Design Review Manual on Fire Safety

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Foreword

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Part 1
Means of Egress

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- *Regarding the Level 1 (most important) of checklist, technical description are mentioned referring to RAJUK GAZETTE.*
- *In the "Design Review", brief explanation how to use the checklist are mentioned.*
- *To be revised for user friendly, with illustration, photograph, etc.*

1. Importance of "Means of Egress"

(BNBC Part IV, 3.1, 3.2, Gazette Appendix 1)

A means of egress (means of escape) is a safe exit way when the building is in fire and an evacuation system with the provisions of reentry for rescue and fire fighters. Requirement, specification and so on to realize proper means of egress are stipulated in Bangladesh National Building Code (hereinafter referred to as "BNBC") and Dhaka Metropolitan City Building Rules 2008 (hereinafter referred to as "Gazette") as well. All building to be designed and/or constructed have to follow these codes and rules.

2. Definition

2.1 Components of Means of Egress

(BNBC Part IV, 3.2, Gazette Appendix 1)

A means of egress shall consist of three prats such as: a) Exit Access, b) Exit and c) Exit Discharge. Instead, lifts, escalators, moving walkways cannot be regarded as components of the means of escape.

2.2 Exit Access

(Gazette Appendix 1, 04)

Exit Access means the pathway which leads to the entrance of an exit. Sometimes locked door is fatal obstacle for refugee on fire incident in Bangladesh, therefore, doors on escape route shall be opened in normal and should not be lockable doors. For the fire exit access, level changes shall be taken care. Usually slight level change or gap isn't matter for the occupant but when the fire incident arise, this will be the trip hazards because visibility is limited by smoke.

Figure I-1: Simulation of foot contacting for small elevation
[Source: NFPA 101 Handbook, 2021]

2.3 Exit

(Gazette Appendix 1, 04)

Exit is that portion of the means of escape which is protected from the incidence of fire and provides a safe path to the exit discharge.

Figure I-2:****

2.4 Exit Discharge

(Gazette Appendix 1, 04)

Exit discharge is the portion between the termination of exit and the last wall of the area of safe refuge.

Figure I-3:***

2.5 Occupant Load

Occupant Load means the number of people.

It is better to mention additionally, if there are Definition which is Not familiar with the private company designer and/or is difficult to understand.

3. Design Review

3.1 Occupant Load

(Gazette Appendix 1, 04)

3.1.1 **Maximum Occupant Load**

(Gazette Appendix 1, 04.01, 04.02, 04.03)

(1) Essential Point

Maximum occupant load shall be according to the "Table I-1: Numbers of Different Users". (Please note that classification and the number are different from BNBC Part IV, 3.5)

Table I-1: Numbers of Different Users

Building Type		Area used per person Square meter (m2)
A: Residential		18 Gross
B: Educational Institution	Classroom	2 Net
	Pre-school	3.5 Net
C: Institutional		12 Gross
D: Health care	In-patient area	15 Gross
	Out-patient area	10 Gross
E: Public Gathering and	Fixed seat	(*1)

Religious Building	Fixed without seat	0.7 Net
	Standing area only	0.3 Net
	With table and chair	1.5 Net
F: Commercial	Office and others	10 Gross
	Shopping	3 Gross
G: Industry		10 Gross
H: Warehouse		30 Gross
J: Risky use		10 Gross

(*1) In Assembly Buildings and Institution Type Buildings where there are fixed seats, number of occupants will be determined by the total number of seats in those places; For fixed seats without dividing arms, the capacity shall be taken as one person for every 500 mm width of seat.

The occupant load calculated as above need not exceed one person per 0.3m2 of usable floor space.

[Source: Gazette Appendix 1, 04.01, 04.02]

(2) How to use Checklist

(a) Please input “planned occupant load” per building into check sheet.

(b) If candidate from Sheet 1 is "7", which means Building Type is E: Public Gathering and Religious Building, with fixed seat, calculate occupant load according to the above (*1).

(c) Please select candidate from Sheet 1, and input the number into check sheet.

(d) Please input “planned floor area” in total into check sheet.

3.1.2 Occupant Load of a Mezzanine Floor

(Gazette Appendix 1, 04.04)

(1) Essential Point

The occupant load of a mezzanine floor discharging through a floor below shall be added to the receiving floor’s occupant load.

(2) How to use Checklist

(a) Please input “Yes” when added properly, or “N/A” when there are not mezzanine floor.

3.1.3 **Roofs used as public assembly**

(Gazette Appendix 1, 04.05)

(1) Essential Point

If roofs are used as public assembly, then they should be provided with exit facilities according to the occupant load.

(2) How to use Checklist

(a) Please input "Yes" when provided properly, or "N/A" when there are not roofs used as public assembly.

3.2 Capacity of Exit

(Gazette Appendix 1, 05)

(1) Essential Point

The capacity of means of exit must be adequate in relation to the occupant load of the area served thereby and regarding this matter "Table I-1: Numbers of Different Users" would be applicable; The required width and size of each exit component will be computed according to "Table I-2: Width of Exit per user" and Clause "Corridor and Passage".

Table I-2: Width of Exit per user

Building Type	Without Sprinkler system (mm/person)			With Sprinkler system (mm/person)		
	Stair	Ramp & corridor	Door	Stair	Ramp & corridor	Door
A Residential	8	5	4	5	4	4
B Educational						
F1, F2 Commercial						
F4 Commercial						
F5 Daily necessity other services						
G Industry						
H Warehouse						
C1, C2, C3 Institutional	10	5	4	5	5	4
C4 Institutional	8	5	4	8	5	4
D Health care	25	18	10	15	12	10

E Public Gathering and Religious Building	10	7	5	7	5	5
F3 Commercial						
J Risky Usage	8	5	4	8	5	4
Width of Exit will be determined by the user in each floor of the building						

[Source: Gazette Appendix 1, 05]

(2) How to use Checklist

(a) Please input "Required width of stair", "Required width of ramp/corridor" and "Required width of door referring to the "Table I-2: Width of Exit per user". Please note that required width is deferent depend on the condition of Sprinkler system.

(b) Please input minimum value in the building for "Width of planned stair?", "Width of planned ramp/corridor" and "Width of planned door".

3.3 Corridor and Passage

(Gazette Appendix 1, 06)

(1) Essential Point

The length of a dead-end corridor where there is no exit door available shall not exceed 10m.

The width of corridor and passageway in each floor will be controlled by the number of occupants and the minimum measurement will be as follows:

- 1.1 m where serving an occupant load of more than 50.
- 0.9 m where serving an occupant load of 50 or less.
- 2.4 m in Health Care Service Buildings (Occupancy D) where movement of Beds is necessary.
- 1.8 m in Educational Buildings (Occupancy B) where the occupancy load is more than 150.

The minimum clear height of the corridors and passageways shall not be less than 2.4 m.

(2) How to use Checklist

(a) Please input maximum "Length of dead end corridor" in the building. When there

are no dead end, input “0” (zero).

(b) Please input minimum “width of corridor and passageway” in the building considering occupant load and/or occupancy, or input “N/A” when not applicable.

(c) Please input minimum height of the corridors and passageways.

3.4 Assembly Aisles

(Gazette Appendix 1, 07, BNBC 3.8)

(1) Essential Point

In Assembly Buildings, where there are seats, tables, equipments, displays etc., there should be provision of unobstructed aisles leading towards the Exit.

Exit Access can be horizontal or maximum 1:10 ratio sloped ramp. Its minimum width shall be obtained at the rate of 5 mm per person.

If Exit Access is stepped, then minimum tread depth shall be 275mm and the height of the riser will have to be between 100- 200 mm.

In case of plain level or sloped aisle, if there are seats on both sides of the aisle, then the minimum width will have to be 1 m and if seats are on one side of the aisle then, minimum width will have to be 0.9 m.

(2) How to use Checklist

(a) In case that building to be checked is not Assembly Buildings, please input “N/A”, in this article.

(b) Please input “the number of person to use where there are seats, tables, equipment, displays, etc.”

(c) Please input maximum ratio sloped ramp. In case that there are no ramp (horizontal only), please input “N/A”.

(d) Please input minimum “Width of exit access” in the building.

(e) Please input “tread depth”. In case that Exit Access is not stepped, please input “N/A”.

(f) Please input “height of riser” (minimum and maximum). In case that Exit Access

is not stepped, please input “N/A”.

(g) Please input “minimum width of aisle”. In case that there are no aisle with seats on both.one side, please input “N/A”.

3.5 Doorways

(Gazette Appendix 1, 08)

(1) Essential Point

Each occupant of a room or space shall have access to at least one exit or exit access door and the occupant load per exit door and the travel distance up to that door shall not exceed the values of maximum occupant load and maximum travel distance as shown in “Table I-3: Maximum user number and Maximum travel distance for one exit door”.

Table I-3: Maximum user number and Maximum travel distance for one exit door

Type of Buildings	Max. user number	Max. travel distance (m)
A. Residential C. Institution D. Healthcare	12	23
B. Educational	50	23
E. Public gathering and religious		
F. Commercial		
G. Industrial		
F. Storage	30	30
J. Risky usage	5	8

[Source: Gazette Appendix 1, 08]

If the occupant load using the Exit door and the travel distance exceeds the values specified in above Table, then minimum two exit doors have to be provided.

The width of the exit door cannot be less than 1m and the height cannot be less than 2m.

Sliding or Hanging Doors cannot be used as Exit Doors.

All Exit Access Doors will have to be of side-swinging type; In case of hazardous establishment or when occupant load exceeds 50, the doors shall swing outward from the room or towards the direction of travel. Even if the door swing obstructs the width of the corridor, but it will not constrict the width of the corridor below 0.9 m; but, only in case of pressurized rooms, sliding doors can be used.

Exit doorways shall not open directly on a flight of stairs; If the Exit doorway open towards the stair, towards the outside a space equal to the width of the door plus at least

0.9 m wide area have to be kept and the floor of the room and stair landing should be at the same level.

Revolving doors cannot be used as a means of exit in assembly, educational or institutional buildings or in buildings where occupant load is 200 or more; In other cases, revolving doors can be used where there are half the number of exit way; No technology based revolving door can be accepted which cannot be operated manually during emergency.

All exit doors shall be openable from the side the serve without the use of a key.

(2) How to use Checklist

(a) Please input "A-J" referring to sheet 3.

(b) Please input maximum "user number" per exit door and travel distance" to exit door.

(c) In case that occupant using the exit door and travel distance exceeds, please check whether minimum two exit doors exists or not. In case that occupant using the exit door and travel distance does not exceed, please input "N/A".

(d) Please input minimum "width of the exit door".

(e) Please input minimum "height of the exit door".

(f) Please check whether all exit doors are side-swinging type or not.

(g) When occupant load exceeds 50, please check whether Exit Door swing outward towards the direction of travel or not.

(h) When the Exit doorway open towards the stair, please check whether a space towards the outside equal to the width of the door plus 0.9m wide or not.

(i) In case of assembly, educational or institutional buildings or in buildings where occupant load is 200 or more, please check revolving doors is not used for means of exit. In case that the building is not assembly, educational, institutional buildings nor in buildings where occupant load is 200 or more please input "N/A".

3.6 Stairways

(Gazette Appendix 1, 09)

(1) Essential Point

The required width of exit stairways will be computed in accordance with the provisions of "Table I-1: Numbers of Different Users" and "Table I-2: Width of Exit per user", but it shall not be less than the width described in "Table I-4: Width of Fire Exit Stairways".

Table I-4: Width of Fire Exit Stairways

Type of Buildings		Minimum Width of Stairway (m)
A. Residential	A1, A2	1.0
	A3, A5	1.5 1.15
	A4	According to Rule .1 (d)(10)
B. Educational Institution	Occupant Load up to 150	1.5
	Occupant Load more than 150	2.0
E. Assembly and Religious Building	E1, E3, E5	2.0
	E2, E4, E6	1.5
Others		1.5
Note: If there is only one stairway in a building and if that stairway also is used as the Fire Escape then the Width of that stairway will be the higher value of the two, minimum value of stairway width described in Rule 58 (d) (1) and the stairway width obtained from "Table I-4", applicable according to circumstances.		

[Source: Gazette Appendix 1, 09]

The minimum dimensions of landings and platforms in Exit Stairways shall not be less than the specified width of the stairway, but in case of straight run stairway, except that the landing between two stair flights shall not be required compulsory to be wider than 1.2 m in the direction of travel.

Spiral and winding stairways shall be permitted as a means of escape only within a dwelling unit and from a mezzanine floor not more than 25m^2 in area and the minimum width of all such stairways shall be 650mm. Each tread shall have a depth of 200 mm (which will be measured at a distance of 300mm from the narrower end), all treads shall be identical; Riser cannot be more than 225mm; In case of adjacent risers, a permissible tolerance of 5mm in height difference can be accepted and this can be maximum 10mm between the maximum and minimum height of risers.

If the stairways serving as Fire Exit have an unobstructed width of 1 m, then there will be continuous hand-rail in one side of the stairway; If the width is more than that then continuous handrails will be in both sides; if such stairways have an unobstructed width of more than 2.2 m, then handrails have to be provided at the middle also.

All exit stairways shall have to be constructed of materials that are fire-resistant, but solid wooden handrails will be permitted.

An exit stairway can be built around a lift shaft only if the enclosure of the lift shaft is totally solid (free from holes) and made up of material with fire-resistance rating required for the type of construction of the building.

Exterior staircases used as fire escapes shall not be considered as a means of exit, unless they lead directly to the open space at ground level, are separated from the building interior by fire resistive assemblies or walls and are constructed of noncombustible materials.

(2) How to use Checklist

(a) Please check whether the width of exit stairs satisfied with "Table I-4: Width of Fire Exit Stairways" referring to sheet 4.

(b) If there is only one stairway in a building and if that stairway also is used as the Fire Escape, please check whether the Width of that stairway is wider than the higher value of the two, minimum value of stairway width described in "Table I-5: Minimum clear width (without obstacle) of stair and the stairway width obtained from "Table I-4: Width of Fire Exit Stairways".

Table I-5: Minimum clear width (without obstacle) of stair

Building Classification	Min. width of Stair (meter)
A. Residential	
A 1 Single Family Residence	1.00
A 2 Apartment and Flat	1.15
A 3 Mess, Hostel	1.25
A 4 Low income Residence	***
A 5 Residential Hotel	1.25
B. Educational Institution	1.50
C. Institutional	1.50
D. Health Services	2.00
E. Assembly	2.00
F. Commercial Buildings	
F 1 Office	1.50
F 2 Small Shops and Market	1.50
F 3 Big Shops and Market	2.00
F 5Other Daily Essential Services	1.50
G. Others	1.25
*** According to Rule 58 (d) (10)	1.25

[Source: Gazette 58(d)(1)]

(c) Please input specified width of the stairway referring to sheet 4.

(d) Please input dimensions of landing and platforms in exit stairway.

(e) Please check whether continuous handrail for stairways serving as fire exit upon consideration with its width.

3.7 Ramps

(Gazette Appendix 1, 10)

(1) Essential Point

The minimum width of exit ramp shall not be less than the width of the corridor as described in Sub-Section 06.

The slope of the Exit ramp shall not exceed 1:12 and its upper surface will have to be constructed with non-slip construction materials or have to be constructed such so that the ramp is not dangerously slippery.

If the slope of the ramp is more than 1:15, then guards or handrails shall have to be provided on both sides of the ramp.

(2) How to use Checklist

(a) Please input minimum "width of ramps" in the building considering occupant load and/or occupancy, or input "N/A" when not applicable.

(b) Please input minimum "slope ratio of an exit ramp" (steepest) or input "N/A" when not applicable.

(c) Please check upper surface of ramp whether the ramp is dangerously slippery or not.

(Is it possible to judge using design drawings?)

(d) If the slope of the ramp is more than 1:15, please check whether guards or handrails is provided on both sides of the ramp.

3.8 Horizontal Exits

(Gazette Appendix 1, 11)

(1) Essential Point

The horizontal exit shall be separated and protected from the area of fire incidence by self-closing type door.

The width of this type of exit cannot be less than 1 m.

If the horizontal exit way is sloped than the slope will be maximum 1:12 and in this type of horizontal exits no steps can be used.

The capacity of the refuge area shall be computed as the minimum net floor area excluding stairways, shafts etc. and shall be 0.28 m2 per occupant; In case of health centres where patients are confined to beds, the required capacity of refuge area shall have to be 2.8 m2 per bed.

(2) How to use Checklist

(a) Please check whether self-closing door to separate and protect from fire incidence area is installed. *(Is it possible to judge using design drawings?)*

(b) Please input "the width of horizontal exit".

(c) Please input "ratio of slope" when the horizontal exit way is sloped, or input "N/A" when not applicable.

(d) Please input "refuge area".

(e) Please input "occupant per refuge area" as the minimum net floor area excluding stairways, shafts etc. *(is it possible to recognize "refuge area"?).*

(f) In case of health centres where patients are confined to beds, please input "no. of bed".

3.9 Number of Exits

(Gazette Appendix 1, 12)

(1) Essential Point

Only one means of exit shall be enough for the buildings specified in "Table I-6: Buildings Served by One Means of Exit" if they do not have more than one floor below the level of exit discharge.

Table I-6: Buildings Served by One Means of Exit

Classification of Occupancy	Maximum Number of Storeys	Conditions of maximum Occupancy and Travel Distance in each floor
A1	4	Occupant load 12 and Travel Distance 23 m
A1, A3, A4, A5	10	In each floor, maximum 4-unit dwellings and Travel Distance 23 m
B, C, D, E, F, G	2	Occupant load 50 and Travel Distance 23 m
H	1	Occupant load 30 and Travel Distance 30 m
J	1	Occupant load 5 and Travel Distance 8 m

[Source: Gazette Appendix 1, 12]

For all other buildings other than those in "Table I-6: Buildings Served by One Means of Exit", the required number of exits shall depend on the occupancy load as specified below –

- Occupant Load up to 500 - Minimum 2 Exits
- Occupant Load from 501 to 1000 - Minimum 3 Exits
- Occupant Load more than 1000 - Minimum 4 Exits

For all buildings either 10 storied or of more than 33 m height, and buildings having a floor area larger than 500 m^2 on each floor , used as educational institution, Health care service, commercial building, institutional building, assembly building, industrial building, storage, or hazardous building, there should be minimum two Exits and in this case, the staircase shall have to be fire resistant and shall lead directly to an open space or to a designated area of refuge.

(2) How to use Checklist

(a) Please input "classification of occupancy" (B, C, D, etc.). In case of "A Residential", please mention in detail (A1, A2, A3, A4 or A5).

(b) Please input "the number of exit" and "travel distance", and check whether the number of exit satisfied required value and check whether the travel distance satisfied required value.

(c) If "classification of occupancy" is A1, A3, A4 or A5, please input "the number of unit dwelling" as well, or input "N/A" when not applicable.

(d) For all other buildings other than those in "Table I-6: Buildings Served by One Means of Exit", please input "occupant load" and check whether the number of exit satisfied required value.

(e) In case that building is10 storied or of more than 33 m height, and buildings having

a floor area larger than 500 m2 on each floor used as educational institution, health care service, commercial building, institutional building, assembly building, industrial building, storage, or hazardous building, please check whether minimum two exits are planned, and it is planned to be fire resistant and lead directly to an open space or to a designated area of refuge.

3.10 Length of Travel

(Gazette Appendix 1, 13)

(1) Essential Point

In the same building, in case of more than one exit, the Exits will have to be located such that the maximum travel distance from the occupied portion of the floor to any of the exits shall be as follows:

- Building Type A, B, C, D, E, J- 25m
- Building Type F, H - 30m
- Building Type G - 45m

If more than one exit is required in a building, then the exits shall be placed as remote as possible from each other and whichever direction the occupant would travel, he /she would have to find an exit.

(2) How to use Checklist

(a) Please input “building type”.

(b) Please input maximum “travel distance” from the occupied portion of the floor to any of the exits. In case there is only one exit, please input “N/A”.

Part II
Smoke and Heat Vents

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1. Importance of Smoke and Heat Vents

Smoke is the worst cause of casualty by fire incident more than fire itself. Heat produced by smoke inflow also major element to human death. Remarkable feature of the smoke is the propagation through a building. Smoke easily spread upwards due to its buoyancy and this will be the critical during evacuation and shall be solved with the help of smoke control measures which is called smoke and heat vents.

2. Definition

2.1 Smoke and Heat Vents

Smoke and heat vents are the openings to be installed in the roof/ceiling/wall as an active fire protection measure. The purpose of installation is to vent smoke and heat developed by the fire.

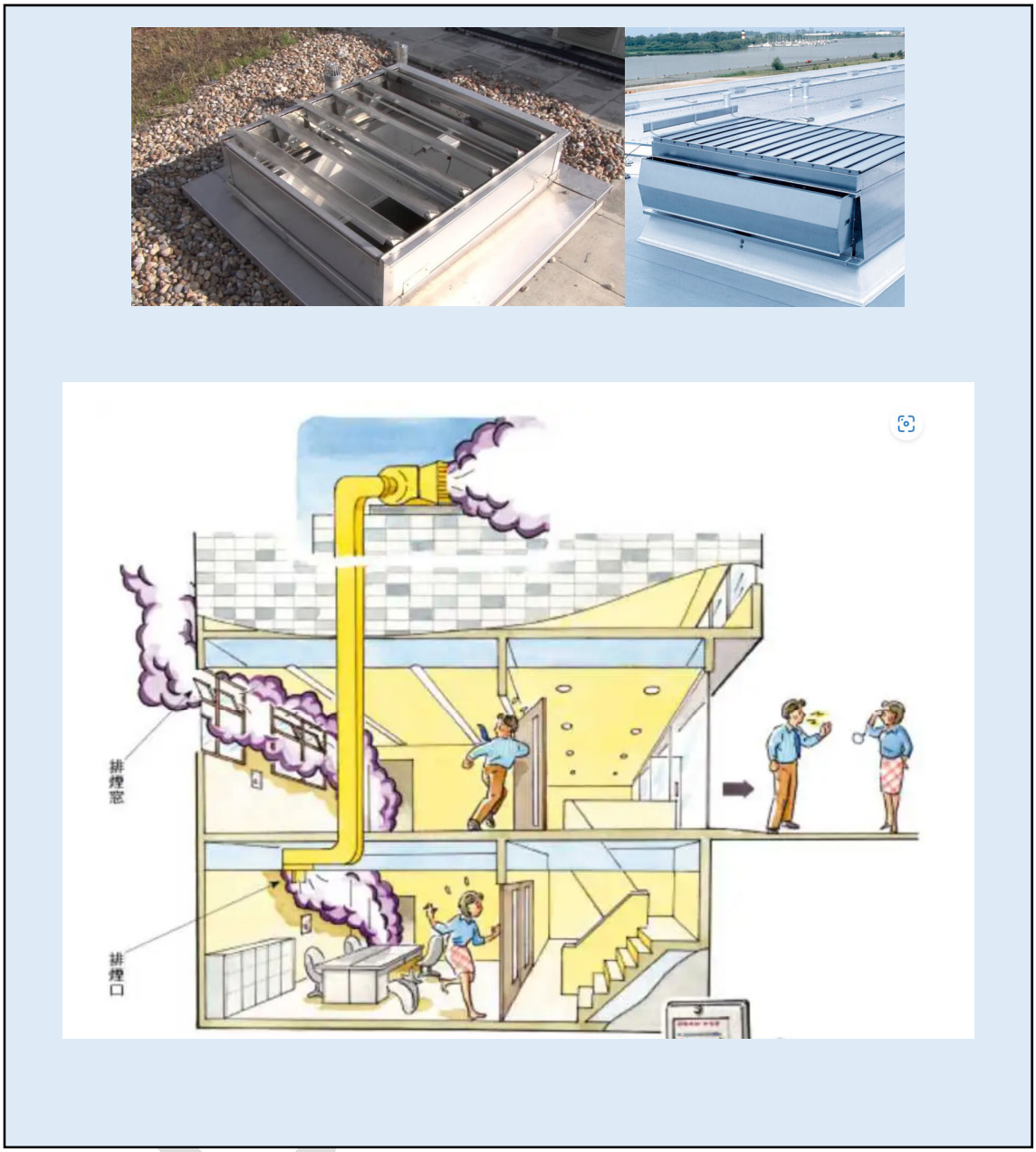

Figure II-1: Smoke and Heat Vents

[Source: Upper: IProtect Group Pty Ltd, Bottom: Himawari Denki Setsubi]

Design Principle: Ventilation design for smoke have principle objective according to; Slow, stop, or reverse the descent of a smoke layer produced by fire in a building, by exhausting smoke to the exterior.

Calculation Principle: Ventilation amount shall be designed according to;
Vent area required to achieve a mass rate of flow through the vents that equals the mass

rate of smoke production.

2.2 Smoke-proof Enclosure

(BNBC Part IV, 3.13)

Any compartment or a room or a control area surrounded by barrier walls within a building structure shall be protected from smoke penetration during a fire incident occurred elsewhere in the building, and shall be termed as smoke proof enclose.

3. Design Review

3.1 Smoke and Heat Vents

(BNBC Part IV, 2.6)

(1) Essential Point

3.1.1 Area of restricted ventilation

(BNBC Part IV, 2.6.a))

Smoke and heat vents shall be installed in areas of restricted ventilation such as:

1) Windowless buildings

2) Underground structures

3) Factories floor spaces of restricted ventilation

Figure II-2: Factory with Ventilation

[Source: (M.Hossain, Benson Lau, Brian Ford, Improving Ventilation Condition of Labour – intensive Garment Factories in Bangladesh, 2014)]

3.1.2 Exit access travel distance

(BNBC Part IV, 2.6.b))

Exit access travel distance is critical for fire incident evacuee. More than 23m, smoke and heat vents shall be constructed.

3.1.3 Vent area and spacing of the vents

(BNBC Part IV, 2.6.c))

The vent area and spacing of the vents shall comply with Table 4.2.1, in case of occupancy H, J, and K (Storage, Hazardous and Garages).

Table II-1: smoke and Heat Vent Size and Spacing

Table 4.2.1: Smoke and Heat Vent Size and Spacing

Use group	Hazard Condition	Vent Area to Floor Area Ratio	Max Spacing of Vent Centres
Occupancy H1	Low Hazard	1:150	45 m
Occupancy H2	Moderate Hazard	1:100	36 m
Occupancy J1	High Hazard	1:30 to 1:50	22.5 m to 30 m
Occupancy J2, J3, J4	High Hazard	1:30 to 1:50	22.5 m to 30 m
Occupancy K1, K3	Low Hazard	1:150	45 m

[Source: Table 4.2.1, Part IV, BNBC]

3.1.4 Closure

(BNBC Part IV, 2.6.d))

Closures of natural draft, smoke and heat vents shall be installed in such a way that fire service personnel can open it easily during a fire.

(2) How to use Checklist

(a) Please check smoke and heat ventilation is designed for an area of restricted ventilation. If there are no area of restricted ventilation, please input “N/A”.

(b) Please check smoke and heat ventilation is designed in case that exit travel distance is more than 23m. If all of exit travel distance is less than 23m, please input "N/A".

(c) Please select occupancy. And then, please input Vent area and Floor area. Additionally, please input spacing of vent centers. Smoke and heat vent size and spacing will be automatically checked whether these are comply with table 4.2.1 or not.

(d) Please check closures of natural draft, smoke and heat vents can be opened easily during a fire.

3.2 Smoke Proof Enclosure

(BNBC Part IV, 3.13).

(1) Essential Point

3.2.1 Basic Policy

(BNBC Part IV, 3.13)

Smoke Proof Enclosure is dedicate to reduce risk for smoke inflow and accumulation and save occupant (resident, worker, etc.) of buildings. Any compartment or a room or a control area surrounded by barrier walls shall be protected from smoke penetration during a fire.

In general, it is important for Smoke Proof Enclosure to consider for 2 direction.

1) Vertical spread

Vertical fire spread is observed when area formulate vertical direction. Staircase, EV shafts, HVAC (heating, ventilation, air conditioning) shafts is typical case. Vertical spread of smoke is observed 3~5m/sec, this speed is faster than human evacuation activities. So smoke proof enclosure for vertical stair or shaft is quite essential..

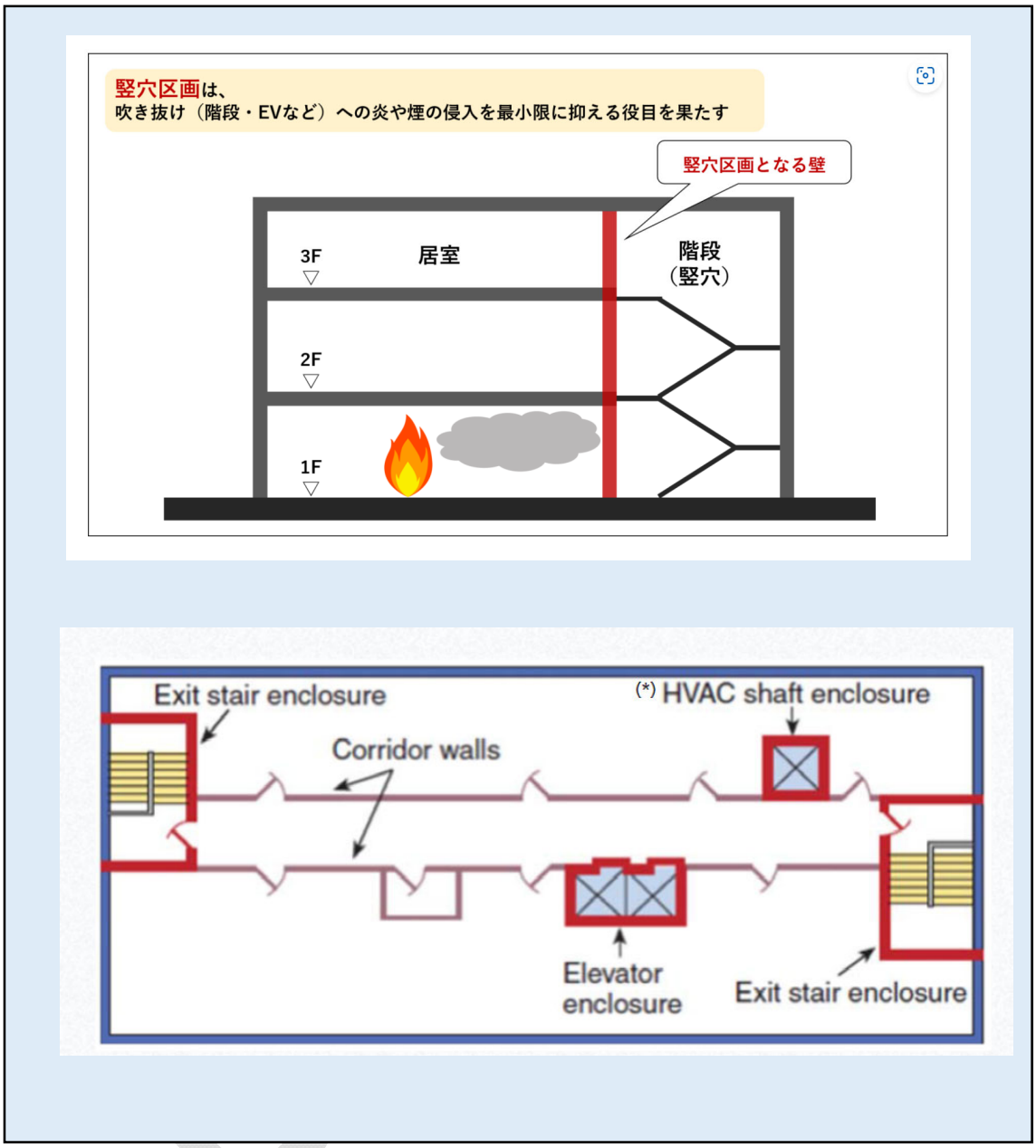

Figure II-3: Vertical spread and Protection of vertical shafts

[Source: Upper: Kakunin Shinsei Navi, Bottom: NFPA, Handbook 2012]

2) Horizontal spread

Horizontal fire spread is harsh when combustible material exists. Transformer room, Sub-station room, Generator Rooms, Car Parking rooms is typical case. Final Escape Route is also require to prevent horizontal penetration of fire because if Final Escape is surrounded by smoke, resident couldn't evacuate from building. At the same time, room designed for fire fighting like Fire Control Panel Room or Fire Pump rooms shall be

Smoke Proof Enclosure. Vertical spread of smoke is observed 0.5~1m/sec, this speed is as same as human evacuation activities. But evacuation is affected by obstacle or corner, so clearance of route for evacuation and regular fire drill is required for fire safety.

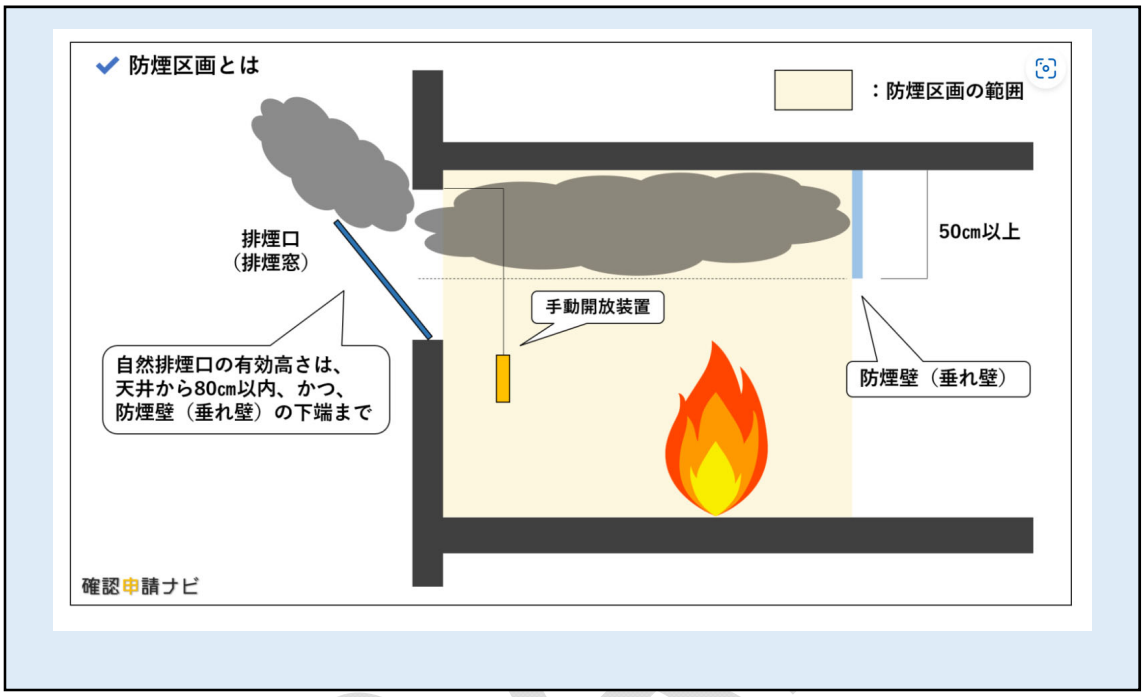

Figure II-4: Horizontal spread

[Source: Kakunin Shinsei Navi]

3.2.2 Exit Stairway

(BNBC Part IV, 3.13.2)

Where serving occupants are located in a high rise building, all exit stairways shall be protected by a smoke proof enclosure.

3.2.3 Vestibule

(BNBC Part IV, 3.13.3)

The minimum width of vestibule shall be equal to width of connected corridors or passage. And the minimum length of vestibule in the direction of travel shall be 1.8m

3.2.4 Fire Resisting Rating

(BNBC Part IV, 3.13.4)

The minimum fire resistance rating of the walls forming a smoke proof enclosure around stairway including the vestibule hereof shall be 4 hours. And it shall be separated from the area of incidence having no openings other than the fire door.

3.2.5 Doors in Smoke Proof Enclosure

(BNBC Part IV, 3.13.5)

All doors in smoke proof enclosure and the vestibule shall be self-closing type or they shall be fitted with automatic closing device actuated by the fire detection system.

3.2.6 Ventilation for Vestibule

(BNBC Part IV, 3.13.6, 3.13.7)

Each vestibule shall have a natural ventilation with a minimum area of openings of 2 sqm divided into two in an exterior wall. If the enclosed staircase is windowless, mechanical ventilation shall be installed.

(2) How to use Checklist

(a) In case of high rise building, please check exit stairways are protected by a smoke proof enclosure. If the target building is not high rise, please input "N/A".

(b) Please input width of corridors and passage connected to vestibule, and width and length of vestibule to access enclosed stairway.

(c) Please input fire resistance rating of the walls forming a smoke proof enclose around stairway including vestibule.

(d) Please check all doors in smoke proof enclosure is designed to be self-closing type or fitted with automatic closing devices.

(e) Please check each vestibule have minimum area of openings of 2 sqm divided into two in an exterior wall for natural ventilating.

(f) Please check mechanical ventilation is designed if staircase and/or vestibule are windowless. If there is no windowless staircase and/or vestibule, please input "N/A".

Part III
Fire Fighting

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1. Importance of "Fire Fighting"

(BNBC Part IV, 4.2, 4.3, 4.4)

The primary objective of fire fighting is to save human life and property. According to statistics from the National Fire Protection Association (NFPA, An international non-profit organization based in the United States that deals with fire prevention.), fires result in thousands of fatalities and injuries each year on all over the world. Effective fire fighting measures include 1. Early detection, 2. Fire Extinguish 3. Occupant Evacuation, and each procedures are vital for minimizing casualties and reducing property damage.

Compliance with International Standards: International codes and standards, such as those developed by the NFPA, UL (Underwriters Laboratories Limited Liability Company, U.S.A.), FM (Factory Mutual System) and BSI (British Standard Institution), provide comprehensive guidelines for fire safety design, construction, and maintenance. Compliance with these standards ensures that buildings and facilities meet minimum safety requirements and adhere to best practices recognized globally.

"Fire fighting" is the active method to extinguish fire. Water is the most common agent to extinguish fire. Checking water discharge (litre/ min) and duration of discharge (min) is the most important checking point on design phase. If both two conditions are determined, other equipment will be selected to satisfy the specification.

Main fire fighting equipment in the building is systems below,

1) Sprinkler System (NFPA 13)
2) Standpipe and Hose Systems [Fire hydrant](NFPA 14)
3) Foam extinguish system
4) Gaseous extinguish system (NFPA 2001: Standard on Clean Agent Fire Extinguishing System)

Not only water but also many agent such as foam, inert gas, dry chemical, wet chemical dry sand and ash are used to control fire. Especially the gaseous system shall be used where water or foam cannot be used.

Table III-1: Fire Protection Flow Requirements

Name of system	Applicable occupancy	Remark
Sprinkler System	All occupancy include Resident, Office, Industrial	Couldn't install for the electrical room and equipment toward water.
Fire hydrant	All occupancy include Resident, Office, Industrial	User of hydrant require the training due to the pressure
Foam extinguish	Parking, Oil plant	Foam discharge pollute area and environment.
Gaseous extinguish	Server room, machine room, electrical room.	Some agent have toxicity for human.

[JET]

2. Definition

2.1 Water source

Water fire fighting system isn't only the operation unit like fire hydrant, fire fighting sprinkler head, but also system includes a suitable water supply from water source. Water reservoir tanks is commonly used for the water source and there is 2 types. Transportation of water to each floor used kinetic energy from the roof top tank called as "Roof gravity tank" due to their function and position. Other type is storage tank method which is consisted storage tank under basement and pumping units. These units supply the water by the water pump pressure as shown in the figure Figure III-1. Also pump installation process is specified by the NFPA 20. Important point is the tank used for fire fighting purpose couldn't use in other purpose.

As other method, direct connection to water main is supplied from water supply line, sometimes with additional pump pressure. In Bangladesh, this method isn't common due to the fluctuation of water supply. .

Water Sources for Fire Protection are as follows:

1. Roof gravity tank
2. Direct connection to water main
3. Storage tank

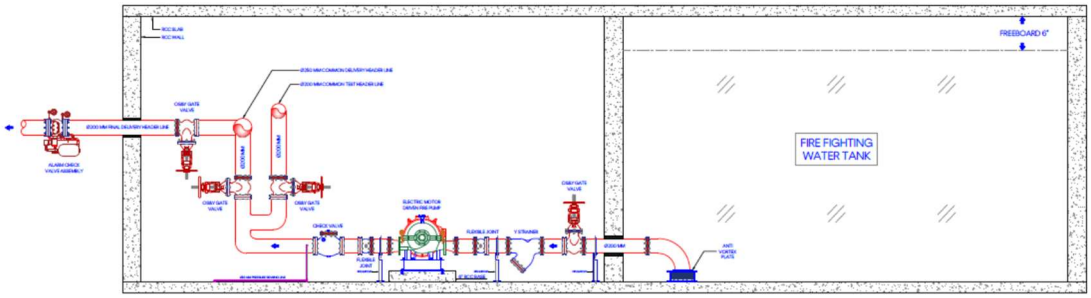

Figure III-1: Sectional View of Storage Tank using Electric Fire Pump

[Source: Inferno Engineering]

2.2 Fire Protection Flow Requirements

In the view of fire protection, height of building is clarified as below.

H1: 0~51m

H2: 51~102m

H3: 102m~

Duration of the water supply shall be longer in proportion building going to be higher. At the same time building have more fire safety risk, duration of the water supply shall be longer either.

Table III-2: Fire Protection Flow Requirements

Building Type**	Sprinkler System (litre/min.)	Standpipe and Hose System (litre/min.)	Duration in Minutes for Building Heights		
			Up to 51 m	51 m to 102 m	Above 102 m
Light hazard- I	1000	1000	30	38	45
Light hazard- II	1900	1900	50	62	75
Ordinary hazard- I	2650	1900	75	95	112
Ordinary hazard-II	3200	1900	75	95	112
Ordinary hazard-III	4800	1900	75	95	112

[Source: Table 4.4.1, Part IV, BNBC]

Water supplies for standpipes and sprinklers will be determined by the Building type hazard.

Table III-3: Water Supplies and Standpipes and Sprinklers

Building Type	Occupancy Group	Sprinkler System (l/min)	Standpipe System (l/min)	Duration (min) Up to 51m	51m to 102 m	Above 102m
Light Ⅰ	A1, A2, A3, E1	1000	1000	30	38	45
Light Ⅱ	A4, A5, B, C, D, E2, E3, I2, I4, F1	1900	1900	50	62	75
Ordinary Ⅰ	I1, I3, I5, F2, F3, G1	2650	1900	75	95	112
Ordinary Ⅱ	G2, H1	3200	1900	75	95	112
Ordinary Ⅲ	H2, J	4800	1900	75	95	112

[JET]

Light hazard-I: Occupancy groups
A1 (Single Family dwelling)
A2 (Two families dwelling)
A3 (Flats or apartment)
E1 (Offices)

Light hazard-II: Occupancy groups
A4 (Mess, boarding houses, dormitories and hostels)
A5 (Hotels and lodging houses)
B (Educational facilities)
C (Institution for care)
D (Healthcare facilities)
E2 (research and testing laboratories)
E3 (Essential services)
I2 (Small assembly with fixed seats)
I4 (Small assembly without fixed seats)
F1 (Small shops and market)

Ordinary hazard-I: Occupancy groups
I1 (Large assembly with fixed seats)
I3 (Large assembly without fixed seats)

	I5 (Sports facilities)
	F2 (Large shops and market)
	F3 (Refueling station)
	G1 (Low hazard industries)
Ordinary hazard- II:	Occupancy groups
	G2 (Moderate hazard industries)
	H1 (Low fire risk storage)
Ordinary hazard- III:	Occupancy groups
	H2 (Moderate fire risk storage)
Extra hazard:	Occupancy group J (Hazardous building)
	Pressure and flow requirement for this group shall be determined by Fire Department but shall not be less than required value for Ordinary hazard- III

(Occupancy Type: Table 3.1.1, Part II, BNBC)

2.3 Automatic Sprinkler System

An automatic sprinkler system for fire protection purposes, is an integrated system of pumping, riser pipe and sprinnkler unit designed in accordance with fire protection standards. As a reference NFPA standard, for normal residential building RMG (Ready Made Garment) buildings, automatic sprinkler protection shall be installed throughout all portions of high-rise buildings with an occupied floor higher than 23m ($75ft^2$). As other factor building size for each floor is the condition to install sprinkler system. Normal residential building require to install which building floor wider than $1524m^2$($5,000ft^2$). Besides, in case sprinkler system will be installed for the building, other safety measure will be eased. Table 4.3.2, BNBC is the good example.

Table III-4: Required Width per Occupant

Table 4.3.2: Required Width per Occupant

Smaller or Equivalent

Occupancy		Buildings without Sprinkler System (mm per person)			Buildings thoroughly Sprinkled (mm per person)		
		Stairways	Ramps & Corridors	Doors	Stairways	Ramps & Corridors	Doors
A B E F1, F2 G H	Residential Educational Business Mercantile Industrial Storage	8	5	4	5	4	4
C1, C2	Institutional	8	5	4	5	5	4
C3, C4, C5	Institutional	10	5	4	8	5	4
D	Health Care	25	18	10	15	12	10
I F3	Assembly Mercantile	10	7	5	7	5	5
J	Hazardous	8	5	4	8	5	**4**
K, L, M		8	5	4	5	4	4

Note: width of the components of egress shall be divided by value specified in this table to determine the maximum allowable occupant load served by them.

(Source: Table 4.3.2, Part IV, BNBC)

Fire fighting sprinkler is consisted by 2 parts.

1. Sprinkler head

Sprinkler head have many variety to adapt occupancy and location. But basic principle and working flow is similar. 2 type of triggers are common in Bangladesh.

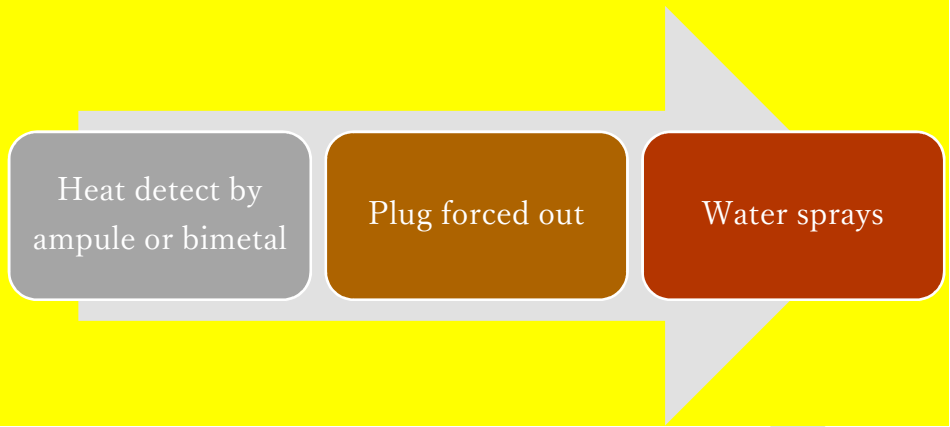

Figure III-2: Basic flow of fire fighting sprinkler

[JET]

1) Ampule type

Type of Sprinkler head below all of sprinkler head is ampule type except than Concealed type. This type is the most common type of trigger in Bangladesh. Glass ampule filled with a glycerin-based liquid that will expand with heat.

Figure III-3: Type of Sprinkler head

[Source: RSC Fire Safety Manual for RMG Buildings_Version 1.0_November 2021]

2) Metal plate

This type two metal plate called bimetal held together by a soldered plate. When the solder melts spring arms pull the plates apart, releasing the plug.

2. Water tube and alarm valve

Most type of sprinkler water tube is filled by pressurized water. Alarm valve is the valve with will alarm when water pressure is lower than settled value or water velocity is detected. As you know when sprinkler is worked water pressure will be less and water will move. This occasion is reliable fire incident signal so this signal will transmit to the control panel as emergency situation.

2.4 Standpipe and Hose system [Hydrant system]

(BNBC Part IV, 4.2)

Fixed type fire hydrant system comprises of stand pipes and hose or reel pipes, sprinklers, drenchers or similar devices in appropriate combinations of these. Fire hydrant is common equipment which is frequently observed on high-rise building.

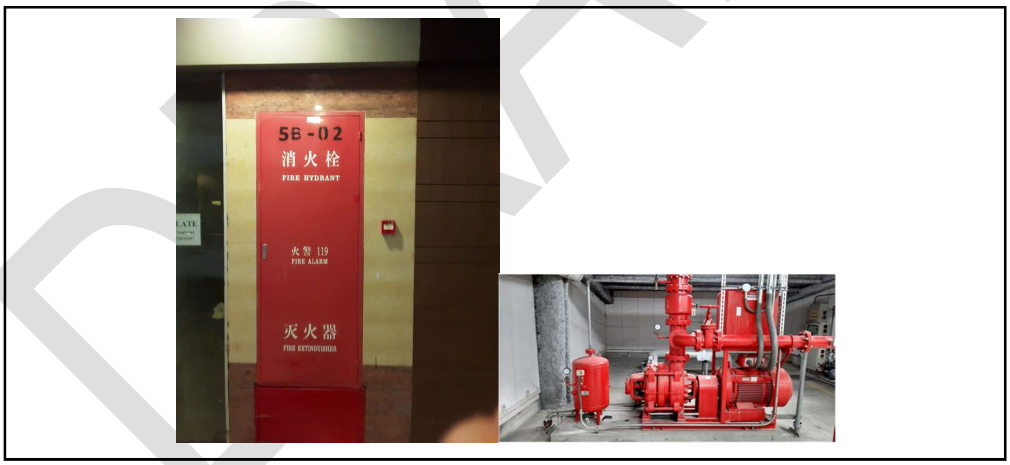

Figure III-4: Example of Fire Hydrant Unit

[JET]

Hydrant are essential components of water supply system and serve as crucial access points for firefighters and floor warden to obtain water during fire emergencies. There are 3 classes of the Fire hydrants stipulated on NFPA14 2019 (5.3 Class of Standpipe System.).

Class I: System provides 65 mm hose connection to supply water for use by fire departments.

Class II: System provides 40mm hose stations to supply water for use primarily by trained personnel or by the fire department.

Class III: System provides 40mm hose stations to supply water for use by trained personnel and 65mm hose stations to supply a larger volume of water for use by fire departments

[Source: NFPA 14 (2019) 3.3.22 System Classes]

Table III-5: Feature and user of the Fire hydrant for each class

Class	Diameter of hose	For Trained personnel	For Fire fighter
I	65mm		✓
II	40mm	✓	✓
III	65mm		✓
	40mm	✓	

[JET]

Fig: Class I system (Left-Landing Valve, Right-Angle Valve)

Fig: Class II system (Left-Hose Rack, Right-Hose Reel)

Fig: Class III system (Combination of Class I & Class II System)

Figure III-5: Components of fire hydrant for each classes

[Source: Md. Habbibullah Nayam Civil Membership of IEB]

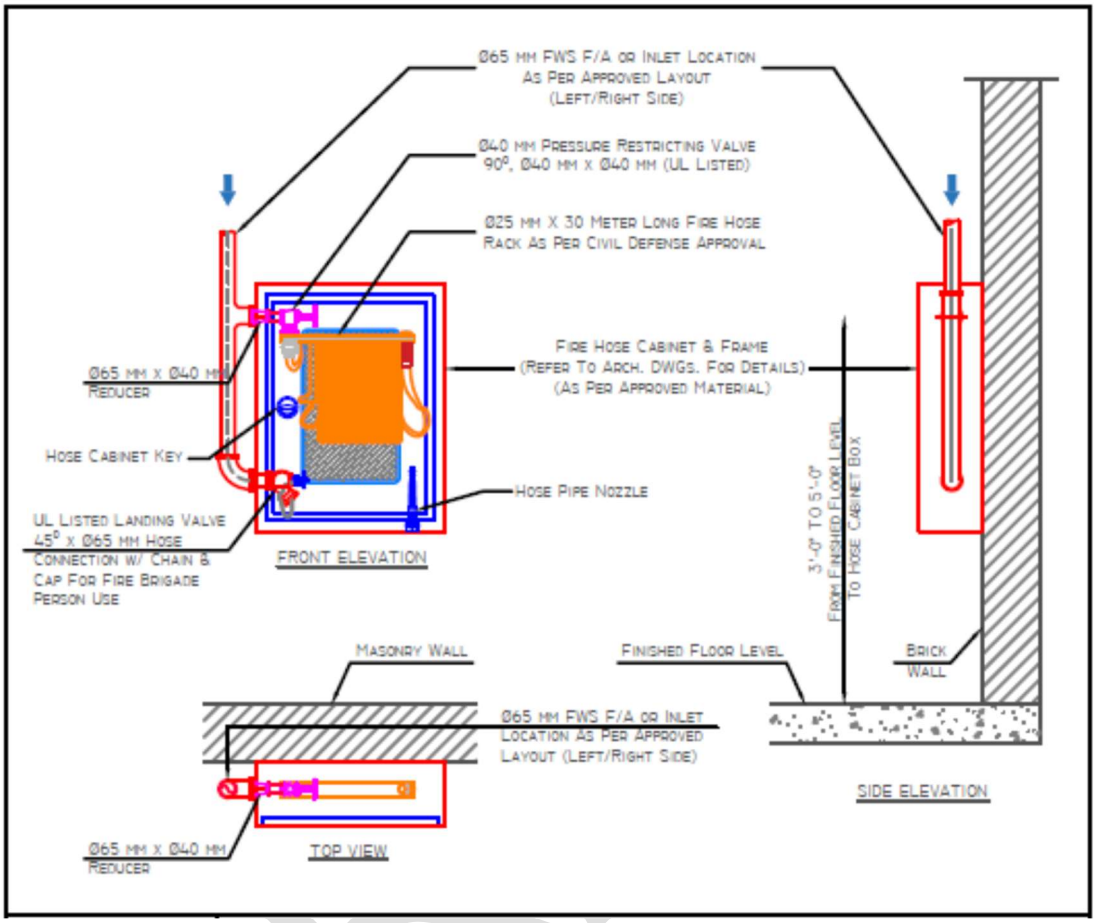

Figure III-6: Class-III Hose Connection Details

[Source: Inferno Engineering]

Standpipe systems are another means of providing water for fire fighting within buildings. These systems consist of pipes, valves, and outlets located at various levels of the building, allowing firefighters to connect hoses and deliver water directly to the fire area. BNBC require buildings above a certain height or occupancy threshold to be equipped with standpipe systems to enhance fire suppression capabilities.

2.5 Fire Class and Fixed Installation Other Than Water

(4.1.4, 4.3, Part IV, BNBC)

Fire class is classified by 5 category as below.

- Class A: Fire involving common combustible such as wood, paper, plastics, clothes etc. It comes from ordinary combustible material (Paper, wood, rubber, and many

plastics).

- Class B: Fire involving flammable liquids and gases, such as gasoline, propane, and solvents. It may come from petroleum greases, oils, oil-based paints and alcohols
- Class C: Fire involving live electrical equipment such as computer, fax machine, etc. It comes from energized electrical equipment (appliances, wiring or outlet).
- Class D: Fire involving combustible metals such as magnesium, lithium, aluminum, etc. Combustible metals include titanium, zirconium, sodium and potassium.
- Class K: Fire involving cooking media such as cooking oils and fats.

Figure III-7: Sign of the fire class

[Source: Fire safety inspection: ITC]

Fire extinguish agent have some variety and there is 4 types of the agent according below.

Table III-6: Brief classification of extinguisher type

Extinguisher Type	Fire class	Example
Water	A	Combustible solid, paper, wood.
Water mist	A, B, C	A class and Flammable Liquid, Oils, Electrical fire
Powder	A, B, C	A class and Flammable Liquid, Oils, Electrical fire
Carbon Dioxide	B, C	Not effective for combustible solid (Class A)
Foam	A, B	Effective for Flammable Liquids and oils.

Other than water there is 3 type of agent is used for each fire class. Water is basically effective only for the Class A, but mist water extinguisher have some effective extinguish capability for Class B and C. Over this specification correct implementation for other agent is essential for the variety of fire incident. But fire Type D (Combustible Metal) have chemical reaction by water so water or wet agent pouring is strictly prohibited. Only specialized fire extinguisher for Type D and dry sand is used as extinguisher.

2.6 Foam extinguishing system

Foam extinguishing systems is foam shape agent that can extinguish flammable or combustible liquid by cooling and separating the ignition source from the surface.

Figure III-8: Example of Foam extingishing system

[JET]

2.7 Gaseous extinguishing system

Gaseous extinguishing system is used for the electrical room, server room, and other machinery room with have delicate and fragile system.

Extinguish agent have some variety as below

Table III-7. Agents Addressed in NFPA 2001

Agent Designation	Chemical Name	Chemistry
FK-5-1-12	Dodecafluoro-2-methylpentan-3-one	$CF_3CF_2C(O)CF(CF_3)_2$
HCFC Blend A	Dichlorotrifluoroethane HCFC-123 (4.75%)	$CHCl_2CF_3$
	Chlorodifluoromethane HCFC-22 (82%)	$CHClF_2$
	Chlorotetrafluoroethane HCFC-124 (9.5%)	$CHClFCF_3$
	Isopropenyl-1-methylcyclohexene (3.75%)	
HCFC-124	Chlorotetrafluoroethane	$CHClFCF_3$
HFC-125	Pentafluoroethane	CHF_2CF_3
HFC-227ea	Heptafluoropropane	CF_3CHFCF_3
HFC-23	Trifluoromethane	CHF_3
HFC-236fa	Hexafluoropropane	$CF_3CH_2CF_3$
FIC-13I1	Trifluoroiodide	CF_3I
IG-01	Argon	Ar
IG-100	Nitrogen	N_2
IG-541	Nitrogen (52%)	N_2
	Argon (40%)	Ar
	Carbon dioxide (8%)	CO_2
IG-55	Nitrogen (50%)	N_2
	Argon (50%)	Ar
HFC Blend B	Tetrafluoroethane (86%)	CH_2FCF_3
	Pentafluoroethane (9%)	CHF_2CF_3
	Carbon dioxide (5%)	CO_2

[Source: NFPA 2001 (2018)]

In Bangladesh HFC-227ea which is called as FM-200 is the mostly installed to the building.

Figure-III-9 Example of Gaseous storage [Source: Yamato Protec]

Table-III-8 Special agent other than Clean agent.

System	Standard	Agent	Remark
Carbon dioxide system	NFPA 12	CO2	Harmful for human.
Halon 1301 system	NFPA 12A	Halon1301	Harmful for environment.

[Source: JET]

2.8 Portable Fire Extinguisher

（4.4, Part IV, BNBC）

Portable Fire Extinguisher is defined as: 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. (10-9 NFPA 10 [2018])

Portable Fire Extinguisher is assembled and completed entity by manufacturer, so this is tightly tied with industrial standard.

According to NFPA 10, relationship of requirement by the industrial standard is as follows.

(1) Carbon dioxide types: ANSI/UL 154, CAN/ULC-S503, Standard for Carbon-Dioxide Fire Extinguishers

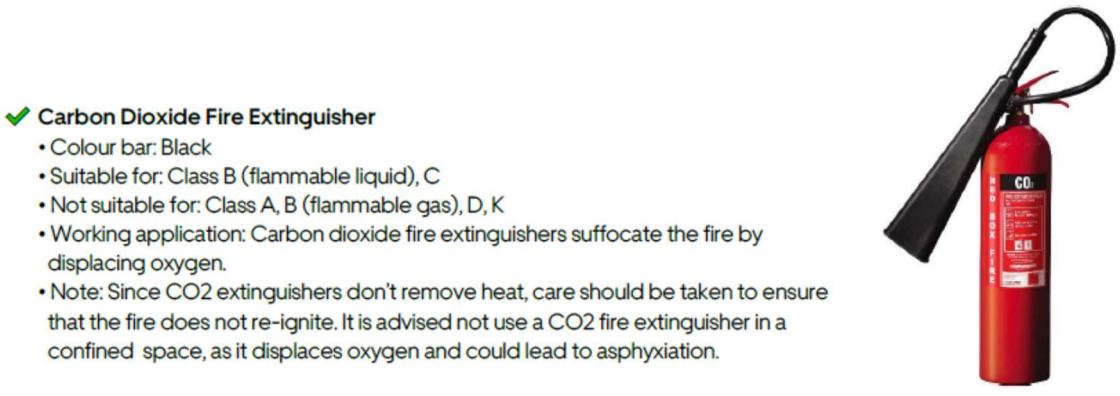

Figure III-10: Carbon-Dioxide Fire Extinguishers

[Source: Md. Habbibullah Nayam Civil MIEB]

Carbon dioxide type is the most common extinguisher in Bangladesh.

(2) Dry chemical types: ANSI/UL 299, CAN/ULC-S504, Standard for Dry Chemical Fire

Extinguishers

✔ **Dry Powder Fire Extinguisher**
- Colour bar: Blue
- Suitable for: Class A, B, C, D
- Not suitable for: Class K
- Working application: Dry powder fire extinguishers do not remove heat from the fire, they interrupt the combustion process. They may also encrust the fuel and starve it of oxygen.

Figure III-11: Dry Chemical Fire Extinguishers

[Source: Md. Habbibullah Nayam Civil MIEB]

Dry powder type is sometimes called as "ABC" extinguisher due to the availability of variety of fire.

(3) Water types: ANSI/UL 626, CAN/ULC-S507, Standard for Water Fire Extinguishers

✔ **Water Fire Extinguisher**
- Colour bar: Red
- Suitable for: Class A fires only
- Not suitable for: Class B, C, D, K
- Working application: The water has a cooling effect on the fire's fuel and reduces the temperature until combustion can no longer be supported.

Figure III-12: Water Fire Extinguishers

[Source: Md. Habbibullah Nayam Civil MIEB]

(4) Halon types: CAN/ULC-S512, Standard for Halogenated Agent Hand and Wheeled Fire Extinguishers

Halons include bromochlorodifluoromethane (Halon 1211), bromotrifluoromethane (Halon 1301), and mixtures of Halon 1211 and Halon 1301 (Halon1211/1301). Usually implemented to the Data center, PC room or electrical room where the water or powder

isn't permitted. Recently production of Halons is prohibited to allied country for treaty because Halons have risk to reduce Ozone layer in stratosphere.

(5) Film-forming foam types: ANSI/UL 8, CAN/ULC-S554, Water Based Agent Fire Extinguishers

2 type of Film-forming foam is used.

1. AFFF (Aqueous Film-Forming Foam)

The foam formed acts as a barrier both to exclude air or oxygen and to develop an aqueous film on the fuel surface that is capable of suppressing the evolution of fuel vapors.

2. FFFP (Film-Forming Fluoroprotein Foam)

In addition to an air-excluding foam blanket, this solution can deposit a vaporization-preventing film on the surface of a liquid fuel.

(6) Halocarbon types: ANSI/UL 2129, CAN/ULC-S566, Standard for Halocarbon Clean Agent Fire Extinguishers

Halocarbon types agents are similar to halon agents in that they are nonconductive, noncorros.

3. Design Review

3.1 Fixed Type Fire Hydrant System

(BNBC Part IV, 4.2)

(1) Essential Point

Hydrant is designed based on the hydraulic calculation based on the 2 factor, such as water head and flow rate.

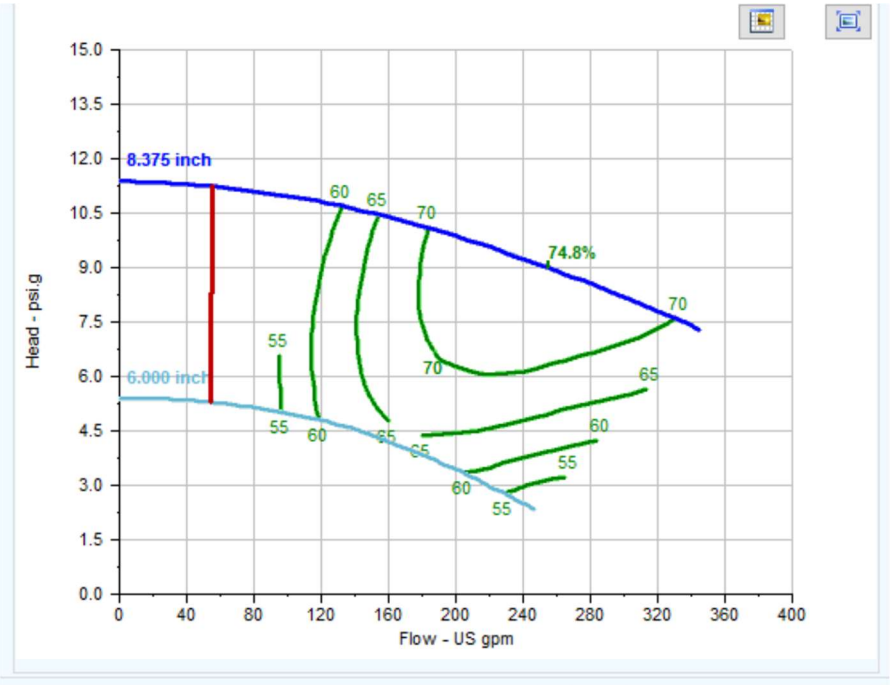

Figure III-13: Hydraulic Calculation

[Source: Example using "Pipe flow expert"]

Minimum requirement of the water discharge and duration is stipulated on 4.2 Fixed Type Fire Hydrant System, BNBC 2020 [Table 4.4.1. Fire Protection Flow Requirements]. And detail of water pressure or hydraulic calculation should follow NFPA 14. That is rely on the building type on the table so flow of the design review is below

1. Specify the Building type
   Specify the height
2. Note the discharge and duration time
3. Check the amount of water reservoir.

After the determination of condition above pipe and pump size will be selected.

3.1.1 Water Quantity for Fire Protection

(BNBC Part IV, 4.2.1)

Checking water flow rate (litre/min.) and duration of discharge (min) is the most important check point on design phase.

3.1.2 Water Sources for Fire Protection (Direct Connection to Water Main)

(BNBC Part IV, 4.2.2.1)

Direct connection to water main is the equipment to gain water source from outside and supply to the fire fighting sprinkler and fire hydrant system. Public water supply system or private system is the channel of supply.

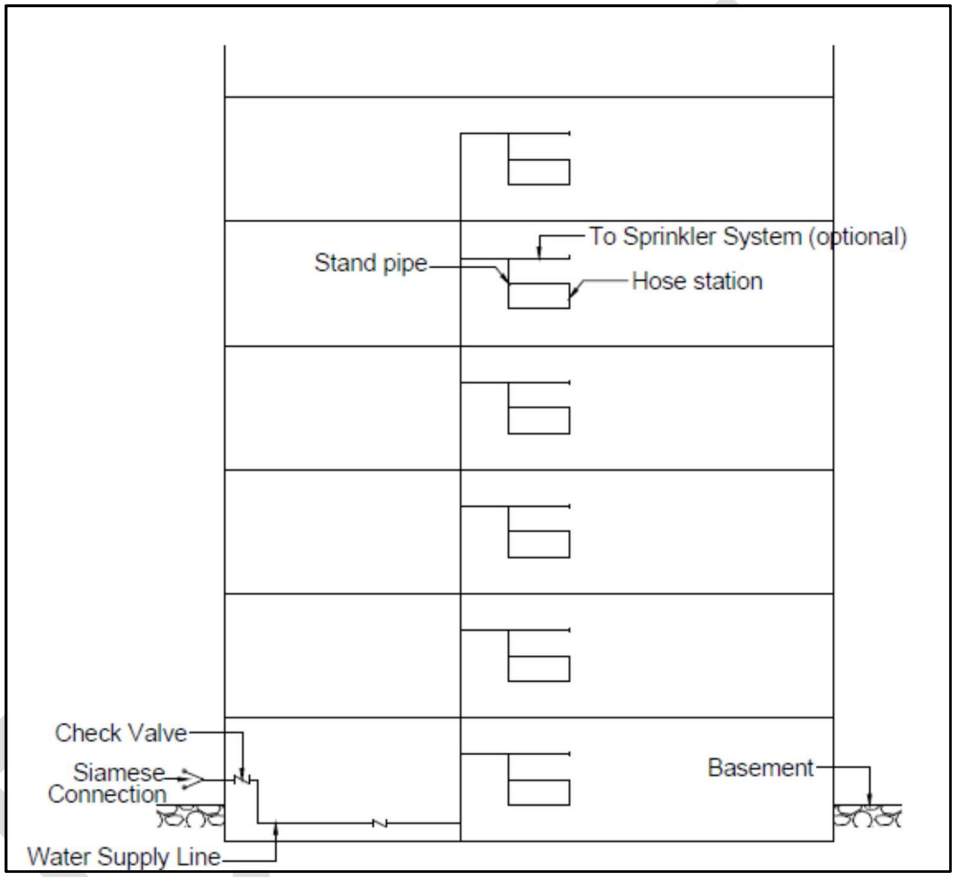

Figure III-14: Direct Connection to Water Main

[Source BNBC 2020 4.2.2.1 Direct Connection to water main]

3.1.3 Water Sources for Fire Protection (Storage Tanks)

(BNBC Part IV, 4.2.2.3)

Specification of storage tanks is determined by the amount of water discharge and flow rate of fire hydrant or fire fighting sprinkler. For the storage tank, design position of pumping system and water level alarm system is also important point to check. Lower than highest position of fire pump suction line is regarded as the “unusable volume”

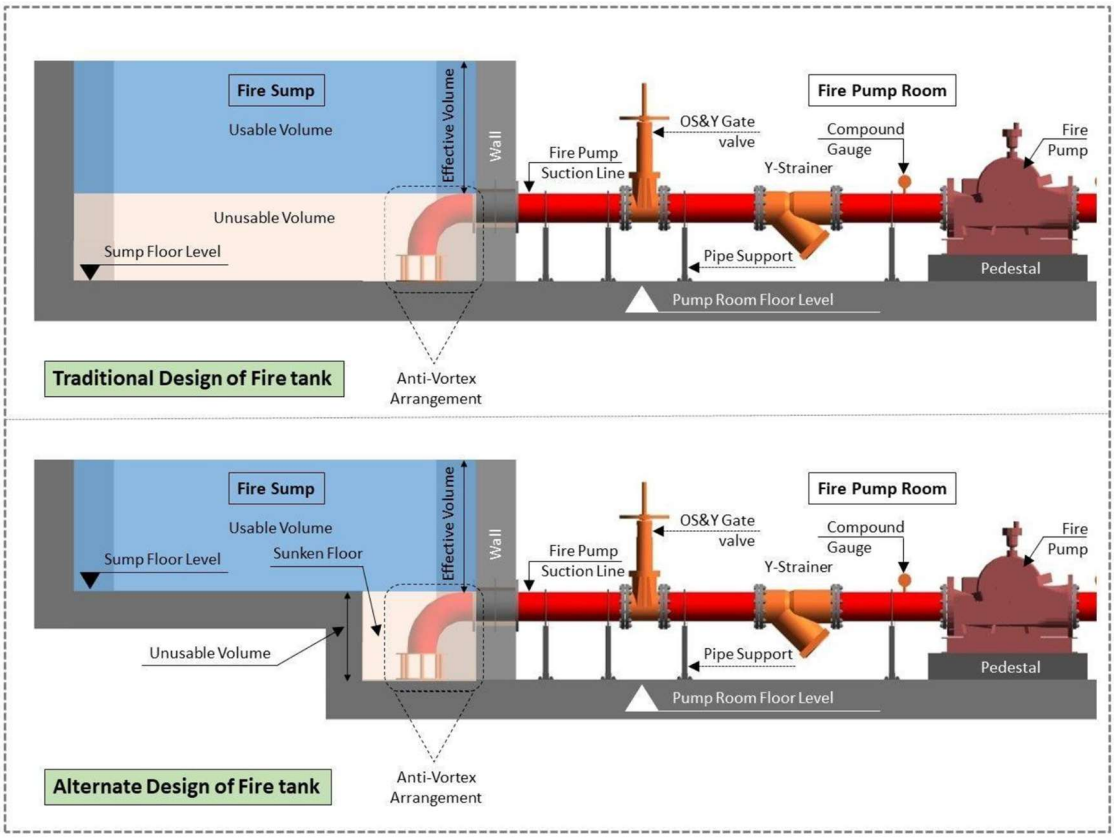

Figure III-15: Storage Tanks

[Source: Md. Habbibullah Nayam Civil MIEB]

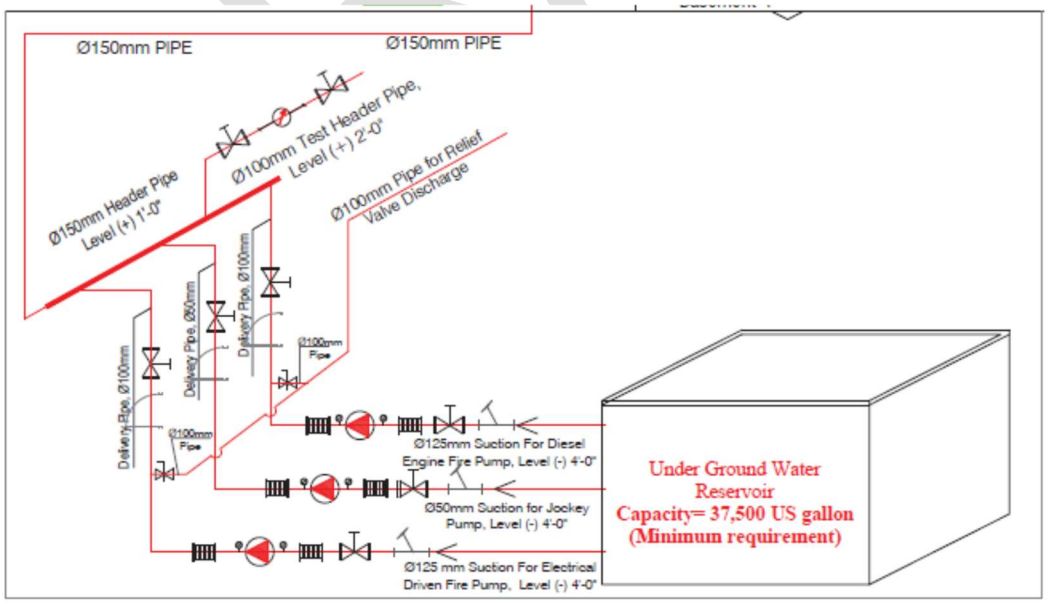

Figure III-16: Storage Reservoir and Riser Unit Diagram

[Source: MEP Engineering Consultancy Firm]

Water level alarm have to notice for user about the decrease of water and overflow of water.

3.1.4 Sprinkler System

(BNBC Part IV, 4.2.10)

Design of Sprinkler system is similar to the design of fire fighting hydrant.

1. Specify the Building type
2. Note the discharge and duration time
3. Check the amount of water reservoir.

After the determination of condition above pipe, pump size, water flow alarm system will be selected. Finally type of sprinkler and minimum distance for each sprinkler head will be calculated.

Pump discharge pressure is simply calculated by the sum of 3 element.

Discharge pressure = Nozzle pressure - Friction loss – Elevation loss

Pump discharge pressure need to be added for the loss which is happened on the transportation of water.

(2) How to use Checklist

(a) Please select Building Type from the candidate. In case that of “Extra Hazard”, please select “Ordinary Hazard III” instead.

(b) Please select Building Height from the candidate.

(c) Please input Duration in minutes of fire protection flow.

(d) Please input flow rate of Standpipe and Hose system.

(e) (d) Please input flow rate of Sprinkler system

(f) Please input floor area covered by standpipes.

(g) Please input floor area covered by sprinklers.

(h) Please input storage tank volume in m3.

3.2 Fixed Installation Other Than Water

(BNBC Part IV, 4.3)

(1) Essential Point

Fixed fire extinguisher system using agent other than water have complex system compared with water fire extinguisher.

3 type of fire extinguisher is remarkable system as fire installation other than water.

1. Foam installation

Foam fire suppression systems are utilized for extinguishing flammable liquid fires by forming a blanket of foam that smothers the flames and suppresses vapor release. These systems typically consist of foam concentrate storage tanks, proportioning devices, and foam discharge nozzles. Foam systems are commonly installed in industrial facilities, fuel storage areas, and aircraft hangars where flammable liquids are present.

2. Dry powder installation

Dry powder usually used for 4 groups as follows.

1) Warehouse for car and vehicle
2) Car parking
3) Transformer, Boiler, Telecommunication equipment room.
4) Storage for wood or paper garbage, resin and wooden product.

Figure-III-16 Dry powder extinguish system
[Source: Yamato Protec]

Usually process of discharge is as follow.

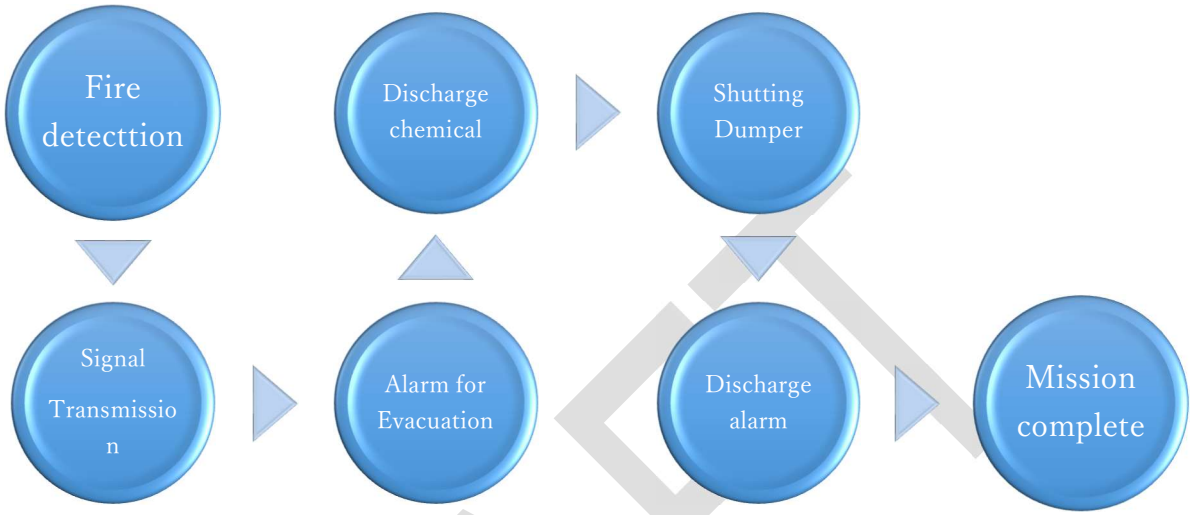

Figure-III-17 Dry powder extinguish system

[Source: Yamato Protec]

This process as same as gaseous extinguish system which require evacuation of occupants.

3. Gaseous installation

An automatic detection and suppression system usually consisted in a single system. Some gaseous extinguish system like CO2 is harmful for the people and have some fatal accident. NFPA2001 clearly mention and clarify the toxicity using NOAEL [No observable adverse effects level] and LOAEL [Lowest observable adverse effects level] According to this fact safety measure by manufacturer is basically severe and protected by double or more safety system. Basically confirmation of gaseous extinguish system is to be followed manufacturer standard and guidance. Therefore confirmation and knowledge of compliance standard or certificate is the most effective check point for the system.

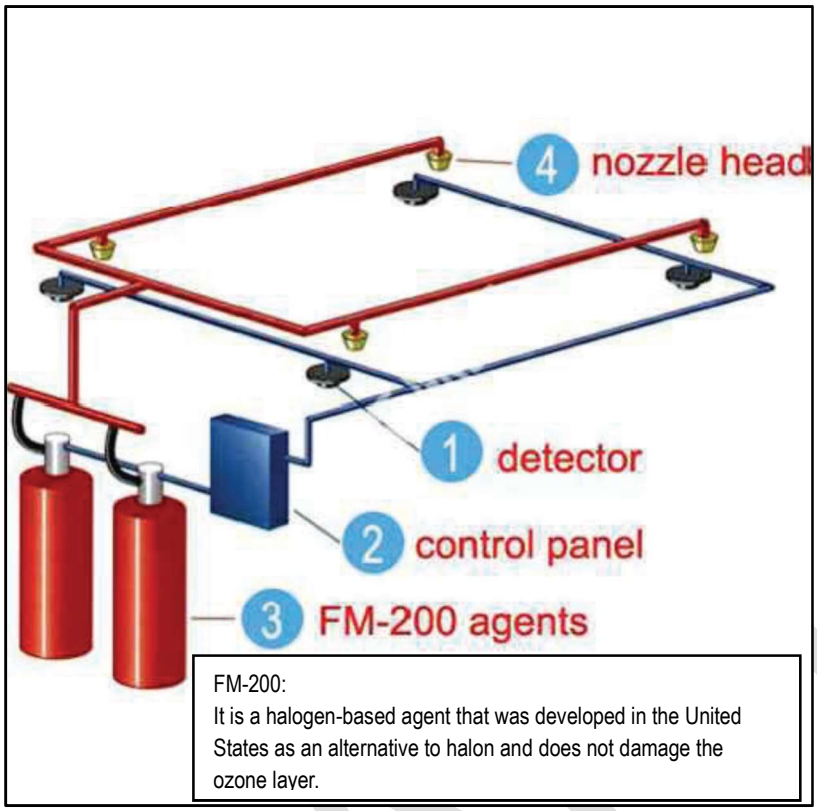

Figure III-17: System of Fire Suppression System using FM-200

[Source: MEP Engineering Consultancy Firm]

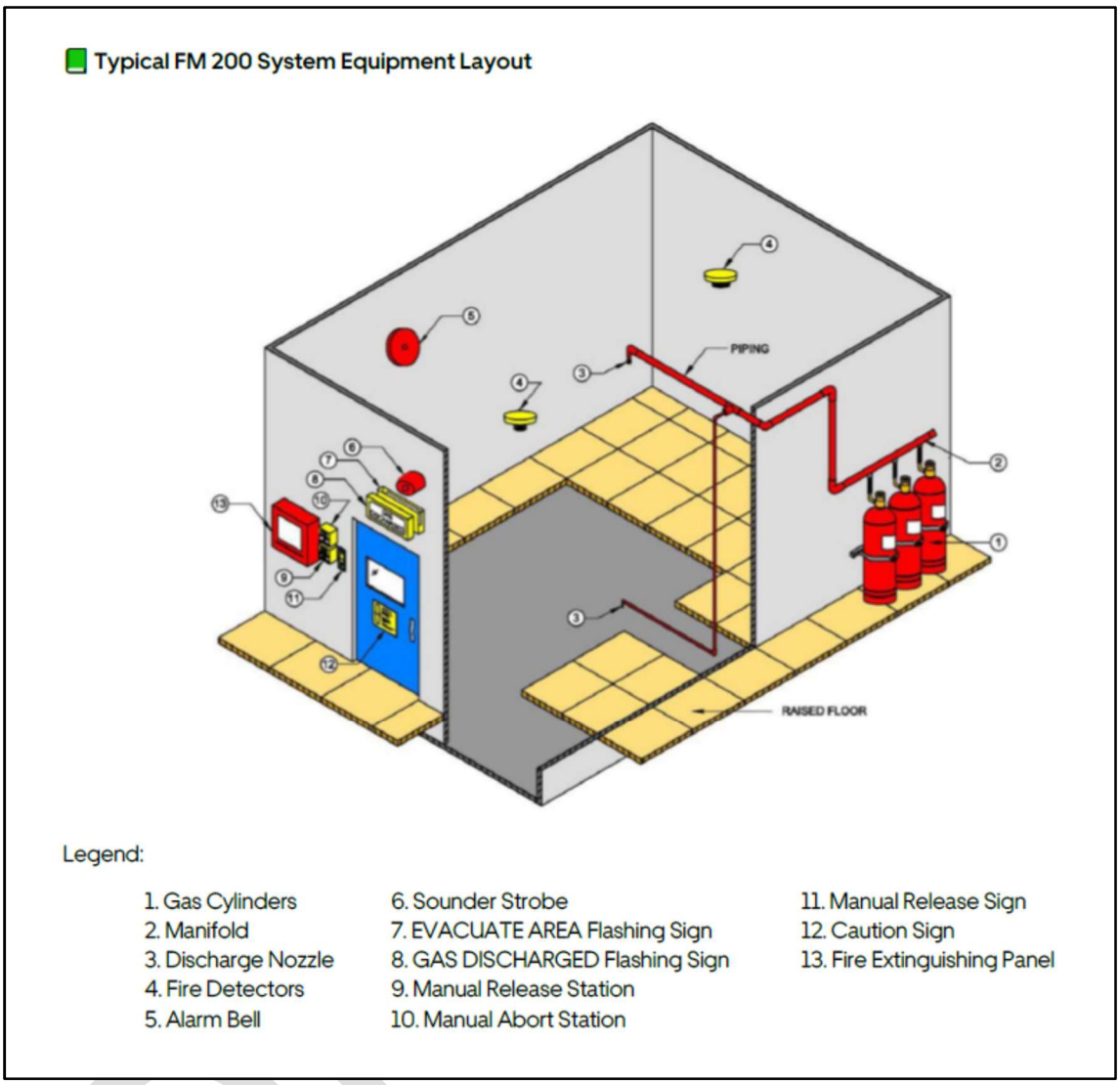

Figure III-18: Typical FM 200 System Equipment Layout

[Source: Md. Habibullah Nayem, Civil, MIEB]

Design principle is well described on NFPA2001 (Standard of clean agent fire extinguishing systems). Design of the gaseous extinguish system is begin from the calculation of the amount agent.

W=(V/S) x (C/100-C)

W: Weight of the Agent (kg)

V: Volume of enclosure to be protected (m3)

C: Agent volumetric design concentration (% by volume)

S: Specific vapor volume

Gaseous system is fixed system but location of speaker and alarm display shall be design

to protect user from inhalation of gas. And position of the non-return valve is critical matter to determine the amount of agent volume to each part of enclosure.

(2) How to use Checklist

(a) Please clarify fixed installation other than water designed for target building.

(b) Please check the item listed in checklist (type by type).

(c) Please check whether compliance standards or certificate for fixed installation is specified in the design drawings.

3.3 Portable Fire Extinguisher

(BNBC Part IV, 4.4)

(1) Essential Point

Portable fire extinguisher sometimes called as hand held extinguishers and familiarized as the most common equipment for the user or occupant. However, generally user should be trained personnel, because there is effective handling method and user may be panic in the incident. Portable Fire extinguisher is the most common item to deal with the small fires in active way. For the allocation of portable fire extinguisher is flexible but consideration and comment from the designer must be respected for the owner.

The minimum number of portable fire extinguisher shall be ascertained, in accordance with the occupancy hazard, specification of the manufacture and guide line set by NFPA 10. In case of Fire Class A and/or B, it is specified by NFPA 10 as follows.

Table III-7: Fire Extinguisher Size and Placement for Class A Hazards

Table 6.2.1.1 Fire Extinguisher Size and Placement for Class A Hazards

Criteria	Light-Hazard Occupancy	Ordinary-Hazard Occupancy	Extra-Hazard Occupancy
Minimum-rated single extinguisher	2-A	2-A	4-A
Maximum floor area per unit of A	3000 ft^2 (279 m^2)	1500 ft^2 (139 m^2)	1000 ft^2 (92.9 m^2)
Maximum floor area per extinguisher	11,250 ft^2 (1045 m^2)	11,250 ft^2 (1045 m^2)	11,250 ft^2 (1045 m^2)
Maximum travel distance to extinguisher	75 ft (22.9 m)	75 ft (22.9 m)	75 ft (22.9 m)

Note: For maximum floor area explanations, see E.3.3.

[Source: NFPA 10, 2022]

Table III-8: Fire Extinguisher Size and Placement for Class B Hazard

Table 6.3.1.1 Fire Extinguisher Size and Placement for Class B Hazards

Type of Hazard	Basic Minimum Extinguisher Rating	Maximum Travel Distance to Extinguishers	
		ft	m
Light	5-B	30	9.14
	10-B	50	15.25
Ordinary	10-B	30	9.14
	20-B	50	15.25
Extra	40-B	30	9.14
	80-B	50	15.25

Note: The specified ratings do not imply that fires of the magnitudes indicated by these ratings will occur, but, rather, they are provided to give the operators more time and agent to handle difficult spill fires that have the potential to occur.

[Source: NFPA 10, 2022]

(2) How to use Checklist

(a) Please clarify type of fire extinguisher (carbon dioxide types, dry chemical types, water types, Halon Types, film-foaming types, foam types, Halon carbon types) and check whether these are suitable/proper for room/building utilization.

(b) Please check whether every portable fire extinguisher is located where they are accessible.

(c) In case of Fire class A or B, please check the number and travel distance of portable fire extinguisher is proper, referring to the table 6.2.1.1 and/or table 6.3.1.1, NFPA 10, 2022.

Part IV
Fire Detection and Alarm System

Contents

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1. Importance of "Fire Detection and Alarm System"

(BNBC Part IV, 4.6)

Fire Detection and Alarm System have been proved as a reliable method to decrease risk of fire. "Fire Detection" detect fire and send signal to "Alarm System". "Alarm system" inform fire to user/occupant or person who shall be termed as Fire watch.

These system is invented more than 100 years ago and dedicate to find initial fire incident. To inspect fire detection and to activate their function is essential for fire safety.

According to the diagram below, "Notify Evacuation" by Alarm System is the first process to begin evacuation. It means alarm system have important mission and responsibility to save human life on fire incident.

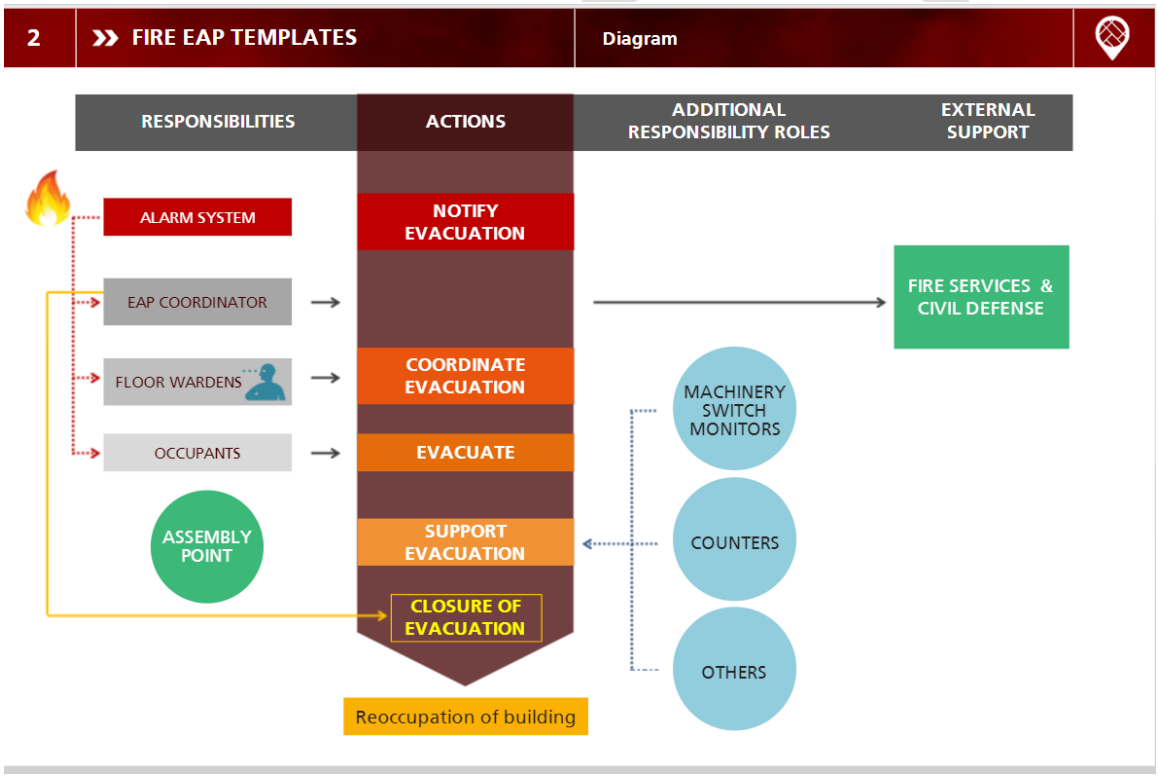


Figure IV-1: EAP (Evacuation Action Plan)

Source: ITC (International Training Center)

2. Definition

2.1 Fire Detection

(BNBC Part IV, 4.6.1)

Fire Detection shall be done by Human surveillance, Automatic smoke or/and heat detection, or Video surveillance.

2.1.1 Human Surveillance

(BNBC Part IV, 4.6.1)

Human surveillance shall be acceptable where the user and occupant are capable of maintaining surveillance fire and smoke.

2.1.2 Automatic Smoke, Heat Detection

(BNBC Part IV, 4.6.1)

Automatic fire and smoke detection system shall be a necessity when the size, arrangement and occupancy of the building become such that a fire itself cannot provide adequate warning to its occupants.

Figure IV-2: Automatic Detection System （補足説明（英訳）が必要）

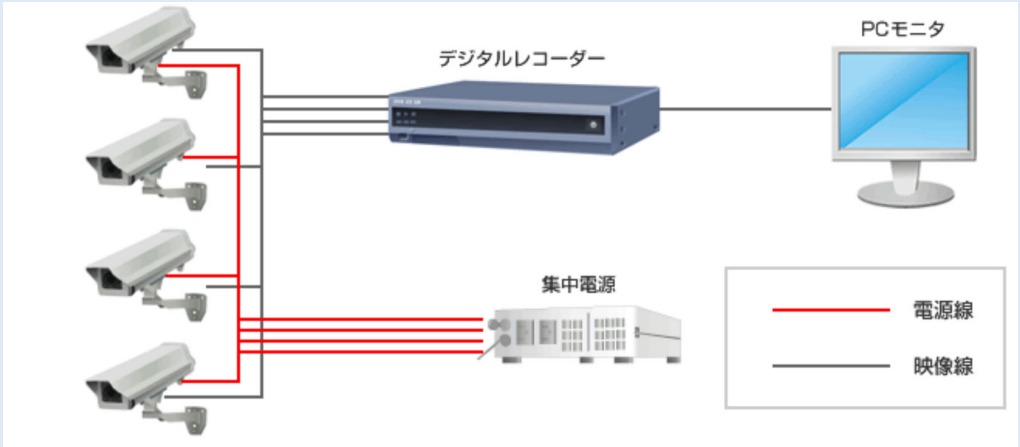
[Source: Japan Fire Alarm Manufacture's Association]

2.1.3 Video Surveillance

(BNBC Part IV, 4.6.1)

CCTV (Closed Circuit Television System) shall be installed systematically to cover an area for detecting any incision of smoke and fire. CCTV will remain under either human surveillance or monitored by compatible software to transmit signal to the fire alarm

system and to the authorized persons.



Source: Heiwa Techno System

Figure IV-3: CCTV (Closed Circuit Television System) （補足説明（英訳）が必要）

[Source: Heiwa Techno System]

2.2 Detector Type

Distinction of Detector feature is essential skill to review fire safety equipment.
Smoke detector can detect initial fire incident, though unit cost are more expensive than heat detector in general. Smoke detector is suitable for general use but couldn't install in kitchen, washroom or other area where usually filled with smog or vapor.
Heat detector isn't suitable with sun exposed or temperature fluctuated environment.
BNBC Part IV, Chapter 5, Appendix C "Selection and Sitting of Fire Detection System" is important to consider choice and installation of Fire detectors.

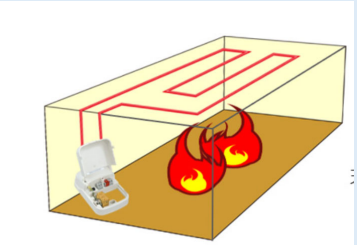
2.3 Heat Detector

(BNBC Part IV, Appendix C, C.2.1, C.2.3, NFPA 72 3.3.77.8, 11, 20)

"Point" or "Spot" type detectors are actuated by heat at layer adjacent to it over a limited area. "Line" type detectors are sensitive to the effect produced by heated gas along any portion of the detector line.

Spot type

Source: Hochiki Corporation



Line Type

Source: NOHMI BOSAI LTD.

Figure IV-4: Heat Detector

[Source: Left: Hochiki Corporation, Right: NOHMI BOSAI LTD.]

2.4 Flame Detector

(BNBC Part IV, Appendix C, C.2.2)

Flame Detector could detect flame rapidly so is more likely used for rapid flaming properties like power plants, chemical plant, distilleries etc. Also Flame Detector is suitable for widely open area in the building. Smoke will scatter into the air in opened area so, detection of smoke is comparatively late. So this is used for Atrium or theatre, the place with high ceiling.

Flame detectors are sensitive to radiation emitted by flames. Since heat, smoke and flame are produced during a fire, detectors responding to all these are accepted as general purpose detectors. Fixed temperature heat detectors are suitable for use where ambient temperatures are high and or may rise and fall rapidly over a short period.

Source: Hochiki Corporation

Figure IV-5: Flame Detector

[Source: Hochiki Corporation]

（ Reference information: Detail explanation）

Flame detectors are a type of fire detection device that can sense the presence of flames by detecting the electromagnetic radiation emitted in specific wavelength ranges.

There are several different operating principles used in flame detectors:

UV/IR Flame Detectors [1]
These detect the ultraviolet (UV) and infrared (IR) radiation emitted by flames, while ignoring radiation from normal hot bodies like incandescent lights. They use sensors tuned to specific UV and IR bands where flames produce high radiation but ordinary hot objects do not.

UV/VIS Flame Detectors [2]
Similar to UV/IR detectors, but they detect the ultraviolet (UV) and visible (VIS) spectral ranges from 0.185 - 0.7 μm where flames emit strongly. This dual-band detection improves rejection of false sources.

IR3 Flame Detectors [3]
These advanced detectors use three infrared (IR) bands (1.0 - 1.1 μm, 2.5 - 2.7 μm, and 4.5 - 4.8 μm) that are analyzed for the unique patterns exhibited by hydrocarbon flames, while rejecting other hot objects.

Visual Flame Detectors [4]

Using specialized software algorithms, these detect the unique flicker frequency signatures and patterns of flames through CCTV video cameras rather than dedicated flame sensors.

In addition to the detection principle, flame detectors can also be classified by their field of view:

Single IR Flame Detectors
Have a relatively narrow field of view designed to monitor a specific area or piece of equipment.

Multi IR Flame Detectors

Use multiple IR sensors arranged to provide a wider combined field of view up to 120° or more to monitor larger areas.

Triple IR (IR3) detectors as mentioned above effectively have three "views" of different IR bands.

Flame detectors are ideally suited for environments with potential gas/vapor leaks and high ceilings where smoke detectors may not be effective. However, care must be taken to avoid interference from hot objects, arc welding, or flickering light sources [5].

[1] https://booksite.elsevier.com/9781856179171/appendices/datasheets/Section_9.pdf
[2] https://constructionmanuals.tpub.com/14182/css/14182_107.htm
[3] https://www.cambridgevacuum.com/documents/articles/cvengnr/ir3.pdf
[4] https://www.femalifesafety.gov/docs/Visual-Flame-Detection.pdf
[5] https://www.nfpa.org/assets/files/AboutTheCodes/72/72-10.pdf

2.5 Smoke Detector

(BNBC Part IV, Appendix C, C.2.4)

Smoke Detector is a devise capable of sensing visible or invisible particles produced during combustion. Smoke detector is possible to detect combustion earlier than heat detector and flame detector, so that smoke detector shall be prioritized in general. However, for smoking room, kitchen, restroom and/or the place with high humidity, heat

detector shall be prioritized to avoid malfunction.

Three types of smoke detectors are commonly used. First type is actuated by absorption or scattering of visible or near-visible light by combustion product and known as "optical detector". The second type is actuated by the production on ionization current within the detector and referred to as "ionization detector". The third type is sensitive to carbon monoxide or other products of combustion and is known as "chemically sensitive detector". In general, these should be used at places where ambient temperature varies between 0℃ to 35℃.

2.5.1 Optical Smoke Detectors

(BNBC Part IV, Appendix C, C.2.4.1)

Normally this detector light beam from the source to receiver when smoke flow into the chamber, the smoke particles will reflect some light onto the photo cell.

Invisible smoke from a clear burning shall not actuate such detectors. But they respond quickly where smoke is optically dense and as such suitable for use in dust free clean atmosphere. Over a period of time, due to dust and dirt, the sensitive surface of photo sensitive element and/or executor lamp of optical detectors may loss its efficiency and as such optical detectors should be cleaned and maintained regularly.

Source: ST HW Czech Republic

Figure IV-6: Smoke Detector (Optical Detector)

[Source: ST HW Czech Republic]

2.5.2 Ionization Chamber Smoke Detectors

(BNBC Part IV, Appendix C, C.2.4.2)

These responds quickly to invisible smoke of clear burning, but may not respond to fire producing dense smoke. These can be used in dust free, humidity controlled area. Smoke and other fumes, dust including slow accumulated and disturbed aerial dust, fiber, steam and condensation produced by normal processes and vehicle engines may cause false alarm. Warehouses exposed to fast air flows can also cause false alarm. Burning of polyvinyl chloride will not sensitize the detector in time and may provide late warning or no warning at all.

Source: C TEC UK

Figure IV-7: Smoke Detector (Ionization chamber)

[Source: C TEC UK]

2.5.3 Chemically Sensitive Smoke Detectors

(BNBC Part IV, Appendix C, C.2.4.3)

Chemically coated sensitive elements react to carbon monoxide or other products of combustion present in smoke. Dust or moisture adversely affects the sensitive elements and are not very suitable for residential use.

Source: Apollo Fire UK

Figure IV-8: Smoke Detector (Chemically Sensitive)

[Source: Apollo Fire UK]

（ Reference information: Detail explanation）

Ionization Smoke Detectors [1]

These have a small amount of radioactive material that ionizes air between two electrodes, allowing a small current to flow. When smoke enters, it disrupts this current flow, triggering the alarm.

Photoelectric Smoke Detectors [2]

These use a light source and photoelectric sensor. Smoke particles dispersing into the optical chamber scatter the light beam, allowing the sensor to detect the smoke and activate the alarm.

Projected Beam Smoke Detectors [3]

These have a separate light transmitter and receiver unit that detects smoke by monitoring the obscuration of a projected light beam over longer linear distances.

Video Smoke Detectors [4]

Using video cameras and imaging analysis, these detect characteristic patterns, color, and behavior of smoke to provide very early warning.

In addition to the detection principles, smoke detectors can have different configurations:

Spot-Type Smoke Detectors

The common type that monitors a localized area around the detector.

Duct Smoke Detectors [5]

Designed to be installed within air ducts and ventilation systems to detect smoke present in circulating air flows.

Projected beam, air-sampling, and aspirating detectors can also provide early warning for larger areas and high ceilings. Proper selection depends on the environment, response time needs, and regulatory requirements like NFPA 72 [6].

Smoke detectors need regular testing, cleaning and eventual replacement as dust and contamination reduces their sensitivity over time [7]. Locations also must avoid sources of potential false alarms.

[1] https://www.usfa.fema.gov/downloads/pdf/statistics/v1i6-508.pdf

[2] https://www.nfpa.org/Public-Education/By-topic/Smoke-alarms/Ionization-vs-photoelectric

[3] https://www.systemsensor.com/en-us/Documents/Beam_PTBeam_PROF.pdf

[5] https://www.kiddefiresystems.co.uk/knowledge/duct-smoke-detectors/

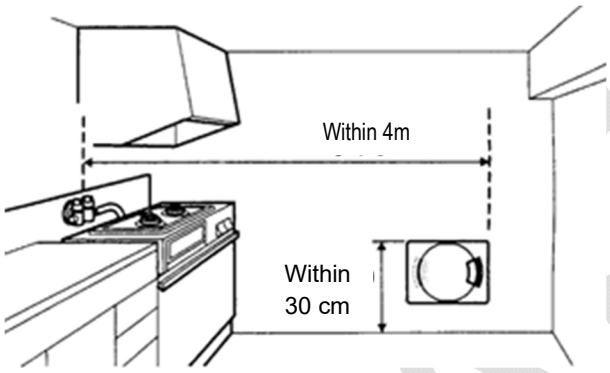
[6] https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=72

[7] https://www.usfa.fema.gov/downloads/txt/txt_smoke_alarm_position.txt

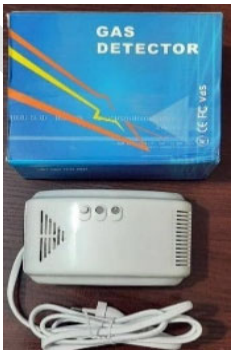
2.6 Gas Detectors

(NFPA72 2022 3.3.77.10 [Not mentioned in BNBC])

Gas Detectors is a device that detects the presence of a specified gas concentration. Gas Detectors shall be used for kitchen, pantry and pipe shaft include flammable gas supply. Other than that, gas detectors shall be installed in basement and other specified fire prevention object which the unspecified person visit or stay. In Bangladesh, it is common to use natural gas made of methane gas which specific gravity is lighter than the normal air and liquefied petroleum gas (LPG) which specific gravity is heavier than the normal air. Thus, gas detector for LPG shall be installed within 30cm above floor level, and within 4m from the equipment to use gas.



Source: Furukawa Gas Co., Ltd.



Source: Impress Corporation Limited

Figure IV-9: Gas Detector for LPG（required to be replaced)

[Source: Left:Furukawa Gas Co., Ltd., Right: Impress Corporation Limited]

2.7 Fire Alarm System

(BNBC Part IV, 4.6.2)

It is a combination of compatible devices, which can produce an alarm in the event of fire when activated with necessary electrical energy.

In a fire incident, panic management shall be the prime concern for a successful relocation, delayed egress or evacuation of occupants from a building structure. Means of egress system is so designed that all alarms of a building shall not be activated at a time.

As per design scenarios a systematic execution protocol shall be developed where a building shall be sub-divided into zones for installation alarms and for fight in place, relocation of occupants, delayed egress or immediate evacuation.

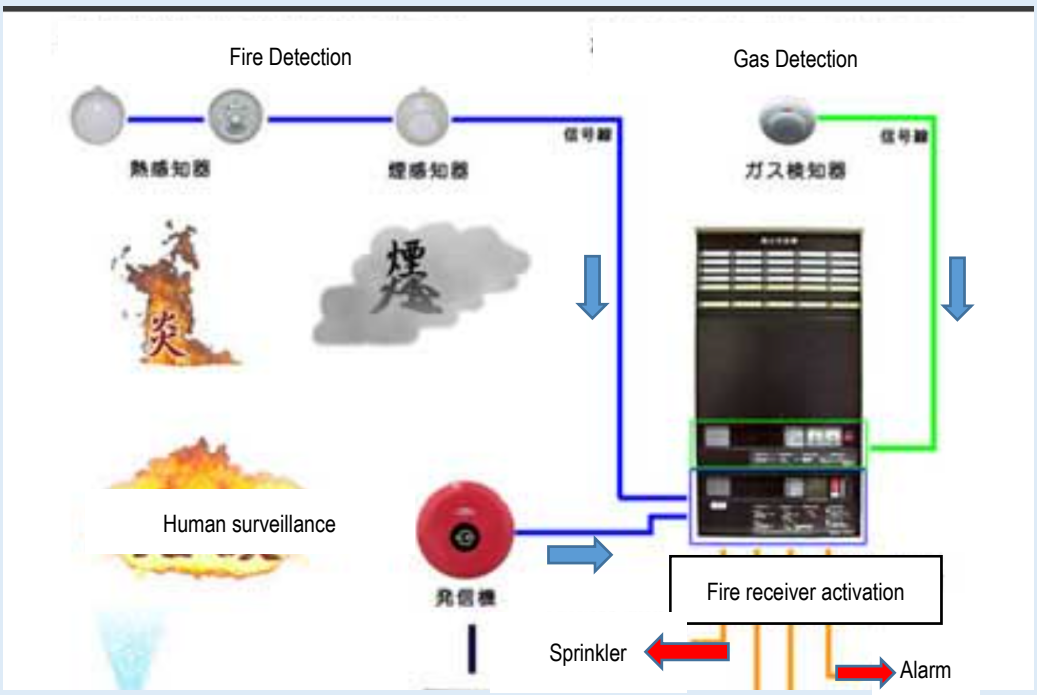
Alarm system can be of different types, such as audible alarm, visual alarm, vibration alarm, and display alarm.

Audible alarm may be ringer, bell, horn, chime and voice command via public address system (PA system).

Visual alarm may be a bright white light emitting device to draw attention. A visual alarm shall be installed where a person working alone in a room or space having hearing limitations.

Vibration alarm is an alarm activated thorough vibration can be used for alarm.

Display alarm is an alarm such as textual, graphical or pictorial display on screens or monitors which can be used as alarm.



Source: Asahi Sogo Service

Source: Impress Corporation Limited

Figure IV-10: Fire Alarm System and Fire Alarm Control Panel

[Source: Upper: Asahi Sogo Service, Bottom: Impress Corporation Limited]

（required to be replaced 補足説明（英訳）が必要）

A fire alarm system is designed to detect the presence of fire, alert occupants, and notify emergency responders. The main components include:

Initiating Devices [1]
Smoke detectors (ionization, photoelectric, beam, air-sampling)
Heat detectors (rate-of-rise, fixed temperature)
Manual pull stations
Other detectors (flame, gas, etc.)

Notification Appliances [2]
Audible Devices (speakers, bells, horns)
Visual Devices (strobes, lights)

Fire Alarm Control Panel (FACP) [3]
The intelligent controller that monitors inputs from initiating devices and activates notification appliances and other outputs based on programming.

Transmission Equipment [4]
Interfaces to monitoring companies or emergency services over phone lines, IP/internet, cellular, or radio links.
Power Supplies
Main and backup batteries provide continuous operation if primary power is lost.
In addition to these core components, fire alarm systems can include:

Emergency Communication Systems [5]
Interface phones, area of refuge stations, fire fighter phones for mass notification and two-way communication.

Smoke Control Systems [6]
Interfaces to control smoke dampers and pressurization fans to manage smoke movement.

Mass Notification Systems [7]
Provide customized live/pre-recorded voice instructions and signage for occupant protection.
Fire alarm systems are designed and installed per codes like NFPA 72 based on the occupancy type, size, and hazards present. Proper spacing, location and periodic inspection/testing of devices is critical [8].
Advanced addressable systems allow precise location of alarms and streamlined testing/maintenance. Proper design ensures system effectiveness and avoids excessive unwanted alarms.

[1] https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=72
[2] https://www.usfa.fema.gov/downloads/pdf/designers_manual.pdf
[3] https://www.notifier.com/DesktopModules/Bring2mind/DMX/Download.aspx?portalid=0&EntryId=3934
[4] https://www.coopernotification.com/product-category/fire-alarm/fire-alarm-transmission/
[5] https://www.qrfs.com/blog/182-emergency-communication-systems-within-fire-alarm-systems/
[6] https://nacord.com/wp-content/uploads/2019/12/SmartQuote_5-1-19.pdf
[7] https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=72
[8] https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=72

3. Design Review

(1) Essential Point

Basically for the design review, it is expected to check 3 points, such as types, location and quality of detector. Besides, it is essential to check whether fire alarm system is planned properly.

(a) Types of detector

Design reviewer shall check “types (what kind) of detector” and also check “the

combination of occupancy and detector is comply or not". This mean detector fully activate their function when they installed in each installed site.
Understanding of specification of each detector is quite essential.

(b) Location of detector

Considering the prevailing weather condition of the occupancies and the false alarm, the type of detectors and the area of coverage shall be decided. Area of coverage of detectors is dependent on many factors. The following aspects shall be taken into considerations in the design of detectors.

- Various forms of overhead heating
- Exhaust air from air cooling equipment blowing out into the room or factory area
- Deep beams
- Roofs and ceiling of unusual shape
- Building with ground areas above 10 m and up to 30 m in height
- Staircases
- Canteen and Restaurants
- Plant Rooms
- Ambulant air currents

(c) Quality

Detector shall be fully complied standard, specification and be guaranteed. All detector shall be comply with at least one Specification stipulated below:

- NFPA
- UL
- FM

(2) How to use Checklist

(a) Please select "Type of Fire Detection" from the candidate: 1) Human Surveillance, 2) Automatic smoke and/or Heat detection, 3) Video surveillance. In case of "2) Automatic smoke and/or Heat detection", required to check the following (b) to (d).

(b) Please check Smoke detector and/or Heat detector is designed for office, living rooms in the residential building and similar facility. If the answer to the above a) is 1) or 3), please input "N/A".

(c) Please check Smoke detector is designed for staircase, corridor, sleeping rooms in

the residential building and similar facility. If the answer to the above a) is 1) or 3), please input “N/A”.

(d) Please check Heat detector is designed for smoking room, kitchen, restroom, the place with high humidity and similar facility. If the answer to the above a) is 1) or 3), please input “N/A”.

(e) Please check Flame detector is designed for Atrium or theatre, the place with high ceiling. If there are no high ceiling room, please input “N/A”.

(f) Please check Gas detector is designed for the area which have leakage risk of combustible gas. If there is no area in the building, please input “N/A”.

(g) Please check Fire Alarm System is designed. If it is not required for the building to be designed, please input “N/A”.

(h)

Part V
Electrical Material and Equipment

Contents

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1. Importance of "Electrical Material and Equipment"

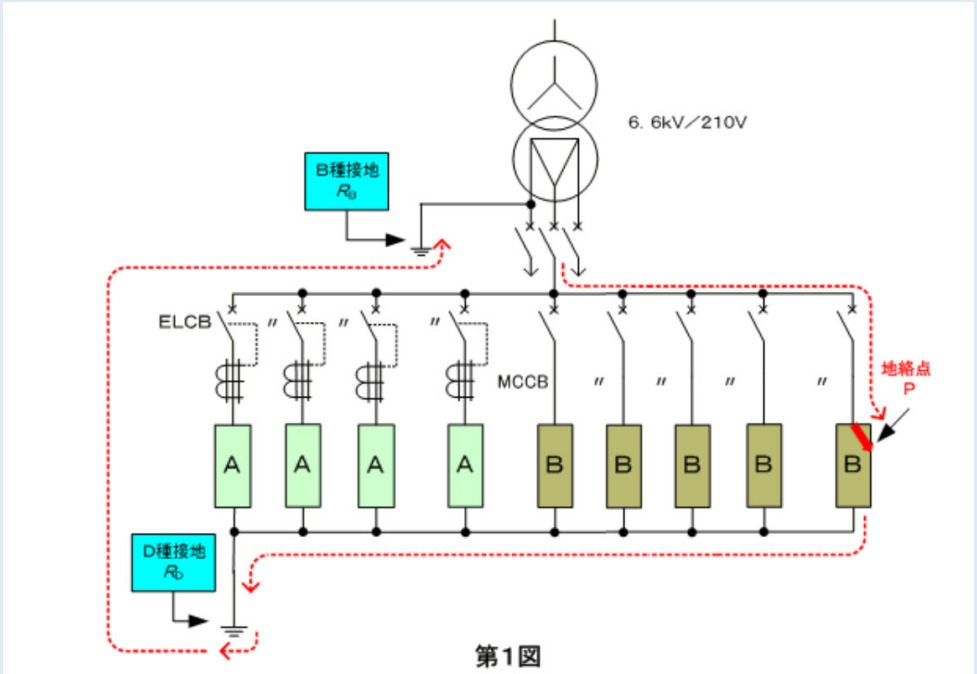
(BNBC Part VIII, 1.3)

More than 30% of fire accidents in Dhaka are caused by faulty electrical outlets and appliances. Maintenance stage is the most important part to prevent from fire incident, however, it is possible to reduce the risk of fire incident at design stage.

2. Definition

2.1 Circuit Breaker

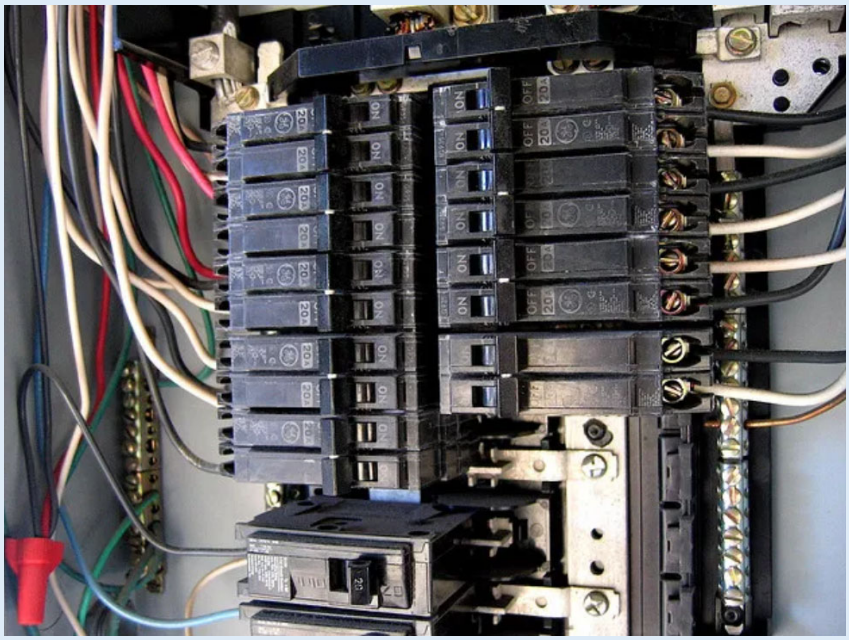
"CIRCUIT BREAKER" is a device designed to open and close a circuit by non-automatic means and to open the circuit automatically on a predetermined overcurrent, without injury to itself when properly applied within its rating. It include Molded Case Circuit Breaker (MCCB), Earth-Leakage Circuit Breaker (ELCB), etc.



Source: Japan Electric Engineers Association

Figure V-1: CIRCUIT BREAKER

[Source: Japan Electric Engineers Association]



Source: RAJUK

Figure V-2: CIRCUIT BREAKER (Need to be replaced by RAJUK)

[Source: RAJUK]

2.2 Insulation

"INSULATION" is suitable non-conducting material, enclosing, surrounding or supporting a conductor. Usually it is made of PVC, polymer, and specially treated rubber.

2.3 Over Current

"OVER-CURRENT" is a current exceeding the rated current. For conductors, the rated value is the nominal current carrying capacity.

Normally over current is detected by MCCB (Molded Case Circuit Breaker) and electrical circuit will open if MCCB detect over current.

MCCB have nominal current ratings as xx A (Anpea) which means circuit current become over nominal current rating, MCCB open the circuit immediately.

Some type of MCCB have setting current value that isn't only nominal current. Figure 3 shows MCCB Nominal current 125A and could adjust to other value (120A, 100A, 80A)

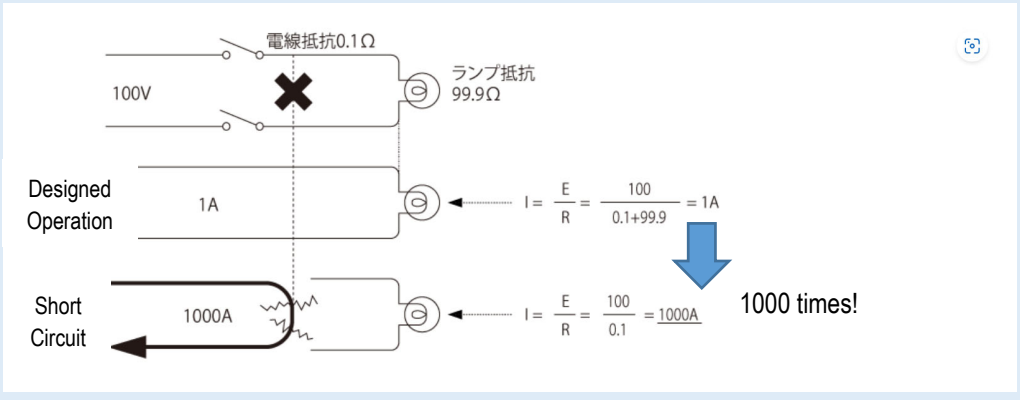
Sourse: Alfanar Corporation

Figure V-3: Molded Case Circuit Breaker

[Sourse: Alfanar Corporation]

2.4 Short Circuit

Short circuit is the accident on electrical circuit. When each conductors touch each other in their own circuit, huge current will flow. Sometimes that will be fire incident. As a protection method of short circuit, suitable installation of MCCB for circuit should be considered on design phase.



Source: Panasonic Corporation

Figure V-4: Short Circuit

[Source: Panasonic Corporation]

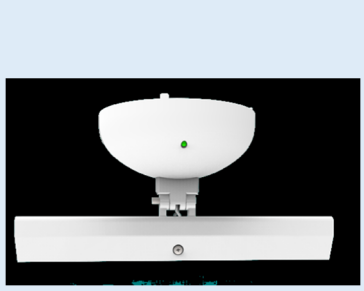
2.5 Exit Sign

"EXIT SIGNS" is illuminated sign to inform occupant the exit location. Not only daytime but also exit signs should be recognized by occupant at night, or during dark periods. Luminance on the surface of Exit sign shall not be less than 53.8 lux and this luminance value is called a foot candle. Foot candle luminance could fully show up $1ft^2$ area from 1 ft distance from light source. This light source is considered minimum requirement for evacuation activity for occupant.

Exit sign must be active in emergency situation so sign should be illuminated with 2 separate power supplies (Generator supply or Battery). Location of escape signs have to be considered the signs are not hidden or overwhelmed by other signage or obstacle.

In summery important points to consider for Exit sign is 3 points below.

1) Guarantee of lighting intensity
2) Location
3) Color



Exit Sign Flame

Exit Sign

Source: Hochiki Corporation

Figure V-5: Exit Sign

[Source: Hochiki Corporation]

3. Design Review

3.1 Over-current and Short Circuit Protection of Circuits

(BNBC Part VIII, 1.3.30)

(1) Essential Point

Proper design of circuit breaker, bus-bar, and earth terminal is essential for electrical

safety. Especially over-current and short circuit is directly lead fire incidents.

Appropriate protection shall be provided at the distribution boards for all circuits and sub-circuits against short circuit and over-current. The installed protective devices shall be capable of interrupting any short circuit current that may occur, without causing any danger. The ratings and settings of fuses and the protective devices shall be coordinated so as to obtain absolute certain discrimination of the faulty area only during a fault.

Where circuit breakers are used for protection of main circuit and the sub-circuits, discrimination in operation shall be achieved by adjusting the protective devices of the sub-main circuit breakers to operate at lower current settings and shorter time-lag than the main circuit breaker.

A fuse carrier shall not be fitted with a fuse element larger than that for which the carrier is designed.

The current rating of fuses shall exceed the current rating of full load current in the circuit protected by the fuse.

(2) How to use Checklist

(a) Please request the designer/engineer to submit drawing indicating protective device of circuits.

(b) Please check whether short circuit and over-current protection are provided at the distribution boards for all circuits and sub-circuits.

3.2 Means of Exit Signs and Illumination

(BNBC Part IV, 3.16)

(1) Essential Point

All required means of exit or exit access in buildings or areas requiring more than one exit shall be signposted. The signs shall be clearly visible at all times, where necessary supplemented by directional signs. All exit doors shall be clearly marked for easy identification. (Except residential buildings)

Illumination: Signs shall be internally or externally illuminated by two electric lamps or shall be of self-luminous type.

(2) How to use Checklist

(a) Please check the occupancy of the building. In case of A1, A2, or individual unit of A3, input “Yes”, and otherwise input “No”.

(b) In case the answer for the above (a) is “No”, please check whether Exit sign is designed on drawing or not. In case the answer for the above (a) is “Yes”, please input “N/A”.

Checklist for Means of Egress

Part	Clause	Heading and Article	Checklist	Result of Check	Input	Criteria	Judgement
Gazette	4.	Occupant Load	**Occupant Load**				
Gazette	4.	Occupant Load	Planned occupant load (total number per building)	_____ person	25	---	---
Gazette	4.	Occupant Load	Planned occupant load (total number per building), If candidate from Sheet 1 is "7",	Caliculate maximum occupant load.	30	---	---
Gazette	4.	Occupant Load	Maximum occupant load	Select candidate from Sheet 1 (except Public Gathering and Religious Building with Fixed seat)	a	---	18
Gazette	4.	Occupant Load	Planned floor area	_____ m2	490	---	---
Gazette	4.	Occupant Load	IF candidate from Sheet 1 is "except 7" Planned area per one person (How many square meter(m2) per one person)	_____ m2	19.6	According to Table-1 on Gazzette	Comply
Gazette	4.	Occupant Load	IF candidate from Sheet 1 is "7", the occupant load per 0.3m2 of usable floor space (How many person per 0.3 sqeare meter(m2))	_____ m2	0.00	1 or less	N/A
Gazette	4.	Occupant Load	The occupant load of a mezzanine floor is added to the receiving floor’s occupant load.	Yes, No, N/A	N/A	Yes or N/A	Comply
Gazette	4.	Occupant Load	If roofs are used as public assembly, they are provided with exit facilities according to the occupant load	Yes, No, N/A	N/A	Yes or N/A	Comply

Checklist for Means of Egress

Part	Clause	Heading and Article	Checklist	Result of Check	Input	Criteria	Judgement
			Capacity of Exit				
Gazette	5.	Capacity of Exit	Occupant load	____ person	25	---	---
Gazette	5.	Capacity of Exit	Required width of stair (Refer to Sheet 2)	____ mm/person (to check each floor, if required)	8	---	200
Gazette	5.	Capacity of Exit	Required width of ramp/corridor (Refer to Sheet 2)	____ mm/person (to check each floor, if required)	5	---	125
Gazette	5.	Capacity of Exit	Required width of door (Refer to Sheet 2)	____ mm/person (to check each floor, if required)	4	---	100
Gazette	5.	Capacity of Exit	Width of planned stair	____ mm (to check each floor, if required)	1,150		Comply
Gazette	5.	Capacity of Exit	Width of planned ramp/corridor	____ mm (to check each floor, if required)	N/A		Comply
Gazette	5.	Capacity of Exit	Width of planned door	____ mm (to check each floor, if required)	1,150		Comply
			Corridor and Passage				
Gazette	6.	Corridor and Passage	Length of dead end corridor	____ m (maximum length)	0	less than 10 m	Comply
Gazette	6.	Corridor and Passage	Where serving an occupant load of more than 50, Width of corridor and passageway	____ m (to check each floor)	N/A	1.1m or over, N/A	Comply
Gazette	6.	Corridor and Passage	Where serving an occupant load of 50 or less. Width of corridor and passageway	____ m (to check each floor)	1.22	0.9m or over, N/A	Comply
Gazette	6.	Corridor and Passage	In Health Care Service Buildings (Occupancy D) where movement of beds is necessary, Width of corridor and passageway	____ m (to check each floor)	N/A	2.4m or over, N/A	Comply

Checklist for Means of Egress

Part	Clause	Heading and Article	Checklist	Result of Check	Input	Criteria	Judgement
Gazette	6.	Corridor and Passage	In Educational Buildings (Occupancy B) where the occupancy load is more than 150, Width of corridor and passageway	____ m (to check each floor)	N/A	1.8m or over, N/A	Comply
Gazette	6.	Corridor and Passage	Clear height of the corridor and passageway	____ m (minumun height)	2.85	2.4m or over	Comply
			Assembly Aisles				
Gazette	7.	Assembly Aisles	The number of person to use where there are seats, tables, equipment, displays, etc.	____ person	500	---	2500
Gazette	7.	Assembly Aisles	Maximum ratio of Exit Access	1 : __ N/A	9	less than 1:10	Not comply
Gazette	7.	Assembly Aisles	Width of Exit Acceess	____ mm (minimum Width)	2000	5mm per person (Judged autmatically)	Not comply
Gazette	7.	Assembly Aisles	Minimum tread of depth of step	____ mm (minimum), N/A	300	275mm or over, N/A	Comply
Gazette	7.	Assembly Aisles	Height of reiser of step	____ mm (maximum), N/A	150	200 mm or less, N/A	Comply
Gazette	7.	Assembly Aisles		____ mm (minimum), N/A	150	100 mm or over, N/A	Comply
Gazette	7.	Assembly Aisles	Width of plain level or sloped aisle	____ m (minimum, both sides seats), N/A	1	1.0 m or over, N/A	Comply
Gazette	7.	Assembly Aisles		____ m (minimum, one sides seats), N/A	1	0.9 m or over, N/A	Comply
			Doorways				
Gazette	8.	Doorways	Type of Buildings	Select candidate from Sheet 3	A	---	12
Gazette	8.	Doorways	Type of Buildings	Select candidate from Sheet 3			23
Gazette	8.	Doorways	The number of users of each occupant of a rooom or space	____ person (maximum, per each occupant of a room or space)	5	Belonging to type of building	Comply
Gazette	8.	Doorways	Travel distance up to exit acceess door	____ m (maximum, per each occupant of a room or space)	23.0	Belonging to type of building	Comply
Gazette	8.	Doorways	If "Not comply" for above 2, the munber of exit door	____ exit door, N/A	N/A	2 or over	Comply
Gazette	8.	Doorways	Width of Exit Door	____ m (minimum)	1.5	1m or over	Comply

Checklist for Means of Egress

Part	Clause	Heading and Article	Checklist	Result of Check	Input	Criteria	Judgement
Gazette	8.	Doorways	Height of Exit Door	____ m (minimum)	2.13	2m or lower	Comply
Gazette	8.	Doorways	All Exit Door are side-swinging type (except for pressurized rooms)	Yes, No	No	Yes	Not comply
Gazette	8.	Doorways	Exit Door swing outward towards the direction of travel when occupant load exceeds 50	Yes, No, N/A	No	Yes or N/A	Not comply
Gazette	8.	Doorways	If the Exit doorway open towards the stair, towards the outside a space qeual to the width of the door plus 0.9m wide area have to be kept.	Yes, No, N/A	No	Yes or N/A	Not comply
Gazette	8.	Doorways	In assembly, educational or institutional buildings or in buildings where occupant load is 200 or more, revolving doors is not used for means of exit.	Yes, No (Not used), N/A	No	No or N/A	Comply
			Stairways				
Gazette	9.	Stairways	Width of exit staiways	____ m (minimum), N/A	1.15	---	---
Gazette	9.	Stairways	The width of exit staiways is wider than the value situpulated in " B: Width of Fire Exit Stairways", sheet 4	Yes, No, N/A	Yes	Yes or N/A	Comply
Gazette	9.	Stairways	If there is only one stairway in a building and if that stairway also is used as the Fire Escape, the Width of that stairway is wider than the higher value of the two, minimum value of stairway width described in Table: “Minimum clear width (without obstacle) of stair” and the stairway width obtained from Table : “Width of Fire Exit Stairways”	Yes, No, N/A	Yes	Yes or N/A	Comply
Gazette	9.	Stairways	Specified width of stairway	____ m (minimum), N/A	1.15	---	---
Gazette	9.	Stairways	Dimention of landings and platforms (Except straight run stairway)	____ m (minimum), N/A	1.20	Wider than specified, N/A	Comply
Gazette	9.	Stairways	There are continuous handrail for stariways serving as fire exit - Width 1m: one side - Width 1 - 2.2m: Both side - Width 2.2m -: Both side and middle	Yes, No, N/A	No	Yes, N/A	Not comply
			Ramps				
Gazette	10.	Ramps	Where serving an occupant load of more than 50, Width of Ramps	____ m (to check each floor)	4.5	1.1m or over, N/A	Comply

Checklist for Means of Egress

Part	Clause	Heading and Article	Checklist	Result of Check	Input	Criteria	Judgement
Gazette	10.	Ramps	Where serving an occupant load of 50 or less. Width of Ramps	____ m (to check each floor)	N/A	0.9m or over, N/A	Comply
Gazette	10.	Ramps	In Health Care Service Buildings (Occupancy D) where movement of Beds is necessary, Width of Ramps	____ m (to check each floor)	N/a	2.4m or over, N/A	Comply
Gazette	10.	Ramps	In Educational Buildings (Occupancy B) where the occupancy load is more than 150, Width of Ramps	____ m (to check each floor)	N/a	1.8m or over, N/A	Comply
Gazette	10.	Ramps	Slope of the Exit ramp	1 : __ N/A	10	less than 1:12, N/A	Not comply
Gazette	10.	Ramps	If more than 1:15 above, guards or handrail on both sides of the ramp	Yes, No, N/A	No	Yes, N/A	Not comply
			Horizontal Exits				
Gazette	11.	Horizontal Exits	Width of horizontal exit	_____m, N/A		More than 1m, N/A	Not comply
Gazette	11.	Horizontal Exits	Slope of Horizontal exit	1 : __ N/A		less than 1:12, N/A	Not comply
Gazette	11.	Horizontal Exits	Refuge area	_____ m2, N/A	90	---	---
Gazette	11.	Horizontal Exits	Occupant per refuge area	_____ person	5	More than 0.28m2 per person, N/A	Comply
Gazette	11.	Horizontal Exits	Capacity of the reguge area for 1 bed	_____ bed, N/A	10	More than 2.8 m2 per bed, N/A	Comply

Checklist for Means of Egress

Part	Clause	Heading and Article	Checklist	Result of Check	Input	Criteria	Judgement
			Number of Exits				
Gazette	12.	Number of Exits	Classification of occupancy	A1,A2,A3,A4,A5,B,C,D,E,F,G,H,J	A2	---	N/A
Gazette	12.	Number of Exits	Classification of occupancy	A1,A2,A3,A4,A5,B,C,D,E,F,G,H,J	A2	---	23
Gazette	12.	Number of Exits	The number of Exit, considering maximum occupancy, Table-5		1		Comply
Gazette	12.	Number of Exits	Travel distance, Table-5	_____m	15.0	---	Comply
Gazette	12.	Number of Exits	In case of Residential building (except single family residence), the number of unit dwelling per floor, table-5		2	4 or less, N/A	Comply
Gazette	12.	Number of Exits	Occupant load	_____ person	90	---	2
Gazette	12.	Number of Exits	For all other buildings other than those in Table-5, the required number of exits		N/A		
Gazette	12.	Number of Exits	in case 10 storied or of more than 33 m height, and buildings having a floor area larger than 500 m2, minimum two exits are planned	Yes, No, N/A	Yes	Yes, N/A	Comply
Gazette	12.	Number of Exits	in case 10 storied or of more than 33 m height, and buildings having a floor area larger than 500 m2, it is planned to be fire resistant and lead directly to an open space or to a designated area of refuge	Yes, No, N/A	Yes	Yes, N/A	Comply
			Length of Travel				
Gazette	13.	Length of Travel	Building Type	A,B,C,D,E,F,G,H,J	A		25
Gazette	13.	Length of Travel	Travel distance, in case of more than one exit	Travel distance _____m .N/A	15.0	Type A, B, C, D, E, J - 25m F, H - 30m G - 45m	Comply

Checklist for Smoke and Heat Vents

Part	Clause	Heading and Article	Checklist	Result of Check	Example	Criteria	Judgement
Part IV	**2.6**		**Smoke and Heat Vents**				
Part IV	(a)	Smoke and Heat Vents	If there is an area of restricted ventilation, smoke and heat ventilation is designed. Area of restricted ventilation are followings: 1. Windowless buildings 2. Underground structures 3. Factories floor spaces of restricted ventilation	Yes, No, N/A	Yes	Yes, N/A	Comply
Part IV	(b)	Travel distance	If exit access travel distance is more than 23m, Smoke and heat vents is designed.	Yes, No, N/A	N/A	Yes, N/A	Comply
Part IV	(c)	The vent area and spacing of the vents	Occupancy(*)	Select from candidate, H1, H2, J1, J2, J3, J4, K1, K3	J2, J3, J4		0.033333333 1 22.5 30
Part IV	(c)	The vent area and spacing of the vents	Ratio of Vent and Floor Area		0.4		Comply
Part IV	(c)	The vent area and spacing of the vents	Max spacing of vent center	____ m	24		Comply
Part IV	(d)	Closures of natural draft, smoke and heat vents Installation for Fire service personnel	Fire service personnel can open closures of natural draft, smoke and heat vent easily.	Yes, No, N/A	Yes	Yes, N/A	Comply

Checklist for Smoke and Heat Vents

Part	Clause	Heading and Article	Checklist	Result of Check	Example	Criteria	Judgement
Part IV	**3.13**		**Smoke Proof Enclosure**				
Part IV	3.13.2	For High rise building	In case of high rise building, Exit stairways are protected by a smoke proof enclosure.	Yes, No, N/A	Yes	Yes, N/A	
Part IV	3.13.3	Vestibule	Vestibule to Enclosed stairway	Width corridor ___ m,	2.4		
				Width vestible ___ m,	2.3		Not Comply
				Length in direction of travel ___m	1.8	Length: 1.8m or over	Comply
Part IV	3.13.4	Fire resisting rating	Fire resisting rating of the walls forming a smoke proof enclosure around stairway	___ hours	4	4hours or more	Comply
Part IV	3.13.5	Self-closing door	All doors in smoke proof enclosure shall be self-closing type or fitted with automatic closing devices.	Yes, No, N/A	Yes	Yes, N/A	Comply
Part IV	3.13.6	Ventilation for Vestible	Each vestibule have minimum area of openings of 2 sqm divided into two in an exterior wall for natural ventilating.	Yes, No, N/A	No	Yes, N/A	Not comply
Part IV	3.13.7	Ventilation for Vestible	If staircase and/or vestibule are windowless, mechanical ventilation is designed.	Yes, No, N/A	N/A	Yes, N/A	Comply

Checklist for Fire Fighting

Part	Clause	Heading and Article	Checklist	How to input	Input	Criteria	Judgement
Part IV	**4.2**		**Fixed Type Fire Hydrant System**				
Part IV	4.2	Fixed Type Fire Hydrant	Building Hazard Type:	Light hazard- (L1 or L2)	L1	-	-
Part IV	4.2	Fixed Type Fire Hydrant	Building Heights	0~51m	0-51m	-	-
Part IV	4.2.1	Water Quantity for Fire	Duration of water discharge	___ min	30	Reference	Comply
Part IV	4.2.1	Flow rate	Flow rate of Standpipe and Hose	___ L/min	1000		Comply
Part IV	4.2.1	Flow rate	Flow rate of Sprinkler system	___ L/min	1000		Comply
Part IV	4.2.2.3	Storage Tanks	For standpipes, storage tanks	Floor Area ___ sqm			0
Part IV	4.2.2.3	Storage Tanks	For sprinkler system, storage tanks	Floor Area ___ sqm			0
Part IV	4.2.2.3	Storage Tanks	Storage Tanks volume are satisfy	Volume ___m3			Comply
Part IV	**4.3**		**Fixed Installation Other Than Water**				
Part IV	4.3	Fixed Installation Other Than	In case of "Foam installation", item	Yes, No, N/A		Yes, N/A	Not comply
Part IV	4.3	Fixed Installation Other Than	In case of "Vaporizing liquid	Yes, No, N/A		Yes, N/A	Not comply
Part IV	4.3	Fixed Installation Other Than	In case of "Dry powder	Yes, No, N/A		Yes, N/A	Not comply
Part IV	4.3	Fixed Installation Other Than	In case of "Gaseous installation",	Yes, No, N/A		Yes, N/A	Not comply
Part IV	4.3	Fixed Installation Other Than	In case of "Dry chemical	Yes, No, N/A		Yes, N/A	Not comply
Part IV	4.3	Fixed Installation Other Than	In case of "Wet chemical	Yes, No, N/A		Yes, N/A	Not comply
Part IV	4.3	Fixed Installation Other Than	Specification for fixed installation	Yes, No, N/A		Yes, N/A	Not comply
Part IV	**4.4**		**Portable Fire Extinguisher**				
Part IV	4.4	Portable Fire Extinguisher	Fire extinguishers is planed	Yes, No, N/A		Yes, N/A	Not comply
Part IV	4.4	Portable Fire Extinguisher	Portable Fire Extinguisher is	Yes, No, N/A		Yes, N/A	Not comply
Part IV	4.4	Portable Fire Extinguisher	In case of Fire Class A, covered	Hazard class			#N/A
				Floor area of Fire class A			
				Number of extinguisher			
Part IV	4.4	Portable Fire Extinguisher	In case of Fire Class A, travel	____ m			#N/A
Part IV	4.4	Portable Fire Extinguisher	In case of Fire Class B, travel	Hazard class			#N/A
				Extinguisher Rating			
				Travel distance __m			

Checklist for Fire Detection and Alarm System

Part	Clause	Heading and Article	Checklist	Result of Check	Example	Criteria	Judgement
Part IV	**4.6**	**Fire Detection and Alarm System**					
Part IV	4.6	Fire Detection and Alarm System	Type of fire detection	Detection type: _____	Automatic smoke and/ or Heat detection		-
Part IV	4.6	Fire Detection and Alarm System	Smoke detector or heat detector is designed for office, living rooms in the residential building and similar facility.	Yes, No, N/A	N/A	Yes, N/A	Comply
Part IV	4.6	Fire Detection and Alarm System	Smoke detector is designed for staircase, corridor, sleeping rooms in the residential building and similar facility.	Yes, No, N/A	Yes	Yes, N/A	Comply
Part IV	4.6	Fire Detection and Alarm System	Heat detector is designed for smoking room, kitchen, washroom, the place with high humidity and similar facility.	Yes, No, N/A	No	Yes, N/A	Not comply
Part IV	4.6	Fire Detection and Alarm System	Flame detector is designed for Atrium or theatre, the place with high ceiling.	Yes, No, N/A	N/A	Yes, N/A	Comply
Part IV	4.6	Fire Detection and Alarm System	Gas detector is designed for the area which have leakage risk of combustible gas and similar facility.	Yes, No, N/A	No	Yes, N/A	Not comply
Part IV	4.6	Fire Detection and Alarm System	Fire alarm system is designed.	Yes, No, N/A	No	Yes, N/A	Not comply

Checklist for Electrical Material and Equipment

Part	Clause	Heading and Article	Checklist	Result of Check	Example	Criteria	Judgement
Part VIII	**1.3**		**Over-current and Short Circuit Protection of Circuits**				
Part VIII	1.3.30	Over-current and Short Circuit Protection of Circuits	Over-current and Short Circuit protection are provided at the distribution boards for distribution board and sub-distribution board.	Yes, No, N/A	Yes	Yes, N/A	Comply
Part IV	**3.16**		**Means of Exit Signs and Illumination**				
Part IV	3.16	Means of Exit Signs and Illumination	Occupancy of Target building is A1, A2, or individual unit of A3.	Yes, No, N/A	No	-	-
Part IV	3.16	Means of Exit Signs and Illumination	If "No" for the above, Exit sign is designed on drawing.	Yes, No, N/A	Yes	Yes, N/A	Comply