRE EXTINGUISHER
	FIRE HOSE RACK (MASONARY TYPE CABINET) CONSISTING: 1 NO. Ø40 PRESSURE REDUCING ANGLE VALVE 1 NO. Ø40x30 MTR. LONG HOSE & NOZZLE ON RACK 1 NO. 5 KG CO2 FIRE EXTINGUISHER 1 NO. 6 KG DRY POWDER FIRE EXTINGUISHER



10.7. PORTABLE FIRE EXTINGUISHERS

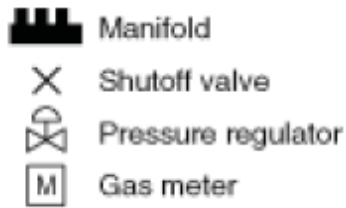
	9 LTR. WATER FIRE EXTINGUISHER
	6 KG DRY POWDER FIRE EXTINGUISHER
	2 KG DCP FIRE EXTINGUISHER
	5 KG CO2 FIRE EXTINGUISHER
	2 KG CO2 FIRE EXTINGUISHER
	6 LTR. FOAM FIRE EXTINGUISHER
	6 LTR. WET CHEMICAL FIRE EXTINGUISHER
	25 KG DRY POWDER FIRE EXTINGUISHER TROLLEY TYPE
	30 KG CO2 FIRE EXTINGUISHER TROLLEY TYPE
	10 GAL. FOAM FIRE EXTINGUISHER TROLLEY TYPE
	10 KG AUTO DRY POWDER FIRE EXTINGUISHER

10.8. GAS BASED FIRE FIGHTING SYSTEM

	Gas System Control Panel (For example, CA for Clean Agent Control Panel)
	Manual station — clean agent
	Abort switch — clean agent
	360° Nozzle
	180° Nozzle



10.9. LPG SYSTEM



PRDP



FREQUENTLY ASKED QUESTIONS (FAQ)

Q1. What is the fire rating for building having more than 2 basements?

- A1.** All structural members up to and including the floor of the lowest level of discharge of underground buildings more than 7000 mm below or more than two level below the lowest level of exit discharge (i.e. All High depth Underground Buildings or Structures) shall be at least 2 hours fire rated construction.

Q2. What is the definition of a high-rise building or structure?

- A2.** The occupancies or Multiple and Mixed occupancies, facilities, buildings and structures having total height of occupiable or usable space of more than 23 Meters above the lowest grade or lowest level of Fire Service Access into that occupancy is categorized as Highrise Building.

Q3. What is the definition of a midrise building or structure?

- A3.** The occupancies or Multiple and Mixed occupancies, facilities, buildings and structures having total height of occupiable or usable space between 15 Meters to 23 Meters from the lowest grade or lowest level of Fire Service Access into that occupancy is categorized as Midrise Building.

Q4. What is the definition of a low-rise building or structure?

- A4.** The occupancies or Multiple and Mixed occupancies, facilities, buildings and structures having total height of occupiable or usable space up to 15 Meters from the lowest grade or lowest level of Fire Service Access into that occupancy is categorized as Low-rise Building.

Q5. What is the definition of a low depth structure or building?

- A5.** A structure or a building with up to two basements or up to 7 m below the level of exit discharge.

Q6. What is the definition of a high depth structure or building?

- A6.** A structure or a building with more than two basements or more than 7 m below the level of exit discharge.



Q7. What is the fire rating and the minimum size of the Emergency Command Centre?

A7. The Emergency command centre shall be separated from other parts of the same building by compartment walls and floors having fire resistance of at least 1 hour with fire suppression system. Minimum size shall be 8.9 m².

Q8. At what level shall the fire pump be installed within the building?

A8. Fire pumps shall be located on the ground floor or below grade level with protected dedicated access from the fire engine access level.

Q9. At what level shall the intermediate fire pumps and water tanks be located for high-rise buildings?

A9. Where multiple pump sets are required in a Highrise building, Intermediate Fire Pumps and Water tanks shall be located at not more than 90 m intervals from the First Fire Pump located at the lowest level of the structure.

Q10. When can the separation between the kitchen and the dining area be exempted?

A10. Separation requirement for kitchen could be exempted when all the cooking facilities in the kitchen are fitted with an approved extinguishing system such as Kitchen hood suppression. Separation requirement for kitchen could also be exempted when an eating establishment is separated from other parts of the same building by walls and floors having fire resistance of at least 1 hour and doors having fire resistance of at least half an hour.

Q11. What is the maximum size of a kitchen allowed in a non-sprinklered building?

A11. For a non-sprinkler protected building, the floor area of the kitchen compartment shall not exceed 150 m².

Q12. What is the fire rating for the separation between theatre, cinema or concert hall from other parts of the building?

A12. A theatre, cinema or concert hall shall be separated from other parts of the same building, which is of a different purpose group, by compartment walls and floors having a fire resistance of at least 2-hour. If the building is protected by an automatic sprinkler system, the fire resistance rating of the compartment walls or floors can be reduced to 1-hour.



Q13. What is the fire rating for hotel bedrooms?

A13. Each hotel bedroom shall be compartmented from adjoining rooms and other parts of the same building by construction having fire resistance rating of at least 1 hour.

Q14. What is the fire rating for labor accommodation bedroom?

A14. Each labor accommodation bedroom shall be compartmented from adjoining rooms and other parts of the same building by construction having fire resistance rating of at least 1-hour.

Q15. What are the kitchen fire rating requirements for a labor accommodation?

A15. Kitchens are only allowed on the ground floor and shall be enclosed with minimum 1-hour fire rated compartment wall, including ½-hour fire rated door. Kitchen shall be separated by 1 hour fire rating and a protected corridor away from the dormitory sleeping area on the ground floor.

Q16. What is the fire rating required for motor vehicle workshop?

A16. A motor vehicle workshop shall be separated from any other part of the same building by compartment walls and floors having fire resistance of not less than 2 hours.

Q17. What is the fire rating and ventilation requirement for a spray painting booth or for any spray painting process?

A17. Areas in which spray painting or other allied processes are performed or carried out, shall be separated from other parts of the same building by compartment walls and floors having fire resistance of not less than 2 hours. Spray painting booths shall have built in vapor extraction system.

Q18. What is the size requirement for cold room and the fire rating of the construction?

A18. Where a cold room has a floor area exceeding 20 m², a separate outer layer of non-combustible construction, including the door, having minimum 1-hour fire resistance rating (with sprinkler), shall be provided to compartmentalize the cold room enclosure from other areas. Provision of the fire resisting outer layer enclosure, including the fire door to the cold room would not be required if the cold room has a floor area not exceeding 20 m² and is



sprinkler protected. The storage materials shall not include highly flammable chemicals. Cold room lesser than 20 m² provided with at least one hour fire rating compartment, need not be provided with sprinklers provided that the storage shall not include flammable materials.

Q19. What shall the maximum allowable area of a mezzanine floor?

A19. The aggregate area of mezzanines within a room, other than those located in special-purpose industrial occupancies, shall not exceed one-third the open area of the room in which the mezzanines are located.

Q20. What is a breeching inlet?

A20. A connection through which the Civil Defence fire department can pump supplemental water into the sprinkler system, standpipe, or other system, furnishing water for fire extinguishment to supplement existing water supplies.

Q21. What is the definition of fire access level?

A21. Level where Civil Defence Fire Appliances (Fire Truck/Engine) are deployed and where fire fighters have direct access into the building.

Q22. What is the definition of fire engine access road?

A22. The road to the building or structure to allow access for Civil Defence fire-fighting and rescue apparatus.

Q23. What is the definition of fire engine access way?

A23. The path adjacent to the building or structure to allow operational setup for Civil Defence fire-fighting and rescue apparatus such as Aerial Appliances.

Q24. What is a landing valve?

A24. A 65 mm diameter water outlet normally located inside or near the staircase landing for trained or Civil Defence fire fighters to use during fire.



Q25. What is the maximum distance allowed between the edge of a fire engine access way and the breeching inlet?

A25. Buildings fitted with standpipes and automatic sprinkler system shall have access ways for pumping appliances within 18 m of the breeching inlet. The breeching inlets shall be visible from the access ways.

Q26. What is the spacing requirement for private fire hydrants along fire engine access way and access road?

A26. Spacing between Private Hydrants along Fire Engine access way and access road are as follows:

- i. Residential and Commercial Occupancies shall be 120 m
- ii. Light Hazard Storage Occupancies shall be 100 m
- iii. Ordinary Hazard Storage Occupancies shall be 100 m
- iv. Light Hazard Industrial Occupancies shall be 100 m
- v. Ordinary Hazard Industrial Occupancies shall be 100 m
- vi. High Hazard Occupancies shall be 60 m

Q27. What is the minimum flow rate for each private fire hydrant?

A27. Minimum flow rate for each Private fire hydrant shall be 500 Gallons per Minute

Q28. What is the minimum pressure required for fire hydrant in relation to landing valves?

A28. Minimum Pressure required for Private fire hydrant is 6.9 bars.

Q29. What is the minimum duration of fire fighting water supply for private fire hydrant?

A29. Private Fire Hydrant Water supply for fire fighting shall be for 2 hours.

Q.30. What is the height limitations for a fire hydrant?

A30. The center of a hose outlet shall be not less than 457 mm and not more than 914mm above final grade.



Q31. How far shall the distance be between the fire engine access way and any access opening of a building?

A31. Access way shall be positioned so that the nearer edge shall be not less than 2 m or more than 10 m from the centre position of the access opening, measured horizontally.

Q32. What is the gradient requirement for a fire engine access way?

A32. Access way shall be laid on a level platform or if on an incline, the gradient shall not exceed 10%.

Q33. What is the maximum allowable dead end distance for a fire engine access way?

A33. Dead-end access way and fire engine access road shall not exceed 45 m in length or if exceeding 45 m, be provided with turning facilities.

Q34. What is the minimum height clearance along fire engine access way and access road?

A34. Overhead clearance of access way and fire engine access road shall be at least 4.5 m for passage of fire fighting appliances. Overhead obstruction to access way could be entrance gate, link or bridges connecting buildings.

Q35. In what type of building shall a fire lift be required?

A35. In any building which is classified as high-rise or High depth building having more than 2 level of basement, there shall be provided at least one fire lift, which shall be contained within a separate protected shaft or a common protected shaft containing other lifts subject to such other lifts being served at each storey by a fire fighting lobby.

Q36. What is the minimum dimension of a fire lift car?

A36. Minimum dimension of a Fire lift car shall be of 1950mm either in length or breadth.

Q37. What is the minimum width of a fire fighting staircase?

A37. Fire-fighting stairs should be a minimum of 1200 mm wide.



Q38. What is the size requirement for a fire fighting lobby?

- A38.** The fire fighting lobby shall have a clear floor area of not less than 5 m². The clear floor area should not exceed 20 m² for spaces serving up to four lifts or 5 m² per lift for spaces serving more than four lifts.

Q39. Where can landing valves be installed in accordance to preference?

- A39.** Landing valves shall be located in accordance to the following preference:
- i. In fire Fighting lobby (if provided), for the first landing valve.
 - ii. In Fire fighting or exit staircase, for the first landing valve.
 - iii. In smoke free enclosure or external corridor.
 - iv. In the common corridor or area within a protected shaft.

Q40. What is the length of coverage for one landing valve?

- A40.** Every part of the floor area shall be within 30 m coverage of a landing valve.

Q41. When shall an emergency command centre be provided?

- A41.** An Emergency Command Centre shall be provided in any building which is 'Highrise' with 23 m or more in height with the exception of One-and-Two-Family Dwelling and such Emergency Command Center shall have the following:

- i. Fire lift
- ii. Emergency voice communication system
- iii. Engineered smoke control system.

Q42. What is the size requirement for an emergency command centre?

- A42.** An Emergency Command Centre shall be of adequate size to house all the terminals and supervisory/control equipment, etc of the building's fire protection/detection systems and a free working space of at least 8.9 m² with no dimension lesser than 2440 mm.

Q43. Where shall the emergency command centre be located?

- A43.** An Emergency Command Centre shall be located adjacent to the fire lift lobby at the designated storey of the building (i.e. the lobby of the building on the first storey or immediately adjacent thereto)



Q44. What is the swing direction for doors for fire exits?

A44. Doors required to be of the side-hinged or pivoted-swinging type shall swing in the direction of egress travel where serving a room or area with an occupant load of 50 or more. A door shall swing in the direction of egress travel under either of the following conditions:

- i. Where the door is used in an exit enclosure
- ii. Where the door serves a high hazard contents area

Q45. What is the type of construction for exit staircase shaft based on the height of the building?

A45. Exit stairs serving High-rise buildings, Midrise buildings, High depth Underground buildings and buildings connecting four or more stories shall be constructed of RCC (Reinforced Concrete) with a minimum of 2 hour fire rating. Exit Stairs serving Lowrise buildings, Lowdepth Underground buildings and buildings connecting Three or less stories shall be protected with 2 hour fire rated construction.

Q46. Can spiral stairs be used for egress?

A46. Spiral Stairs is not allowed as a part of means of egress.

Q47. Can interlocking or scissor stair be treated as 2 staircases?

A47. Interlocking or scissor stairs shall be considered only as a single exit.

Q48. Where shall floor diagrams be provided?

A48. A floor diagram shall be provided in staircase landings on the wall beside the exit door. Floor diagrams shall also be provided beside fire alarm panels, in smoke-free enclosures, in fire fighting lobbies and in individual rooms of hotels and health care occupancies.

Q49. What information shall a floor diagram have?

A49. Floor diagrams shall show the actual floor layout, exit stairways locations, corridors, rooms, landing valves, hosereel, fire extinguishers, lift lobbies and other useful information for fire department as well as occupants.



Q50. What is the mode of ventilation for exit staircases in highrise buildings (23m or more in height)?

A50. Every escape staircase serving buildings of 23 m in height or more must be made a smoke proof enclosure. The means of achieving a smoke proof enclosure should be by pressurization.

Q51. What is the fire rating for a smoke proof enclosure?

A51. A smoke proof enclosure shall be enclosed from the highest point to the lowest point by barriers having 2-hour fire resistance ratings.

Q52. What is the fire rating requirement for an exit passageway?

A52. The exit passageway shall be separated from the remainder of the building by a 2-hour fire resistance rating.

Q53. What is the required mode of ventilation for non-high rise buildings?

A53. Staircase ventilation for non-highrise buildings shall be provided with natural, mechanical ventilation or by providing smoke proof enclosures.

Q54. What is the egress final discharge requirement for sprinkler protected buildings?

A54. For sprinkler protected buildings, not more than 50 percent of the required number of exits, and not more than 50 percent of the required egress capacity, shall discharge through areas on the level of exit discharge.

Q55. What is the minimum separation distance between two exits?

A55. The minimum separation distance between two exits or exit access doors in a sprinklered building shall be not less than one-third the length of the maximum overall diagonal dimension of the building or area to be served. This distance shall be half the diagonal for non-sprinklered buildings.



Q56. What is the minimum clear width of a corridor or passageway?

A56. The clear width of any corridor or passageway serving an occupant load of 50 or more shall be not less than 1200 mm.

Q57. In what situation is single exit permitted in a non-sprinklered apartment building?

A57. Any non-sprinklered dwelling unit shall be permitted to have a single exit, provided that one of the following criteria is met:

- i. The dwelling unit has an exit door opening directly to the street or yard at ground level.
- ii. The dwelling unit has direct access to an outside stair and serves a maximum of two units, both of which are located on the same floor.
- iii. The dwelling unit has direct access to an interior stair that serves only that unit and is separated from all other portions of the building by fire barriers having a minimum 1-hour fire resistance rating, with no opening therein.
- iv. Travel distance from the anywhere in the unit shall not exceed 23m to the final discharge.
- v. Total floor area is less than 500 m²

Q58. In what situation is a single exit permitted in a sprinklered apartment building?

A58. Any building that is protected throughout by an approved, supervised automatic sprinkler system has four or fewer stories, and has not more than four dwelling units per story shall be permitted to have a single exit, provided that all of the following conditions apply:

- i. The stairway is separated from the rest of the building by barriers having not less than a 1-hour fire resistance rating, with self-closing 1-hour fire door assemblies protecting all openings between the stairway enclosure and the building.
- ii. The stairway does not serve more than one-half story below the level of exit discharge.
- iii. All corridors serving as access to exits have a minimum 1-hour fire resistance rating.
- iv. There is not more than 35 ft (10.7 m) of travel distance from the entrance door of any dwelling unit to the exit staircase
- v. One-half-hour fire-rated horizontal and vertical separation between dwelling units is provided.
- vi. Travel distance from anywhere from the unit to the unit exit door shall not exceed 23m.
- vi. Total floor area is less than 500 m²

Q59. What is the definition of a labor accommodation?

A59. Labor accommodations include buildings or spaces in buildings where sleeping accommodation is provided for workers, with or without meals, but without individual



cooking facilities. The phrase "without individual cooking facilities" refers to the absence of cooking equipment in any room or unit.

Q60. What is the height requirement to install a portable fire extinguisher?

A60. The wall mount type portable fire extinguishers shall be installed in such a way that the top of the fire extinguisher is not more than 1.5 meters above the floor and not less than 30 cm from the bottom of extinguisher to the finished floor.

Q61. What is the minimum number of people required to be trained on basic fire awareness and in the use of portable fire extinguishers?

A61. At least 10 % of the Security personnel, Occupants, Employees and Supervisory personnel of each occupancy shall be trained on basic fire awareness, types, use and operation of fire extinguishers in emergency situation.

Q62. At what level shall floor proximity exit signs be installed?

A62. Where floor proximity exit signs are required in such signs shall be located near the floor level in addition to those signs required for doors or corridors. The bottom of the sign shall be not less than 150 mm, but not more than 455 mm, above the floor.

Q63. What is the function of emergency lights?

A63. The objective of having emergency lighting during emergencies or when the normal lighting of the occupied building fails. The emergency light shall fulfill the following functions:

- a. To indicate clearly and unambiguously the escape routes.
- b. To provide illumination along such routes to allow safe movement towards and through the exits provided.
- c. To ensure that fire alarm call points and fire fighting equipment provided along escape routes can be readily located.
- d. To permit operations concerned with safety measures

Q64. Where shall emergency lights be provided?

A64. For all buildings except for One-and-Two-Family Dwelling, emergency lighting shall be provided in all occupancies in the following areas:



- i. along exit corridors, egress path, lobbies and exits staircases
- ii. Over area if there are no explicit paths leading to corridors, lobbies and exits.
- iii. In hotel rooms or suites.
- iv. Educational occupancies used as assembly, i.e. gymnasium, concert halls, auditoriums, theatres.
- v. In office rooms more than 60m².

Notwithstanding the requirements in the clause above, emergency lighting shall be provided in the following locations:

- i. Lift cars
- ii. Emergency command centers
- iii. Generator rooms
- iv. Basement car parks
- v. Fire pump rooms
- vi. Areas of refuge within the same building.

Q65. What is the required brightness level of emergency lights?

A65. Emergency lighting facilities shall be arranged to provide initial illumination that is not less than an average of 1 ft-candle (10.8 lux) and, at any point, not less than 0.1 ft-candle (1.1 lux), measured along the path of egress at floor level.

Q66. In what type of occupancies is central battery required?

A66. Central Battery System is not mandatory. However, stand alone self contained luminaries are not allowed as well. The emergency lighting system shall be either Central Battery system or monitored type self contained emergency lighting system which is diagnostic type and shall be automatically monitored and tested through the Building Monitoring System and the fire alarm control unit.

Q67. What is the definition of emergency voice communication (EVC)?

A67. A system that is interlinked with the fire alarm to give evacuation or emergency messages throughout the premises for all occupants.



Q68. In what type of occupancies requires emergency voice evacuation and communication system?

A68. One way emergency voice evacuation and communication system as well as an emergency command centre shall be provided as follows:

- i. For all large buildings with gross floor area greater than 2800 m² or having a total occupant load exceeding 1000 persons and large industrial and warehouse buildings with gross floor area greater than 5000 m².
- ii. For all buildings which are categorized as high rise or an assembly.
- iii. For hotel or health care occupancies of less than 23m building height.

Q69. In what location are speakers with flashers required?

A69. Speakers with flashers (strobe lights) shall be provided for basement car parks, mechanical or machine rooms, large machining areas of factories (more than 5000m²) and at locations where the ambient noise level is 75db or more.

Q70. What is the fire rating requirement for fire alarm and emergency communication cables?

A70. All circuits necessary for the operation of the notification appliances shall be protected until they enter the evacuation signalling zone that they serve. Any of the following methods shall be considered acceptable as meeting the requirements of this subsection:

- i. A 2-hour fire rated circuit integrity (CI) cable
- ii. A 2-hour fire rated cable system (electrical circuit protective system)
- iii. A 2-hour fire rated enclosure
- iv. Buildings fully protected by an automatic sprinkler system and with the interconnecting wiring or cables used for the operation of notification appliances installed in metal raceways

Q71. Where shall manual call point be located?

A71. Distribution of the manual call points should be such that travel distance should not be more than 45m to reach the nearest manual call point. These figures to be reduced to 25m and 16m in limited mobility areas, and where processes of the area result in a likelihood of rapid fire development.



Q72. What is the height requirement to install a manual call point?

A72. The manual call points shall be installed generally at the height of (1.1 – 1.4) m, above floor level and in plain, accessible, well lit and free-hindrances places. Where disable people are expected to operate, height to be lowered to (91cm-1.2m).

Q73. At what level above the ground for raised floors to have smoke detectors within the concealed space?

A73. For raised floors 400mm and above the floor level and/or containing combustible materials shall be provided with smoke detectors.

Q74. At what height between the suspended ceiling and the ceiling level a smoke detector to be provided?

A74. For suspended ceilings which are above 800mm from the ceiling level and/or containing combustible materials, smoke detectors are to be provided.

Q75. In what condition can alarm notification speakers be used for non-emergency purposes?

A75. Speakers used as alarm notification appliances on fire alarm systems shall also be permitted to be used for non-emergency purposes, provided that condition i or ii is met:

- i. The emergency command centre is constantly attended by trained personnel.
- ii. The speakers and associated audio equipment are installed or located with safeguards to resist tampering or maladjustments of those components essential for intended emergency notification.

Q76. Can alarm notification speakers be used as mass notification speakers?

A76. Speakers used as alarm notification appliances on fire alarm systems shall also be permitted to be used for mass notification systems.

Q77. What is the definition of a class 1 fire fighting system?

A77. Class 1 systems comprises of 65 mm diameter Landing Valve outlets coupled or uncoupled with 65mm diameter, 30 m long re-enforced rubber lined (RRL) hose with multipurpose hose



nozzle for the use of Civil Defence department personnel or other trained fire fighting personnel.

Q78. What is the definition of a class 2 fire fighting system?

A78. Class 2 systems comprises of 25 mm diameter bore for Hose Reel System or 40 mm diameter bore for Hose Rack System, 30 m long dual reinforced rubber hose coupled with 6 or 8 mm bore multipurpose nozzle, for the use of occupants to extinguish small fires or when the fire is at its incipient stages until the arrival of Civil Defence fire fighters.

Q79. What is the definition of a class 3 fire fighting system?

A79. Class 3 system is a combination of both Class 1 & Class 2 systems for the use of occupants and as well as Civil Defence use. In general the class I system equipments are installed in lower level or compartment and class II system equipments in upper level or compartment of a cabinet. Alternatively, because of the multiple use, class III stand pipe system comprising 65 mm diameter landing valve with 65 mm x 40 mm easily removable adapter and coupled with 40 mm diameter, 30 m long fire hose and nozzle may be permitted as a special cases.

Q80. Where shall fire hose stations be located and what is the coverage distance?

A80. The Fire Hose Station should be clearly visible beside the exit way or stairway (maximum allowed 6 meters from exit way or exit staircase). Additional fire hose stations along the exit access corridor, horizontal exit or in the car park floors shall be installed such that all portions of each floor are within 30 m from the fire hose station while measured along the natural path of travel from the hose station.

Q81. At what level of the building shall fire pumps be installed?

A81. Fire Pump shall be located at the lowest level of the building, pumping water upwards. Fire pumps at levels higher than the lowest level of the building with water supply feeding downwards is not allowed.

Q82. What is the arrangement for a dry riser stand pipe system?

A82. Dry riser stand pipe system shall be terminated to a 2-way breeching inlet connection having 100 mm dia flanged outlet with 2 nos of 65 mm dia instantaneous male coupling inlets, located at Fire Access level for Civil Defence.



Q83. What is the pressure limit for a multi wet riser zoning system?

A83. Multiple wet risers' zoning system shall be established in high rise buildings where pressure reducing valve station is utilized with single fire pump set instead of multiple pumping station, to restrict pressure limit with in 12 bar at any Landing valve outlet.

Q84. What is the minimum operating pressure for sprinkler head in ordinary hazard occupancies?

A84. The minimum operating pressure of any sprinkler head for determining the water supply requirements shall be not less than 0.5 bar (7 PSI) in the light hazard occupancy and 1.0 bar (14.5 PSI) in the ordinary hazard occupancies.

Q85. What is the maximum operating pressure in a sprinkler system?

A85. The maximum operating pressure in a sprinkler system shall not be more than 12 bar. Where higher operating pressure is used for the sprinkler system, all the sprinklers, pipes and fittings shall be rated for the higher operating pressure, however the operating pressure shall not be more than 16 bar in any case.

Q86. What shall a fire pump set consist of?

A86. The proposed fire pump set for any water based suppression system including fire hydrants shall consists each of the following:

- i. Main Electric Pump
- ii. Standby Diesel driven Pump
- iii. Electric Jockey Pump
- iv. Pump controllers
- v. Ancillary valves and fittings

Q87. Where shall the fire pump be located in a building?

A87. Fire Pumps shall be located at the ground floor or Fire Access level at the lowest level of the building, pumping water upwards. Fire pumps at levels higher than the lowest level of the building with water supply feeding downwards is not allowed.



Q88. What shall be height limitation of a building for a mechanical floor to house the transfer fire pump and tank?

A88. Any building higher than 90 m in habitable height from the lowest level of the building shall require a transfer pump set and a transfer water tank located on the mechanical floor.

Q89. What is defined as light hazard occupancies?

A89. The areas and occupancies which are used for non-industrial uses and contains low quantity and less combustible materials which are expected to release less heat release rates during fire condition shall be classified as light hazard occupancies.

Q90. What is defined as ordinary hazard occupancies?

A90. The areas and occupancies used for processing and handling of mainly ordinary combustible materials unlikely to develop intensely burning fires in the initial stages shall be classified as ordinary hazard occupancies.

Q91. What is defined as ordinary hazard group 1?

A91. The areas and occupancies which are used for commercial & industrial uses and contains medium quantity and moderate combustible materials and the storages up to 2.4 meters which are expected to release moderate heat release rates during fire condition shall be classified as Ordinary Hazard group-1.

Q92. What is defined as ordinary hazard group 2?

A92. The areas and occupancies which are used for commercial & industrial uses and contain medium quantity and moderate to high combustible materials and the storages up to 3.6 mtrs which are expected to release moderate heat release rates and the storages up to 2.4 mtrs which are high heat release rates during fire condition shall be classified as Ordinary Hazard group-2.

Q93. What is defined as extra high hazard group 1?

A93. The areas and occupancies which are used for industrial uses and contains high quantity and very high combustible materials which will support fast development of fire and are expected to release very high heat release rates during fire condition and having less or no combustible or flammable liquids & gases shall be classified as Extra high hazard group-1.



Q94. What is defined as extra high hazard group 2?

A94. The areas and occupancies which are used for industrial uses and contain moderate to high quantity of flammable & combustible liquids and gases which will support rapid growth of fire and expected to release very high heat release rates during fire condition shall be classified as Extra High hazard group-2.

Q95. What is the temperature and fire rating of smoke exhaust or extract fans?

A95. Smoke Exhaust or extract fans shall be capable of operating effectively at 400°C for 2 hours.

Q96. What is the minimum distance between air intakes and any exhaust discharge openings?

A96. Openings for the intakes of outdoor air to all air handling systems, mechanical ventilation systems, pressurization systems of exit staircases and internal corridors, and smoke control systems shall be no less than 5m from any exhaust discharge openings.

Q97. When can a concealed space between ceiling and roof or raised floors be used as air plenum?

A97. A concealed space between the ceiling and floor above it, ceiling and roof, or raised floor and structural floor of a building may be used as a plenum provided that the concealed space contains only:

- i. Mineral-insulated metal-sheathed cable,
- ii. Aluminum-sheathed cable,
- iii. Copper-sheathed cable,
- iv. Rigid metal conduit,
- v. Enclosed metal trunking,
- vi. Flexible metal conduit,
- vii. Liquid-tight flexible metal conduit in lengths not more than 2 m, or metal-clad cables;
- viii. Communication cables for computers, television, telephone and inter-communication system;
- ix. Fire protection installations;
- x. Pipes of non-combustible material conveying non-flammable liquids

Q98. What is the fire rating of dampers to be installed in ducts penetrating fire walls?

A98. Duct penetrations of fire walls should be avoided. Approved fire dampers shall be provided where air ducts penetrate or terminate at openings in walls or partitions required to have a fire resistance rating of 1 hour or more depending on the fire rating of the wall.



Q99. In which application a fire damper is not required?**A99.** A fire damper shall not be required for the following:

- i. Clothes Dryer Exhaust Ducts
- ii. Hazardous Fume Exhaust Duct
- iii. Stairwell Pressurization Ducts
- iv. Smoke Extraction Ducts
- v. Laundry and Trash Chutes

Q100. What is the type of approved material to be used for the construction of ceiling plenum?**A100.** Materials used in the construction of a ceiling plenum shall be noncombustible or shall be limited combustible having a flame spread index of not more than 25 and a maximum smoke developed index of 50.**Q101. In what situation does staircases serving the basement level need to be pressurized?****A101.** All fire exit staircases that serve the basement floors shall also be pressurized if the same staircase shafts serving the upper floors are pressurized. Fire exit staircases that only serve the basement which have more than 2 levels or more than 7m below the level of discharge (high depth underground buildings and structures) shall be pressurized. Fire exit staircases that only serve the basement which have less than 2 or levels or less than 7m below the level of discharge (low depth underground buildings and structures) shall be provided with mechanical ventilation.**Q102. At what height shall a building have its exit staircases pressurized?****A102.** In any building of which the habitable height exceeds 23 m, any internal exit staircases without adequate provision for natural ventilation shall be pressurized.**Q103. What is the arrangement for multiple injections for staircase pressurization?****A103.** A single-point injection system shall not be used where the stairwell height is more than eight stories. Stairwells more than 3 storeys above grade or 15m in height, whichever lower shall be provided with multiple-injection systems.

Q104. What is the minimum rate of mechanical ventilation for internal corridors?

A104. Mechanically ventilated internal corridor shall have a purging rate of at least 6 air changes per hour.

Q105. What is the minimum rate of mechanical ventilation for basements?

A105. The purge rate for basement shall be at least 9 air changes per hour.

Q106. What is the minimum clear height for the smoke layer when designing smoke management systems?

A106. The design smoke layer base shall be above the heads of people escaping beneath it. The minimum height shall be 1830mm

Q107. In what situation smoke removal system for firefighting operation need to be provided?

A107. Smoke removal system for firefighting operation shall be provided where there are no natural ventilation openings or where there no operable panels or windows.

Q108. What is the percentage of opening required for natural ventilation and the distance from the internal corridor?

A108. Naturally ventilated internal corridor shall be by fixed ventilation openings in an external wall and such ventilation openings being not less than 15 % of the floor area of the internal corridor. Natural ventilation opening shall not be more than 9m from any part of the internal corridor.

