National Tripartite Plan of Action on Fire Safety and Structural Integrity

Version 01G-2013

Guidelines for building assessments (structural & fire) for existing RMG factory buildings in Bangladesh

November 24, 2013

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PART A: Guidelines for assessment of structural integrity of existing RMG factory buildings in Bangladesh

1 Title, Committee, Scope and Definition

1.1 Title

The Guideline for assessment of structural integrity of existing RMG factory buildings in Bangladesh has been developed to provide a common platform for all concerned in the industry to assess the structural integrity of existing RMG factory buildings, and shall be referred to as 'this Guideline' for the rest of the document.

1.2 Technical Committee

This Guideline has been prepared by the Technical Committee of the *National Tripartite Working Group* on the National Tripartite Plan of Action on Fire Safety and Structural Integrity for RMG Sector in Bangladesh. Revisions and suggestions as suggested by the National Tripartite Committee are incorporated in this version.

1.3 Disclaimer

This Guideline is intended for use by professional structural engineers who are competent in evaluating the significance and limitations of its content and who will accept the responsibility for the application of the material it contains. The Guideline committee disclaims any and all responsibility for the stated principles, and shall not be liable for any loss or damage arising there from.

1.4 Scope and applicability

This Guideline shall apply only for the assessment of existing RMG factory buildings. Addition, alteration and expansion of existing RMG factory buildings will not be not covered by this guideline. The construction of any new RMG factory building, as well as addition, alteration, expansion of such buildings, shall be done as per the most updated version of the BNBC.

This Guideline establishes the minimum criteria for the assessment of structural integrity of existing RMG factory buildings against danger to life from building collapse. Criteria that are not specifically mentioned in this guideline shall be settled as per the provision of BNBC.

1.5 Definitions

BNBC shall mean BNBC 2006 except otherwise specifically mentioned.

All definitions as stated in BNBC 2006 shall apply to this Guideline except specifically defined herein.

Authority means the National Tripartite Committee on the National Tripartite Plan of Action on Fire Safety and Structural Integrity for the RMG Sector.

Engineering *team* means a team comprising two engineers having qualifications as stated in this guideline who have been registered by the authority to carry out assessments of structural safety of RMG buildings.

Existing RMG factory building means all buildings used as RMG factories, the construction of which is completed and an RMG factory is in operation at the time of adoption of this Guideline.

Review Panel means a panel of engineers, as defined in this guideline, who will have power to review the decision of any Engineering Team in the matter of factory closure, and may overturn the closure with a unanimous decision of the panellists.

Technical Committee means the Committee responsible for preparation of this guideline for safety assessment of existing RMG factory buildings.

2 Methods for design adequacy assessment

Buildings, structures and components thereof shall be assessed to have design adequacy to support all loads, including dead loads, without exceeding the specified strengths (under applicable factored loads) for the construction materials in the structural members and connections. The ultimate strength design method for RC structures and load factor design method for steel structure shall be the basis of assessment under this Guideline.

3 Safety margins

3.1 Safety of foundations and pile supported structures

The factor of safety for assessing the load capacity of a foundation pile under an existing RMG factory building structure that survived for more than five years after the last level of construction and did not show any sign of major distress in different structural members of superstructure shall be at least 1.5. In evaluating the geotechnical capacity of such a foundation, the drained strength parameters may be used.

3.2 Safety of RC structures

In the strength design method, the safety of RC members of a structure in ensured through the use of strength reduction factor ϕ and load factor ψ_L. These factors are used due to uncertainties involved in the evaluation of strength parameters and load acting on different structural members. The uncertainties about the strength of the structure (structural members) can be reduced where fieldwork has established the actual material strength of steel and concrete, the size, location and configuration of reinforcement, structural dimensions, the actual load acting on structural members and its distribution. This supporting work can serve as justification for using a different strength reduction factor (ϕ) for evaluation of safety and serviceability of existing buildings. The different load factors (ψ_L) (especially for live load) can also be considered for different load combinations during analysis.

Suggested values of ϕ for evaluation of structural safety for which uncertainty has been clearly reduced are reported in Section 20.2.5 of ACI 318-13. Experience and engineering judgment are very important in this regard.

When an analytical evaluation indicates that the existing structure does not satisfy the requirements of ACI 318/BNBC-2006, the building official may approve a lower load rating for the structure based on the results of such evaluation. Strict monitoring on the load intensity and distress propagation may also be recommended in such case.

For existing RMG factory buildings which are functioning comfortably (without showing distress to any structural member/minor distress in the form of cracks width less than 0.25mm) at a particular energy level, a reduced load factor may be recommended for live load/environmental loading (provided the existing energy level will not be disturbed) since the building is already experienced with the live load and some

environmental loading, like wind, creep, shrinkage, temperature change and settlement. A strict monitoring regarding the status of the crack (its extent of propagation and width change) may be recommended for minor cracks in structural members. Based on this discussion, a lower load rating for assessment of an existing structure is considered. The philosophy of reduced uncertainty and justification of using a lower load rating in the case of an existing structure is given in Appendix A.

4 Loading, load combination and restricted reduced loading

4.1 Live load

For the purpose of assessment of an existing RMG factory building, floor live loads for factory floors (sewing & finishing area excluding storage areas) shall be 2.0kN/m[1] (unless demonstrated otherwise analytically). Where factory operations, storage of materials, or equipment weights require live load capacity in excess of 2.0kN/m^2, appropriate allowance in the live load shall be made. Fabric storage areas may require load capacity in the order of 4 kN/m^2 to 9 kN/m^2 depending on the fabric type and densification pattern. The Engineering Team shall make its own assessment of the load capacity required in the storage areas as actual.

A certification letter stating the assessed capacity with accompanying load plans shall be prepared by the Engineering Team in accordance with Section 18 and made available at the factory site for review by the Authority.

During the detailed engineering assessment (Section 17.2), if the Engineering Team finds that the structure (or structural members) has capacity less than that for 2.0 kN/m^2, the assessed floor live load capacity shall be prominently posted on each column, with the following information:

'Reduced Floor Live Load Capacity in this Area: Maximum Permissible Live Load = xx kN/m^2 (xx psf)', where "xx" is the actual design live load capacity of that area as confirmed and documented by Engineering Team. The Engineering Team shall prepare a letter certifying the reduced load capacity for which the structure or part of it may be regarded safe with accompanying load plans prepared in accordance with Section 17.1 or 17.2 and shall be made available at the factory site for review **by the Authority**.

For floor areas designated as storage areas with required live load capacity in excess of 2.0kN/m^2, the actual floor live load capacity shall be prominently posted on each column, as required by Section 1.4.5 (Part 6) of the BNBC. A letter of certification with accompanying load plans and calculations shall be prepared in accordance with Section 17.2 and shall be made available at the factory site for review **by the Authority**.

Factory owners are required to provide clear guidelines to the floor managers regarding acceptable level of live load, including stacking of raw materials and finished products. It is required that at least one factory representative (Load Manager) who is located onsite full time should be trained regarding the structural floor capacity of the factory, and serve as an watchdog to ensure that the operational factory floor loadings are within the safe limit.

4.1.2 Load plans

Load Plans for every floor shall be prepared that reflect the actual use of the factory, including actual material and work product loads as typically stored at maximum density. Load plans will clearly show measured aisle widths and extent of loading areas. The factory owner at each floor level shall post load

plans, duly approved by the Engineering Team. Storage areas shall be clearly marked to indicate maximum allowable stored height of typical stacked materials.

4.1.3 Posting of floor live load

If load plans are prepared and displayed at each floor as per Section 4.1.2, floor live load posting as required by Section 4.1 above or BNBC 2006 Part 6 Paragraph 1.4.5 is not required.

4.2 Lateral load

The BNBC specified lateral loadings shall be considered for assessment of all existing RMG factory building structures.

4.3 Load combinations

The following load combinations may be considered for ***assessment of existing RMG factory building structures***:

RC Structures	Steel Structures
1. 1.2 D+1.6L 2. 1.05D+1.25L+1.0W (or 1.0E) (Lateral loads from all possible directions shall be considered)	1. 1.2 D+1.6Lf+0.5L_r 2. 1.2D+1.3W+0.5Lj+0.5L_r 3. 1.2D+1.5E+0.5L_f

D= Dead load, L=Live load, W=Wind load, E= Earthquake load, L_r=Roof live load, L_f=Floor live load.

This Guideline considers day-to-day loading conditions for assessment of existing RMG buildings considering life safety against building collapse. In this consideration, only service level lateral loadings are considered for RC structures. However, assessments should note any key seismic characteristics of buildings in the report. For steel structures the BNBC specified load factors are kept unchanged.

5 Assessment of material strength

In the case of a detailed engineering assessment, the material strength of the main structural members shall, in order of priority, be based on the following:

i. Test results (or manufacturer's certification) performed during the construction, if any,
ii. Results obtained during the assessment by NDT and/or core testing for concrete and test on steel sample collected from the structures.
iii. Strength parameters specified in the construction/design drawings duly verified by testing.

In the case of preliminary analysis and in absence of proper documentation of the structure, the Engineering Team may assume the following material properties, unless good engineering judgment indicates that lesser values should be assumed.

1) Reinforced concrete - 17.3MPa (2500 psi)
2) Reinforcing steel -415 MPa (60ksi) for construction from and after 2004 and 275MPa (40ksi) for construction earlier than 2004
3) Structural steel-A36 (248 MPa (36 ksi) yield strength)
4) Minimum assumed concrete density = 23.60 KN/m3 (150 pounds per cubic foot).

6 Durability and maintenance

Visual inspection should identify the areas of efflorescence and dampness. Water stagnation on the rooftop should be noted. Growth of moss and algae on roof surface indicates water logging and tendency for water absorption of the roof. Efflorescence and dampness may be visible in the ceilings (especially on the top-most floor) and in partition and peripheral walls. All maintenance work carried out up to the present time should be included in the inspection report. Reappearance of efflorescence and dampness should be dealt with seriously, as it can affect the durability of the building and shorten its service life.

7 Additions and alterations

No vertical or horizontal expansion of a factory shall be carried out without first conducting a full detailed engineering assessment (as per Section 17.2) that confirms the structural adequacy of both current and proposed configurations.

When an existing RMG factory building or structure is extended or otherwise altered, all portions affected shall be strengthened, if necessary, to comply with the safety and serviceability requirements provided in the BNBC. The installations of GSM towers on the roof top of any existing RMG factory building shall be critically examined against wind induced forces as per BNBC, using usual load factors, and shall be categorically mentioned in the assessment report. Such towers shall be removed from the building if they are found to adversely affect the safety of the building.

8 Equipment and fixtures

The following non-structural elements suspended from, attached to, or resting atop the structure shall be adequately anchored and braced to resist earthquake forces: *steam pipes, gas pipes, chemical pipes, storage racks, and other elements* identified at the discretion of the Engineering Team.

9 Further construction

When an existing RMG factory is expanded, the provisions of the BNBC (updated version) shall be applicable. All erection loads and other construction loads shall be considered for safety assessment and documented by the Engineering Team.

Temporary construction loading on an existing RMG factory during an expansion or other construction operation shall not compromise the safety of building occupants through overloading elements of the factory. Construction loading shall be properly reviewed to assess the safety of the structure.

10 Distressed members

The cause of distress in the main structural members shall be analysed during the detailed engineering assessment. A strengthening/retrofitting scheme shall be designed and documented by the Engineering Team if it is found that the distress is due to inadequate structural capacity. In any case, any distressed member should be properly repaired so as to ensure durability of the structure.

11 Vulnerable/critical members

Columns with high slenderness, flat plates and footings with inadequate thickness for shear etc. shall be identified as vulnerable critical members. The capacity of such member shall be critically examined and carefully remedied during the assessment.

12 Certification after retrofitting

After implementation of the retrofitting scheme, certification on its proper implementation shall be given by the firm/organisation responsible for supervision of the work and be countersigned by the concerned Engineering Team.

13 Qualifications of the engineering team who can assess and provide certification

Engineering teams shall comprise of at least two qualified professionals with a minimum total combined professional experience of 20 years and no member with fewer than five years professional experience. Teams may be comprised of either two structural engineers or one structural engineer and one geotechnical engineer. Each of the engineers shall have the following qualifications for applying to the Authority for registration as a team:

- Minimum B.Sc. Engg. (Civil or civil and structural or civil and geotechnical) from a recognised university
- IEB Member/Fellow
- Practicing as a structural engineer/geotechnical engineer or employed by an engineering consulting company/institution

Registration of all engineering teams who qualify to assess under this Guideline shall be given for a three-year period by the respective development authority (RAJUK/CDA or the like) in their respective jurisdiction. The Authority may revoke any such registration due to misconduct by the concerned person of any team.

14 New construction of an RMG factory

All new construction of RMG factory buildings shall be done as per the Bangladesh National Building Code, i.e. the most updated version of the BNBC that exists at the time of construction of the building.

15 Additional buyer/brand requirements

Other than the minimum requirements set forth in this Guideline, specific buyer or brand (or group) may set a higher level of guideline for assessment of structural safety of a RMG factory from which the brand would like to source its merchandise. However, compliance to such additional requirements is to be done on mutual agreement between the buyer/brand and the owner of the factory.

16 Structures with no proper documentation

Among the buildings that house RMG factories, there may be buildings that lack basic documentation to

provide evidence of physical design characteristics, such as element dimensions, reinforcing and material strengths, which could be used to readily confirm the structural safety of the factories. Despite lacking documentation, these factories may be considered as useful to the industry. The Engineering Team shall do the assessment of structural integrity of these factories in the following manner.

The Engineering Team appointed by the owner or any third party shall conduct a structural investigation to confirm the structural integrity of the factory building. The investigation and documentation shall be completed to certify the factory safe for operation from a structural point of view. The process shall include the following:

A. Conduct a geotechnical investigation at close vicinity of the structure.
B. Preparation of as-built drawings showing the following:
    1 Plan at each level with all walls, openings, expansion joints and locations and weight of major equipment
    2 Location and plan dimensions of columns at each level
    3 Location and thickness of shear walls
    4 Beam locations with dimensions
    5 Sectional drawings (showing thickness of floor finish, false slab etc.) with the number of levels above grade
    6 Floor to floor heights
    7 Any rooftop construction
    8 Reinforcement details of some columns at GF, 1st floor and roof top level determined using any scanning device or physical exposition.
C. The Engineering Team shall prepare load plans for each level that describe the current and intended future loading of the building, including any fixed equipment, water tanks, material storage areas and any other special loading conditions.
D. The Engineering Team shall state assumptions regarding strength and properties of key construction materials. Unless confirmed otherwise by testing in accordance with applicable ASTM test procedures, the Engineering Team shall determine the material properties as per Section 5 of this Guideline.
E. Conduct and document detailed structural/building condition assessment in accordance with ACI 437/ASTM 2018 or similar good engineering practices. The strength of concrete and amount of rebar in the columns shall be assessed by Schmidt Hammer/UPV/core test and scanning. A possible lower level (grade and amount) of rebars shall be assumed.
F. Conduct a detailed engineering assessment on the basis of prescribed loads to confirm the safety of the building as per this Guideline.
G. Prepare a report documenting the results of the assessment made and suggest appropriate remedial measures, if any.

17 Structural assessment methodology

Structural assessment and certification of safety of an existing RMG factory building shall be carried out in following three steps:

1 Preliminary visual assessment
2 Detailed engineering assessment
3 Design of retrofit scheme

17.1 Preliminary visual assessment

Preliminary visual assessment of an existing RMG factory building shall be conducted by the Engineering Team as per this section. A checklist for acquiring data is provided in Appendix B. The preliminary visual assessment shall include simple calculations to assess the basic capacity evaluation of some of the critical member/columns or foundations. After the preliminary assessment, the Engineering Team shall recommend if a detailed engineering assessment is necessary and provide a preliminary assessment certificate to the owner. A format of the preliminary assessment certificate is provided in Appendix B.

During the preliminary assessment, the Engineering Team shall provide necessary guidance to the factory owner to prepare a floor-wise load plan on A3-sized paper. The Engineering Team shall subsequently vet this load plan and the owner will have to display the floor load plan in an observable location on the floor.

Finding answers to the following questions may be helpful to assess the need for a detailed engineering assessment:

1) Is the vertical load system logical?	Yes/No	If all of these answers are yes, Preliminary Assessment may be sufficient and no further detailed analysis will be required. Detailed Engineering Assessment may be necessary if gross inadequacies are noticed during the preliminary assessment. However, in such cases the building may remain operational subject to conditions.
2) Is the lateral load system apparent and does it have redundancy?	Yes/No	
3) Are you satisfied with key structural elements such as columns, slender columns, flat plates, and transfer structures?	Yes/No	
4) Are you satisfied with the building performance in respect to foundation settlement?	Yes/No	
5) Is the structure free from any visible structural distress (progressive cracking) in main load-carrying members?	Yes/No	
6) Are you satisfied with any vertical or horizontal extensions visible?	Yes/No	
7) Are structural documents available?	Yes/No	

If a detailed engineering assessment is not to be carried out, there is a benefit to having in-situ testing of material strengths coupled with outline calculations.

17.2 Detailed engineering assessment

Every building is expected to have its design documents prepared in accordance with the provisions of Sec 1.9.1 of the BNBC. The minimum requirements for design review and construction observation shall be those set forth under Sec 1.9.2 and 1.9.3 respectively of the BNBC. This section applies to the buildings for which detailed design documentation is available with the owner. For factory buildings that lack proper documentation, the Engineering Team shall prepare detailed engineering drawings and follow the assessment methodology as per Section 16 of this Guideline. The Engineering Team needs to review the following documents for a comprehensive assessment:

1. Architectural drawings (as built)
2. Structural drawings (as built)
3. Geotechnical reports
4. Other structural reports
    i. Test results
    ii. Previous assessment reports

If these documents are not available, they are to be prepared under professional guidance.

The following steps shall be followed during the detailed engineering assessment:

1. The Engineering Team shall verify the design drawings and the as-built condition of the structure by preparing as built drawings showing all possible details of the structural and non-structural elements.
2. The Engineering Team shall carry out necessary investigations as per guidelines of ACI 437 to be satisfied about the strength of the constituent materials and rebar contents in the basic structural elements in at least two lower levels.
3. The Engineering Team shall prepare load plans for each level that describe the current and intended future loading of the building, including any fixed equipment, water tanks, material storage areas and any other special loading conditions.
4. The Engineering Team shall carry out a model-based analysis to assess the safety of the building with the dimensions, loading and strength parameters as actual as possible.
5. The Engineering Team shall carry out the assessment of the existing RMG factory building by following the strength and serviceability provisions of BNBC 2006. Alternatively, under special circumstances, the lower rate provisions of this guideline for assessment of the existing RMG factory buildings may be used for assessment of safety of the structure by following accepted international engineering practice. Expert opinion may be sought under Section 2.2.11 of BNBC (Chapter 2: Organisation and Enforcement) and/or application of Clause 1.5.2 of BNBC (Chapter 1: Purpose and Scope) may be utilised for this purpose.
6. The Engineering Team shall document all of its findings in a proper assessment report that shall contain the description of the structural assessment with basic design information as listed below:
    i. Basic design information of the structure
    ii. Any variation of the as-built condition w.r.t the designed structure
    iii. Results of investigative tests to determine the material strength as well as information on embedded reinforcement
    iv. Results of confirmatory geotechnical investigation
    v. Description of loading and detailed model used for analysis
    vi. Results showing adequacy/inadequacy of various components of the structure
    vii. Comment on the retrofitting need to restore structural safety as required

17.3 Retrofitting needs and implementation

When a structural member is identified to have gross design inadequacies in terms of either not meeting the requirements of strength limit states or serviceability limit states, an appropriate retrofit scheme shall be selected based on standard practice. Such deficiencies for primary load bearing elements such as columns or for punching of flat plates shall be remedied at least to have design adequacy for the actual loading condition, the building is being subjected to at the time of evaluation and also for load that may reasonably be expected for the building during its remaining life. Lateral load also may be reassessed considering that the code specified probability of exceedance of load for new structures with full structure life is supposed to come down gradually for old structures having less remaining life. Engineering judgment for any such reduction of lateral loads for existing RMG factory buildings depending on the age of the building should be conservatively made.

Standard retrofit techniques such as concrete jacketing, micro-concrete encasement, FRP wrapping etc. for strengthening of columns may be applied. Designing bracing systems may reduce column slenderness.

Beam and slab cracks may be repaired by epoxy injection. The use of elements such as ferro cement, micro-concrete and FRP may increase beam and slab strengths.

For implementation of retrofitting schemes, the construction firm/organisation shall have at least five years of experience of such work. All such retrofitting work should be done under guidance of the Engineering Team recommending it.

18 Certification of safety

Based on the preliminary visual assessment and/or detailed engineering assessment, the Engineering Team shall, under joint signature of both the members of the team, provide a certificate for the safe use of the structure. The certificate shall contain the full particulars of the team members including contact information. It should clearly indicate whether the assessed structure is compliant as per BNBC or it is safe for operation under this Guideline. In an appropriate case, the necessary conditions, load restrictions, monitoring requirements shall also be clearly indicated in the certification. All such certification shall become effective once the Authority vets it. Any recommendation of evacuation of the factory shall be effective immediately however, subject to the provision of peer review as per Section 19.

19 Review Panel

Any recommendation made by the Engineering Team towards closure of a factory for the reason of safety shall be automatically peer reviewed by the Review Panel within 48 hours of such decision. The Engineering Team shall submit the report to the factory owner for necessary evacuation and forward a copy of such report to the President of the BGMEA, who will convene and arrange visit of the members of the Review Panel to the respective site in the shortest possible time. The factory shall remain evacuated for safety, but the Engineering Team's report shall not be made public until the Review Panel gives its decision. The Review Panel will give their recommendation on continuing operation of the factory upon physical examination of the structure. The four engineer members of the review panel must make a unanimous decision in order to overturn the closure, The decision of the review panel shall be given within 48 hours of such closing, subject to all arrangements being made by BGMEA. The Review Panel shall be composed of seven members, of which four shall be engineers, as mentioned below; the Chief Inspector of Factories, one senior engineer representing the Accord, one senior engineer representing the Alliance and two senior professors from BUET who are not members of the Engineering Team, a representative of the BGMEA (not below the rank of vice president) and a representative from the workers union.

References:

1 Bangladesh National Building Code (BNBC), 2006
2 ACI 437R-03, Strength Evaluation of Existing Buildings
3 ASTM 2018, Standard Guide for Property Condition Assessments: Baseline Property Condition Assessment Process
4 ACI 318-11, Building Code Requirements for Structural Concrete

Appendix A: Philosophy of using lower load factors for an existing building

Philosophy of using lower load factors for an existing building

An existing building has already passed the construction phase and significant part of its useable life. It is therefore reasonable to assume that much of the uncertainties in strength parameters and loadings that a new (to be built) building might be subjected to are not applicable. The following scenarios explain the philosophy behind using a lower load rating (lower value of live load and/or lower overload factor) for safety assessment of an existing structure:

S = Strength of structure/structural member
Q = Load effect acting on structure
M→ = Safety margin
M=S - Q >0 Ensures safety of the structure

If the existing load effect is Q_E
and the Code specified service load effect for design is Q_c

The different scenarios can be as follows:

i	$S \geq Q$	
ii	$\phi S > Qc$	accepts the possibility of one failure in every 100 structures
iii	$S \geq \psi_L Qc$	accepts the possibility of one failure in every 1000 structures
iv	$\phi S \geq \psi_L Qc$	accepts the possibility of one failure in every 100,000 structures

Where
$\phi \rightarrow$Strength Reduction factor different values for different action and different member
$\psi_L \rightarrow$Load factor

During investigation for safety and serviceability assessment, the following possibilities may arise [$Qc \geq Q_E$]

i	$\phi S \geq \psi_L Qc \rightarrow$Compliant building
ii	$\phi S < \psi_L Qc \rightarrow$Noncompliant (but not unsafe)

$\phi_r S \geq \psi_{rL} Qc$	} →	Safe with reduced strength reduction factor (φ_r) and reduced load factors (ψ_r) No evacuation, but building health monitoring recommended
$\phi S > Qc$ $S > \Psi_L Qc$	} →	Load factor Ψ_L=1.0, No evacuation, but give some time for comprehensive investigation.
$\phi S \geq Q_E$ $S \geq \psi_L Q_E$	} →	No immediate evacuation, but immediate investigation recommended, continuous monitoring recommended
$S < Q_E$	→	Immediate evacuation, propping recommended

Where,
Qc = Code specified service load for design
Q_E = Load acting on the structure at present

Appendix B: Checklist for preliminary assessment for structural safety and reporting format for preliminary assessment for structural safety

Bureau of Research, Testing and Consultation (BRTC)
Bangladesh University of Engineering and Technology (BUET)

Building inspection form for evaluation of structural safety

Project ref no: _____

Building location/address: _____
Owner name: _____ Mobile no. _____
RAJUK/Pourashava/UP: _____ Approval for _____ story in year _____
Approval letter no. _____ Date _____

A. Building construction/As-built data
Construction period: Date of visit:

Phase of construction	Period: from/to	No. of story constructed

Total number of story to date:
Typical floor area: _____ sft per floor
Plan dimension: _____ ft. x_____ ft. Typical grid spacing:

Column Size (GF) : Interior _____ ; Exterior _____ ; Corner _____
Column Size ( ) : Interior _____ ; Exterior _____ ; Corner _____
Column Size ( ) : Interior_____ ; Exterior _____ ; Corner _____
Floor wise usage category: [A load plan showing actual use shall be prepared for different floors]

Floor/floor ht.	Approx live load + DL	Floor	Approx live load + DL	Floor	Approx live load + DL
Basement		4th floor		9th floor	
GF		5th floor		10th floor	
1st floor		6th floor		11th floor	
2nd floor		7th floor		12th floor	
3rd floor		8th floor		13th floor	

Equipment location and capacity:

Sub-station		
Generator		
AC plant		
Boiler		

B. Building design information
Name of design firm/engineer: _____ Qualification: Dipl./B.Sc/M.Sc./PhD
No. of stories (as designed): _____ Foundation type: _____
Structure system type: _____ Building designed as: _____
Critical structural element _____ Flat plate/flat slab/slender column _____

Materials used for construction			Contractor name: _____		
Member location	Design concrete f'c	Aggregate type	Actual f'c	Steel fy	QC test infor.
Foundation					
Column					
Beam					
Slab					

C. Drawing/test results availability:			
Rajuk/local authority approval drawing:		Soil test report	
Architectural working drawing:		Pile load test report	
Structural drawing:		Concrete test report (found)	
Foundation drawing:		Concrete test report (col)	
As-built drawing:		Steel test report	

D. Signs of distress (if any: owner to sign the declaration of Item I)

Member	Floor + grid	Description of distress	Date of appearance	Comments
Beam				
Column				
Slab/Floor				
Partition Wall				
Others				

E. Record of any crack repair:
F. Addition/alteration work:
G. Exposure to aggressive environment:
H. Immediate safety measures:
I. Declaration by owner (optional):

I declare that the information provided is the best description of the building and distress and no repair or conceal of the distress has been made so far. If there any sign of distress is noticed in the structure, I will inform it to the BUET team (01_____) without delay.

Name & Signature of the Owner/Engineer

Signature of BUET Team

Date:

Sample reporting format

Logo/particulars of the engineering team

Ref. No. Date:

REPORT ON PRELIMINARY ASSESSMENT OF STRUCTURAL SAFETY OF xxxx. AT yyyy

INTRODUCTION

Under the ILO-sponsored fire safety and structural integrity assessment program under the National Tripartite Plan of Action, the above named factory building at the above address, has been inspected for a preliminary assessment of structural safety. In order to observe visually the general physical condition of the superstructure and assess the scope of work, two members of the team comprising _____and_____ paid a visit to the building on _____. Senior management of the factory along with other related personnel were present during the visit.

BASIC INFORMATION

The factory building is a three storied RC frame building. The plan of the building was approved by the Local Government Engineering Department (LGED) as a six-storied building in 2002. As per verbal information by the user, it is gathered that the three-story building was constructed in 2002-2003 and is being used as garment factory. Three garment factories, namely _____ , _____ and _____ are housed on the ground, first and second floors of the building. It was reported that the building has no sign of distress. On the basis of visual observations, a study of design drawings of this building and discussion with the personnel present, the following information was noted:

i.	Building usage type:	Garment factory building
ii.	Fire and electrical safety:	Not in the scope of the report
iii.	Structural system:	RC frame building
iv.	Floor system:	RC beam supported slab with a double height waffle slab portico
v.	Floor area:	Approximately 2000 sq. m per floor
vi.	No. of stories:	Existing three story but designed for six story
vii.	Construction year:	2002-2003
viii.	Construction:	By owner under supervision of the XXX
ix.	Floor load:	Live load from garment manufacturing machinery
x.	Foundation type:	Isolated footing for most of the building and partly on pile foundation (as per drawing)
xi.	Design drawings:	Available
xii.	Soil boring report:	Available
xiii.	Construction materials:	Reinforced Concrete
xiv.	Generator:	Located on the ground floor

REPORTED DISTRESS HISTORY

There was no distress history reported.

OBSERVATIONS ON DISTRESS

The building is found to be without any noticeable distress under present level of loading.

Load Plan:

A load plan showing actual use of the factory at different floors has been vetted and enclosed herewith.

CONCLUDING REMARKS

- As per the drawing, the factory building of XX was designed as a XX storied building and it was constructed up to three-storied building in 2003. The building is used for a garment factory.
- It was observed that, due to poor roof drainage, rainwater remains stagnant in some parts of the roof. Drainage should be improved to prevent deterioration of the roof.
- At present there is no observed distress in the building and usage of the building may continue at the present level. Advice from the relevant design engineer should be sought for further vertical extension up to the designed level of six stories.

Disclaimer:

The above comments are made from visual observations of the exposed parts of the superstructure and the best engineering judgments of the visiting members, who do not bear responsibility for any deviation from the predicted behaviour of the structure caused by uncertainties of performance or calamities.

Sd/-

XXXXXX
Name and particulars
of member of the Engineering Team

sd/-

YYYYYY
Name and particulars
of member of the Engineering Team

Encl: Duly vetted load plan showing actual live load in different floors

Seal

PART B: Guidelines for assessment of fire and electrical safety of existing RMG factory buildings in Bangladesh

November 24, 2013

Part 1: General provisions

1 Introduction

The Building Construction Act of 1952 (Act II of 1953) was modified through the Building Construction (Amendment) Act, 2006 (#15-Act/2006). The Act II was further modified through the addition of a new section (18A) which gives the power to carry out the said Act through the development of the Bangladesh National Building Code (BNBC) (SRO-84.Law/2006). The BNBC was empowered to provide for:

a) General building requirements, control and regulations;
b) Fire protection;
c) Building materials;
d) Structural design;
e) Construction practices and safety;
f) Building safety;
g) Alteration, addition to and change of use of existing buildings;
h) Sign and outdoor display; and
i) Material relating to administration and enforcement of the above matters.

The following chapters have been written based on the BNBC for the use of the Moderate Hazard Industries (G2) specifically addressing primarily the Life Safety issues related to the ready-made garments industries.

1.1 Title

The Fire and Electrical Safety Guidelines developed herein with the objective to identify the compliance of G2 Type occupancy (focusing on ready-made garments) in order to assure safety to human lives and property will be referred to as “the Standard” or “this Standard”.

1.2 Scope and applicability

The purpose of this guideline is to establish minimum standards for assessing building adequacy for fire and electrical safety through survey and investigation of existing industrial buildings in the G2 occupancy category and other related occupancy categories in ready-made garments factories, as specified in the BNBC. Addition, alteration, expansion of existing factory buildings shall not be covered by these guidelines. The installation and use of certain equipment, services and appurtenances related, connected or attached to such buildings are also examined herein to achieve the same purpose.

The provisions of these guidelines are applicable to all persons of Bangladesh irrespective of class, creed, culture, religion or sex. The guideline does not in any way create, otherwise establish or designate any particular class or group of persons who will or should be specially protected or benefited by the provisions of this guideline.

The expressed intent of this guideline is to assess human safety from fire and electrical hazards in the said industrial buildings.

If for any case different sections of these guidelines provide different specifications for materials, methods of design or construction, or other requirements, the most restrictive specification shall govern.

In case of any conflict between a general requirement and a specific requirement, the specific requirement shall be applicable.

Inspection conducted or permission granted for any building or plan of building, under the provisions of these guidelines, shall not be construed as a warranty of the physical condition of such building or the adequacy of such plan. Neither the Authority administering the guideline, nor any employee thereof shall be liable in tort for damages for any defect or hazardous or illegal condition or inadequacy in such building or plan, nor for any failure of any component of such building which may occur subsequent to such inspection or granting of permission under the provisions of the guideline.

In general, this guideline was developed based on the BNBC 2006 with the primary focus on assessing the safety of workers with respect to fire and electrical issues in the existing ready-made garments factories in Bangladesh. A few sections in this guideline have been modified to explicitly address the existing conditions of ready-made garments factories in Bangladesh. Those modifications have been separately noted in the corresponding sections.

1.3 Definitions

BNBC shall mean Bangladesh National Building Code 2006 except otherwise specifically mentioned.

All definitions as stated in BNBC 2006 shall be applicable to this Guideline except specifically defined herein.

Authority means the National Tripartite Committee under the Ministry of Labour and Manpower, Government of Bangladesh.

Committee means Technical Sub-Committee constituted to develop the common standard for safety assessment of the G2 Type Occupancy (especially ready-made garments) buildings by the Ministry of Labour and Manpower, GoB.

Technical Team means a team comprising of engineers and architects having qualifications as stated in this guideline who have been registered by the authority to carry out assessment of fire and electrical safety of the G2 Type Occupancy (especially ready-made garments) buildings.

1.4 List of laws, by-laws and statutory regulatory orders

i. Construction Act 1952
ii. The Building Construction (Amendment) Act, 2006
iii. S.R.O. 84-Law/2006 (BNBC)
iv. Fire Prevention and Extinction Act 2003
v. Fire Service Rules, 1961
vi. Bangladesh Labour Act 2006
vii. Bangladesh Labour Act (Amendment) 2010
viii. Bangladesh Labour Act (Amendment) Law No. 30 2013
ix. S.R.O. 101/78/LSWVI/11(4)/78 called as Factories Rules 1979
x. The Electricity Act 1910
xi. The Electricity Rule 1937
xii. The Electricity Regulations 1937
xiii. The Rural Electrification Board Ordinance 1977
xiv. Bangladesh Gs Law 2010
xv. The Bangladesh Energy Regulatory Commission Act 2003
xvi. The Bangladesh Energy Regulatory Commission License Regulation 2006
xvii. Renewable Energy Policy of Bangladesh 2008
xviii. Bangladesh Environment Preservation Act 1995
xix. The Environment Conservation Rules 1997

xx. Boiler Act 1923
xxi. Petroleum Act 1934
xxii. Mineral, Gas Safety Rules 1991
xxiii. Fire Service Rules 1961

1.5 Methodology for fire and electrical safety assessment

Assessment of fire and electrical safety of a RMG building will be done through a two-step process by a team of engineers and architects, with at least ten years experience as an engineer/architect:

1. Preliminary assessment
2. Detailed assessment

Approach

The process of preliminary assessment of fire and electrical safety of an RMG building is done through collection of data during one and/or multiple field visits to the building followed by analysis of collected data. The results of the analysis will provide the information about the current status of the building/factory regarding fire and electrical safety as well as any need for detailed assessment/subsequent modifications by the owner of the building and/or the RMG factory to attain the required safety standard.

Preliminary assessment

The purpose of the preliminary assessment is to identify the major violations of the fire and electrical safety provisions stipulated in the guideline that are likely to be hazardous to human life in the RMG factory.

Preliminary assessment of an existing RMG factory building will be done through collection of field data on two groups of separate but inter-related parameters of the concerned building, namely:

1 Fire safety-related parameters
2 Electrical safety-related parameters

Detailed assessment

The detailed safety assessment is a systematic approach to evaluate potential hazards and recommend suggestions for improvement, which will identify deterioration of building elements/equipment, built-in facilities for fire prevention and fighting, areas of risks or vulnerability, hazards and possibility of accidents. This identification helps to determine actions to minimize hazards, and to ensure that the whole safety arrangement is effective and efficient. Comprehensive field data collection, measurement/testing and subsequent detailed calculation and analysis of the collected data are the major steps of the detailed assessment.

Part 2: Planning and designing for fire safety

2.1 Scope

The provisions of this part shall control the planning, design, installation and management of spaces, equipment and built-in facilities required for fire prevention and fighting in the premises as well as within the building. The standards of this part are based on BNBC 2006 and are applicable for all G2 type industrial buildings (whether the provisions are required by BNBC 2006 or by the owner/user), and the provisions stated herein shall not cover the fire fighting requirements outside the building premises. Tables and graphs used are from BNBC 2006 and are numbered as in BNBC.

2.2 Fire prevention by occupancy and layout categorisation

2.2.1 Occupancy classification: RMG industry building

2.2.1.1 Occupancy classification
(BNBC §1.3 Page 10304)

All buildings shall be classified according to their use or by considering the character of their occupancy. For the purpose of this Guideline, the occupancy classification groups shall be as follows:

Occupancy	A:	Residential
Occupancy	B:	Educational
Occupancy	C:	Institutional
Occupancy	D:	Health Care
Occupancy	E:	Assembly
Occupancy	F:	Business and Mercantile
Occupancy	G:	Industrial
Occupancy	H:	Storage
Occupancy	J:	Hazardous
Occupancy	K:	Miscellaneous

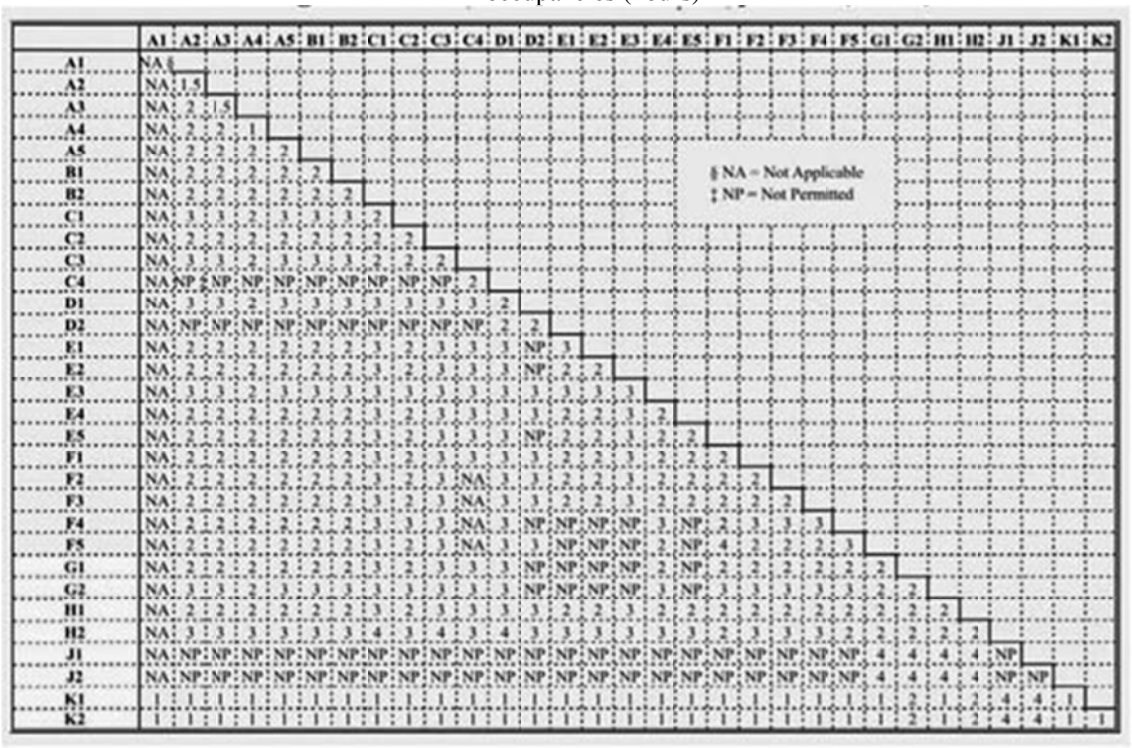
2.2.1.2 Occupancy G: Industrial buildings
(BNBC § 2.1.7 Page 10348)

G2 (Moderate Hazard Industries): These shall include any industrial building in which the contents are moderately combustible and the industrial processes conducted therein are liable to give rise to a fire which will spread with moderate rapidity, giving off considerable smoke, but in which the danger of toxic fumes, biological contamination, radiation or explosions is non-existent.

2.2.2 Mixed occupancy
(BNBC §2.3 Page 10351)

When a building is utilised for more than one occupancy or purpose, each part having a distinct occupancy as defined in BNBC § 2.1 (Page 10343) shall be separated from any other occupancy as specified in Table 2.1. Each portion of the building shall comply with the requirements of this guideline for the occupancy it accommodates. If separation is not provided as specified in Table 2.1, the building shall conform to the requirements of the most hazardous of the occupancies.

Table 2.1: Fire resistance rating requirements for separating walls and floor/ceiling assemblies between mixed occupancies (hours)



(BNBC Table 3.2.1 Page 10352)

2.2.2.1 Non-separated uses

The following occupancies are not required to be separated from uses to which they are accessory:

- Assembly rooms having a floor area not more than $75m^2$
- Administrative and clerical offices and similar offices not exceeding 25 per cent of the floor area of the major occupancy and not related to Occupancy J (Hazardous Buildings)
- Administrative offices, gift shops and other similar uses in Occupancy A (Residential Buildings) provided the use does not exceed 10 per cent of the floor area of the major occupancy
- Kitchens associated with a dining area
- Carports having at least two sides entirely open associated with Occupancy A
- Parking or storage of motor vehicles associated with Occupancy F4 (Garages and Petrol Stations)
- Fuel dispensing pumps covered with a canopy with opening on at least three sides associated with Occupancy F2 (Small Shops and Markets) provided the following conditions exist:

    i. The Occupancy F2 is provided with two exits separated by a distance of at least one-half the maximum diagonal dimension of the building or area to be served and not located in the same exterior wall.
    ii. The pump islands are located more than 6 meters away from the Occupancy F2.

2.2.2.2 Forms of occupancy separations

Portions of a building having different occupancies shall be separated with horizontal or vertical or of any other form of separation as may be required to achieve a complete separation.

2.2.2.3 Types of occupancy separation

The occupancy separations shall be classified as follows:

a) Four-hour fire resistive: The four-hour fire resistive separation shall have no openings therein and shall provide a fire resistance of at least four hours.

b) Three-hour fire resistive: The three-hour fire resistive separation shall provide a fire resistance of not less than three hours. The total width of all openings in any one storey shall not exceed 25 per cent of the length of the wall in that storey and no single opening shall have an area greater than $12m^2$. The openings shall be protected with a fire resistance assembly providing a fire resistance of at least three hours.

   In case of a floor having a three-hour fire resistance rating, the openings shall be protected by vertical enclosures extending above and below such openings. The walls of such vertical enclosures shall be of a construction offering at least two hours of fire resistance. All openings in the walls of these vertical enclosures shall be protected with fire assembly having a fire resistance rating of at least one and a half hours.

c) Two-hour fire resistive: The two-hour fire resistive separation shall be of a construction having a fire resistance rating of not less than two hours. All openings in such separations shall be protected with a fire assembly of a fire protection rating of at least one and a half hours.

d) One-hour fire resistive: The one-hour fire resistive separation shall be of at least one-hour fire protection construction. All openings in such separations shall be protected with a fire protection assembly of at least one-half hour fire resistance.

2.2.3 General requirements for all occupancies
(BNBC §2.4 Page 10354)

2.2.3.1 Location on property

All buildings shall have access to a public road or yard on at least one side of the property.

Fire separation distance of the exterior wall of a building shall be measured from the building face to the adjacent property line. For the purpose of this section, the centre line of an adjoining public way shall be considered an adjacent property line. For two buildings on the same plot an imaginary line equidistant from both buildings shall be considered as the relevant property line.

The exterior walls shall have a fire resistance and opening protection as specified in Tables 2.2 and 2.3 and in accordance with such additional provisions as set forth in BNBC Part 4.

Table 2.2: Fire resistance rating of exterior walls (in hours) for various occupancy groups

Fire separation distance	Occupancy				
	A1, K1, K2	A2, A4	A3, A5,B, C, D, E, F1, F2, G1	F3, F4, F5, G2, H1	H2, J
Up to 1.5 m	1	1	2	3	4
Greater than 1.5 m and up to 3 m	N	1	1	2	3
Greater than 3 m and up to 4.5 m	N	N	N	1	2
Greater than 4.5 m and up to 9 m	N	N	N	N	1
Greater than 9 m	N	N	N	N	N

N = No requirements

(BNBC Table 3.2.2 Page 10355)

Table 2.3 Requirements for opening protection assembly based on fire resistance rating of exterior walls

Fire resistance rating of wall (in hours)	Fire resistance required for opening assembly (in hours)
4	Not permitted
3	3
2	1.5
1	0.5
N	No requirements

(BNBC Table 3.2.3 Page 10355)

Projection beyond exterior building line shall be limited to the sunshade line as specified in BNBC § 1.7.12.4 Page 10317.

When openings in exterior walls not to be protected due to distance from the property line, the aggregate area of such openings shall not exceed 50 per cent of the total area of the wall in each storey.

Note:
The above is related to property protection issues and is not a life safety issue in existing readymade garments factories, thus will not be applicable in the assessment of such buildings.

2.2.3.2 Allowable floor areas

The total area of the building shall comply with Sec 2.4.2.

The area of the mezzanines shall be included in the area of the floor where the mezzanines are located, unless they are considered as separate floors.

A basement floor area need not be included in the total available area of the building provided it is used for car parking, electrical or mechanical plant or service room. For other uses or occupancies in the basement, the floor area shall be included in the total area of the building.

Note:
The above is related to property protection issues and is not a life safety issue in existing readymade garments factories, thus will not be applicable in the life safety assessment of such buildings.

2.2.3.3 Permitted types of construction
(BNBC § 2.4.3 Page 10355)

The types of construction for any occupancy shall conform to the specifications set forth in Table 2.4.

Table 2.4: Permitted types of construction and fire zones for various occupancy groups

Occupancy	Permitted types of construction	Fire zone
A B C D E F1, F2, F3 H1 K	1, 2 or 3	1
F4, F5 G H2	1 or 2	2
J	1	3

(BNBC Table 3.2.4 Page 10356)

The above is related to property protection issues and is not a life safety issue in existing readymade garments factories, thus will not be applicable in the life safety assessment of such buildings.

2.2.4 Requirements for Occupancy G - Industrial buildings
(BNBC § 2.11 Page 10368)

Buildings shall be classified as Occupancy G in accordance with BNBC § 2.1.7 (Page 10348). A non-exhaustive and indicative list of moderate hazard industrial uses is presented in Table 2.5. Storage and use of hazardous materials shall not exceed the exempt amount specified in BNBC § 2.13.1.3 (Page 10376).

Table 2.5: Moderate hazard industrial uses

1. Aircraft
2. Appliances
3. Athletic equipment
4. Automobiles and other motor vehicles
5. Bakeries
6. Beverages (alcoholic)
7. Bicycles
8. Boat building
9. Bailer works
10. Brooms or brushes
11. Business machines
12. Cameras and photo equipment
13. Canneries, including food products
14. Clothing
15. Condensed and powdered milk
16. Construction and agricultural machinery
17. Disinfectants
18. Dry Cleaning using other than flammable liquids in cleaning or dyeing operations
19. Electric light plants and power houses
20. Electrolytic reducing works
21. Electronics
22. Engines, including rebuilding or reconditioning
23. Film, photographic
24. Food processing
25. Furniture
26. Garments industries
27. Hemp and Jute products
28. Laundries (mechanized)
29. Leather and tanneries, excluding enareding or japanning
30. Machinery
31. Mill works, and woodworking, wood distillation and particle boards
32. Motion picture and television filming
33. Musical instruments
34. Pharmaceutical
35. Paper mills or products

36.	Packaging
37.	Plastic products
38.	Printing or publishing or dyeing and printing
39.	Recreational vehicles
40.	Refuse incinerators
41.	Shoes
42.	Soaps and detergents
43.	Sugar production and refineries
44.	Textile and jute mills including canvas, cotton cloth, bagging burlap, carpet and rags
45.	Tobacco
46.	Trailers
47.	Upholstery and manufacturing shop

(BNBC Table 3.2.6 Page 10371)

2.3 Classification of building construction types based on fire resistance

(BNBC § 3.1 Page 10382)

2.3.1 Classification by type of construction

For the purpose of this Guideline, there shall be three types of construction based on fire resistance (Tables 2.6 and 2.7):

Type 1:	Highest degree of fire resistance
Type 2:	Intermediate degree of fire resistance
Type 3:	Lowest degree of fire resistance

2.3.1.1 Permissible types of construction for various occupancies

New buildings

Types of construction permitted for various buildings on the basis of fire zones are specified in Table 2.4.

Existing buildings

Existing buildings in any fire zone need not comply with the provision of this guideline for type of construction unless they are altered or in the opinion of the Authority they constitute a hazard to the safety to the occupants of the buildings or the adjacent properties.

Note:

Existing high-rise RMG factory buildings (height exceeding 20m) will be of Type -1 construction using non-combustible materials. The fire resistance rating requirements for the existing buildings less than 20m high should follow those specified in the guidelines. Fire Services and Civil Defence regulations on construction on rooftop shall be followed.

2.3.2 Exterior walls

The fire resistance rating of the exterior walls shall conform to the provisions set forth in Table 2.2 and 2.3.

Note:
The above is related to property protection issues and is not a life safety issue in existing ready-made garments factories, thus will not be applicable in the life safety assessment of such buildings.

2.3.3 Mixed occupancy separation

When a building accommodates more than one occupancy, each such occupancy shall be separated from the others according to the provisions specified in Sec 2.2.2.

2.3.4 Basement floor

The basement floor of a building shall be enclosed with a one-hour fire resistive construction. Doors in such constructions shall be made of non-combustible materials.

Note:
When the basement is connected to the ground floor through openings, proper protection against smoke shall be provided.

2.3.5 Restricting vertical spread of fire

2.3.5.1 Interior walls

Propagation of fire, smoke, gas or fume through the voids of fire resistive floors and walls shall be restricted by sealing such voids with an approved material which shall have a fire resistance rating of at least equal to that of the floor-wall assembly. The sealing material shall be capable of preventing passage of flame and hot gases sufficient to ignite cotton waste when tested in accordance with ASTM E119-8.

Note:
Relevant international standards equivalent to ASTM E119-8 provided in Appendix I shall also be considered in this context.

2.3.5.2 Exterior walls

Openings in the exterior wall in two consecutive floors lying within 1.5 m laterally shall be separated with a flame barrier projecting at least 75 cm from the external face of the exterior wall. The flame barrier shall have a fire resistance rating of not less than three quarters of an hour.

Note:
The above is related to property protection issues and is not a life safety issue in existing readymade garments factories, thus will not be applicable in the life safety assessment of such buildings.

Table 2.6: Required fire resistance rating of building elements (in hours) for various types of construction

Building element	Type of Construction		
	Type	Type 2	Type 3
(1) Exterior bearing walls	4	2	1
	------ (see Note a) ------		
(2) Exterior non-bearing walls and curtain walls	2	1.5	1
	------ (See Note a) ------		
(3) Interior bearing walls, bearing partitions, columns, girder trusses (other than roof trusses) and framing			
a) Supporting more than one floor	4	2	2
b) Supporting one floor only or a roof only	3	1.5	1
(4) Structural frame and structural members supporting wall	3	1.5	1
	------ (See Note b) ------		
(5) Floor construction including beams	3	1.5	1
(6) Roof construction, including beams, trusses and framing, arches and roof deck			
a) 5m or less in height to lowest member	2	1.5	1
b) More than 5 m but less than 7 m in height to lowest	1	1	1
c) 7 m or more in height to lowest member	0.5	0.5	0.5
(7) Fire walls and party walls	4	2	2
	------ (see Note c) ------		
(8) Enclosure of fire exits	2	2	2
(9) Shafts (other than exits) and elevator hoistways	2	2	2
(10) Access corridors leading to fire exits	1	1	1
(11) Vertical separation of tenant spaces	1	1	1
(12) Non-bearing partition walls	0.5	0.5	0.5
(13) False/suspended ceilings	0.5	0.5	0.5
(14) Smoke barriers	1	1	1
(15) Mixed occupancy separation	------ (See Note d) ------		

Note:
A: Not less than the rating based on fire separation distance (see Table 3.2.2)
B: Not less than fire resistance rating of wall supported
C: Not less than the rating required in Table 3.2.1
D: Fire resistance ratings of mixed occupancy separation, where permitted, shall be as required in Table 3.2.1.

(BNBC Table 3.3.1 Page 10383)

Table 2.7: Fire resistance rating of common construction elements

Structural element	Fire resistance rating
1. SOLID WALLS	
a. 75 mm thick walls of clay bricks	0.75 hour
b. 125 mm thick walls of clay bricks	1.5 hours
c. 250 mm thick walls	5 hours
2. RC WALLS	
a. 150 mm thick RC wall	3 hours
b. 200 mm thick RC wall	4 hours
c. 250 mm thick RC walls	5 hours
d. 300 mm thick RC walls	6 hours
3. RC SLABS	
a. 100 mm RC slabs with 13 mm cover over reinforcement	1 hour
b. 150 mm RC slabs with 19 mm cover over reinforcement	2.5 hours
c. 200 mm RC slabs with 19 mm cover over reinforcement	3.75 hours
d. 250 mm RC slabs with 25 mm cover over reinforcement	5 hours
4. RC COLUMNS (1:2:4)	
a. 250 mm x 250 mm with 25 mm cover over reinforcement	3 hours
b. 300 mm x 300 mm with 25 mm cover over reinforcement	4 hours
c. 400 mm x 400 mm with 25 mm cover over reinforcement	6 hours
d. 400 mm x 400 mm with 50 mm cover over reinforcement	8 hours

(BNBC Table 4.1.1 Page 10409)

2.3.6 Exceptions to fire resistance requirements

The provisions of this section are exceptions to the occupation separation requirements of Table 2.1.

2.3.6.1 Fixed partitions

a) Stores and offices: In such cases where offices, stores and similar places occupied by one tenant are separated by non-load bearing walls that do not form a corridor serving an occupant load, the partition walls may be constructed of any one of the following:

- Non-combustible materials;
- Fire retardant treated wood;
- One hour fire resistive construction;

- Wood panels or similar light construction up to three fourths the height of the room in which placed; and
- Wood panels or similar light construction more than three-fourths the height of the room in which placed with not less than upper one fourth of the partition constructed of glass.

b) Folding, portable or movable partitions: Folding, portable or movable partitions need not have a fire resistance rating if the following conditions are satisfied:

- Required exits are not blocked without providing alternative conforming exits;
- Tracks, guides or other approved methods are used to restrict their locations; and
- Flammability shall be limited to materials having a flame-spread classification as set forth in Tables 2.8 and 2.9 for rooms or areas.

Table 2.8 Flame spread classification

Class	Flame Spread Index
I	0-25
II	26-75
III	76-200

(BNBC Table 3.3.2 Page 10386)

Table 2.9 Maximum flame spread class

Occupancy group	Enclosed vertical exit ways	Other exit ways	Rooms or areas
E	I	II	II
B	I	II	III
C, D	I	I	II
J	I	II	III
F, G, H	I	II	III
A2, A5	I	II	III
A1, A3, A4	III	III	III
K	No restrictions		

(BNBC Table 3.3.3 Page 10386)

c) Walls fronting on streets or yards: For walls fronting on a street or yard having a width of at least 12m, certain elements of the wall may be constructed as follows regardless of their fire-resistive requirements:

i. Bulkheads below show windows, show window frames, aprons and show-cases may be of combustible materials provided the height of such construction does not exceed 5 m above grade.

ii. Wood veneer of boards not less than 25 mm in nominal thickness or exterior type panels not less than 10 mm in nominal thickness may be used in walls provided:

- The veneer does not extend beyond 5 m above grade; and
- The veneer is placed either directly against non-combustible surface or furred out from such surfaces not to exceed 40 mm with all concealed spaces fire blocked.

d) Trim: Wood may be used to construct trim, picture moulds, chair rails, baseboards, handrails and show window backing. If there is no requirement for using fire-protected construction, unprotected wood doors and windows may be used.

e) Loading platform: Non-combustible construction of heavy timber may be used for exterior loading platforms with wood floors not less than 50 mm in nominal thickness. Such wood construction shall not be carried through the exterior walls.

f) Insulating boards: Combustible finished boards may be used under finished flooring.

2.3.7 Shaft enclosures

2.3.7.1 General

Construction requirement for shafts through floors shall conform to the provisions of Table 2.6.

2.3.7.2 Extent of enclosures

Shaft enclosures shall extend from the lowest floor opening through successive floor openings and shall be enclosed at the top and bottom.

Exceptions:

- Shafts need not be enclosed at the top if it extends through or to the underside of the roof sheathing, deck or slab.
- Non-combustible ducts carrying vapours, dusts or combustion products may penetrate the enclosure at the bottom.
- Shafts need not be enclosed at the bottom when protected by fire dampers conforming to "Test methods for fire dampers and ceiling dampers" (U.B.C. Standard No. 43-7), installed at the lowest floor level within the shaft enclosure.

2.3.7.3 Special provision

In groups other than Occupancies C and D, openings which penetrate only one floor and are not connected with any other floor or basement and which are not concealed within building construction assemblies need not be enclosed.

2.3.7.4 Protection of openings

Openings in shaft enclosures shall be protected with a self-closing or an automatic-closing fire assembly having a fire resistance rating of

i. One hour for one-hour fire resistive walls
ii. One and a half hours for two-hour fire resistive walls

2.3.8 Expansion and contraction joints

Expansion and contraction joints provided to accommodate expansion, contraction, wind or seismic movement shall be protected with an approved material having the same degree of fire resistance as that of the wall or floor in which it is installed.

2.4 General height and area limitations

Note:
The following sections under article 2.4 "General height and area limitations" are related to property protection and delineation issues applicable to the construction of new buildings and are not life safety issues in existing ready-made garments factories, thus will not be applicable in the assessment of such buildings.

2.4.1 Height limitations based on road width
(BNBC §1.8.2 Page 10318)

The maximum height of any building of Type 1 construction shall not exceed the nominal value of two times the sum of the width of the front road and the front open space (distance between the front property line and the building). For the purpose of fulfilling this requirement, the height limitations specified in Table 2.9 shall apply.

For plots having front road width not less than 23 m in an approved residential or business and mercantile area, there shall be no restriction on height for residential and business & mercantile buildings of Type 1 construction, provided the minimum open space requirements specified in Table 2.10 are satisfied.

For Type 2 construction, the maximum permissible height of the building shall be 4 storeys or 14 m for values of two times the sum of the width of the front road and the front open space not less than 13.6 m.

For Type 3 construction, the maximum permissible height of the building shall be 3 storeys or 11 m for values of two times the sum of the width of the front road and the front open space not less than 13.6 m.

For buildings more than six storeys or 20 m high, the following arrangements shall be provided:

a) Lifts of adequate size, capacity and number
b) Adequate fire protection and fire fighting arrangements
c) Separate emergency fire escape stair

For buildings in the vicinity of airports or aerodromes, the height shall be limited by the requirements of the civil aviation authority, city or area development authority or other concerned agencies of the Government.

Table 2.9 Height limitations based on road width and front open space

2 times (Front road width plus front open space)	Maximum permissible height					
	Type 1		Type 2		Type 3 [3]	
	No. of storeys	Height (m)	No. of storeys	Height (m)	No. of storeys	Height (m)
Below 10.6 m	3	11	2	8	2	8
10.6 m to below 13.6 m	4	14	3	11	2	8
13.6 m to below 16.6 m	5	17	4	14	3	11
16.6 m to below 19.6 m	6	20	4	14	3	11
19.6 m to below 22.6 m	7	23	4	14	3	11
22.6 m to below 25.6 m	8	26	4	14	3	11
25.6 m to below 28.6 m	9	29	4	14	3	11
28.6 m to below 31.6 m	10	32	4	14	3	11
31.6 m to below 34.6 m	11	36	4	14	3	11
34.6 m to below 37.6 m	12	39	4	14	3	11
37.6 m to below 40.6 m	13	42	4	14	3	11
40.6 m to below 43.6 m	14	45	4	14	3	11
43.6 m to below 46.6 m and so on in increments of 3 m	15	48	4	14	3	11

Note:
1. For plot with front road width (Sec 1.8.2.5) not less than 23 m, residential and business and mercantile buildings of Type 1 construction shall have no height restriction subject to additional open space requirements (Sec 1.8.2.2).
2. The maximum permissible height for Type 2 construction is 4 storeys or 14 m (Sec 1.8.2.3)
3. The maximum permissible height for Type 3 construction is 3 storeys or 11 m (Sec 1.8.2.4)

(BNBC Table 3.1.9 Page 10319)

Table 2.10 Minimum open space requirements for buildings of unlimited height and area

Occupancy	Minimum open space		
	Front (m)	Rear (m)	Side (m)
Residential	4.0	6.0	4.0
Business and mercantile or other	6.0	6.0	6.0

(BNBC Table 3.1.10 Page 10320)

2.4.2 Area limitations based on FAR
(BNBC §1.3.8 Page 10320)

The limiting total building area for different classes of occupancy and types of construction shall be based on the maximum permissible floor area ratio (FAR). For the purpose of this section, FAR shall be calculated as the total floor area of the building in all the storeys divided by the area of the plot.

The maximum permissible values of FAR for different classes of occupancy and types of construction shall be as specified in Table 2.11.

The FAR values specified in Table 2.11 are based on the following considerations:

a) That the approach roads to the plots do not suffer from traffic congestion problems of a serious nature;
b) That the use of the plot as well as that of the others in the area conform with the land use classification indicated in the master plan;
c) That adequate off street car parking facilities are created in conformity with the provisions of this guidelines;
d) That adequate utility services such as gas, electricity, water supply, drainage etc. are provided in accordance with the requirements of this guideline;
e) That fire fighting facilities are available locally so that the fire brigade is able to arrive within half an hour of a distress call; and
f) That adequate fire protection measures are provided in the building in accordance with the requirements of BNBC for the Occupancy class and Type of construction of the building.

The values of FAR specified in Table 2.11 shall be applicable in general, unless the city or area development authority specifies different values of FAR for a particular zone or area with the approval of the Authority. In specifying any deviation in FAR from Table 2.11, the city or area development authority shall take into consideration the following:

a) Occupancy group,
b) Type of construction,
c) Width of approach roads,
d) Traffic density in the approach roads,
e) Population density of the area,
f) Parking facilities,
g) Utility services,
h) Local fire fighting facilities.

For occupancy for which unlimited area is permitted by Table 2.11, the minimum open space requirements specified in Table 2.10 shall be applicable.

For the purpose of calculating FAR, the area of any floor including basement, of which at least two-third is used exclusively for car parking and the remaining one-third is used for purposes such as mechanical plant room, electrical substation, security cabin, reception booth, water tank, pump house, stairs and lifts, which are accessory to the main occupancy, shall be excluded from the total floor area of the building.

Table 2.11 Maximum permissible Floor Area Ratios (FAR)

Occupancy		Subgroup	Type of construction		
			Type 1	Type 2	Type 3
Occupancy A:	Residential	A 1	3.0	2.0	1.5
		A 2	UL	2.0	1.5
		A3	UL	2.0	1.5
		A4	4.5	3.0	1.5
		A5	UL	2.0	1.5
Occupancy B:	Educational	B 1	2.5	1.5	0.5
		B 2	2.0	1.5	0.5
Occupancy C:	Institutional	C1	3.0	1.5	0.5
		C2	3.0	1.5	0.5
		C3	3.0	1.5	0.5
		C4	UL	NP	NP
Occupancy D:	Health Care	D1	6.0	1.5	1.0
		D2	4.0	NP	NP
Occupancy E:	Assembly	E1	3.5	1.0	0.5
		E2	3.5	1.0	0.5
		E3	3.5	1.0	0.5
		E4	3.5	1.0	0.5
		E5	3.5	0.5	0.25
Occupancy F:	Business and	F1	UL	2.0	1.5
	Mercantile	F2	4.0	1.5	1.0
		F3	UL	2.0	1.5
		F4	6.0	1.5	1.0
		F5	3.0	NP	NP
Occupancy G:	Industrial	G1	7.5	1.5	1.0
		G2	5.0	1.5	1.0
Occupancy H:	Storage	H1	6.0	1.5	1.0
		H2	4.0	1.0	0.5
Occupancy J:	Hazardous	J1	3.0	NP	NP
		J2	2.0	NP	NP
Note: UL : Unlimited, NP : Not permitted					

(BNBC Table 3.1.11 Page 10321)

The height limitations imposed in Sec 2.4.1 (Table 2.9) can be exceeded for stepped tower structures if the area limitations imposed by the FAR requirements of Sec 2.4.2 are not exceeded, provided the following conditions are satisfied:

a) The building is of Type 1 construction;
b) The front road width is at least 9 m;
c) Local conditions or regulations do not restrict the height;
d) The minimum ground level open spaces of Table 2.10 are maintained as for buildings of unlimited height

2.4.3 Open spaces within a plot
(BNBC § 1.7 Page 10311)

For the purpose of applying the provisions of open space requirements, the side, rear and front of a plot shall be defined as shown in Fig 2.1 depending on the layout of roads around the plot.

At least one side of all habitable rooms shall be exposed to an exterior or an interior open space or to a balcony or verandah.

The total open area in a plot on which a building of educational, institutional, health care or assembly occupancy is constructed shall not be less than 50 per cent of the plot area.

The total open area in a plot on which a building of residential, industrial, storage, hazardous or miscellaneous occupancy is constructed shall not be less than 33 per cent of the plot area.

For the purpose of the above, the total open area shall include all exterior open spaces and interior courtyards, but exclude the area of any lighting and ventilation shaft.

The total open area requirement for plots on which buildings of business and mercantile occupancy are constructed shall be as decided by the Authority for specific city, municipality, township or area taking into consideration fire safety, height of the building, parking facilities, occupancy load, abutting road widths and general lighting and ventilation.

2.4.4 Separation of buildings in the same plot

For more than one building in the same plot, a minimum separation of 2m between the buildings shall be maintained if the heights of both the adjacent buildings are not more than 8m nor more than two storeys. If the height of either of the adjacent buildings in the same plot is more than 8m or two storeys, mandatory open spaces between the buildings as specified in Fig 2.2 (a) to (c) and in the following shall be maintained:

a) For grid iron layouts such as those shown in Fig 2.2 (a), the end to end open space between the buildings shall not be less than 2 m. The open space between the longer sides of the buildings shall not be less than 0.5 times the height of the shielding building on the south or the east.

b) For staggered layouts such as those shown in Fig 2.2 (b), the open space between the longer sides of the buildings shall not be less than 0.4 times the height of the shielding building on the south or the east, provided that at least 0.33 times the length of the shielded building is left unshielded by the shielding building.

c) For front to end layouts such as those shown in Fig 2.2 (c), the open space between the buildings shall not be less than 3 m, provided that the width of the shielding building on the south or the east is not more than 0.33 times the length of the shielded building. When the width of the shielding building is more than 0.33 times but less than 0.67 times the length of the shielded building, the open space between the buildings shall be at least 0.4 times the height of the shielding building; otherwise the open space between the buildings shall be at least 0.5 times the height of the shielding building. For the purpose of this requirement the width of the shielding building shall be taken as that portion of its width that actually shields the other building, or the aggregate of such widths of all shielding buildings, as the case may be.

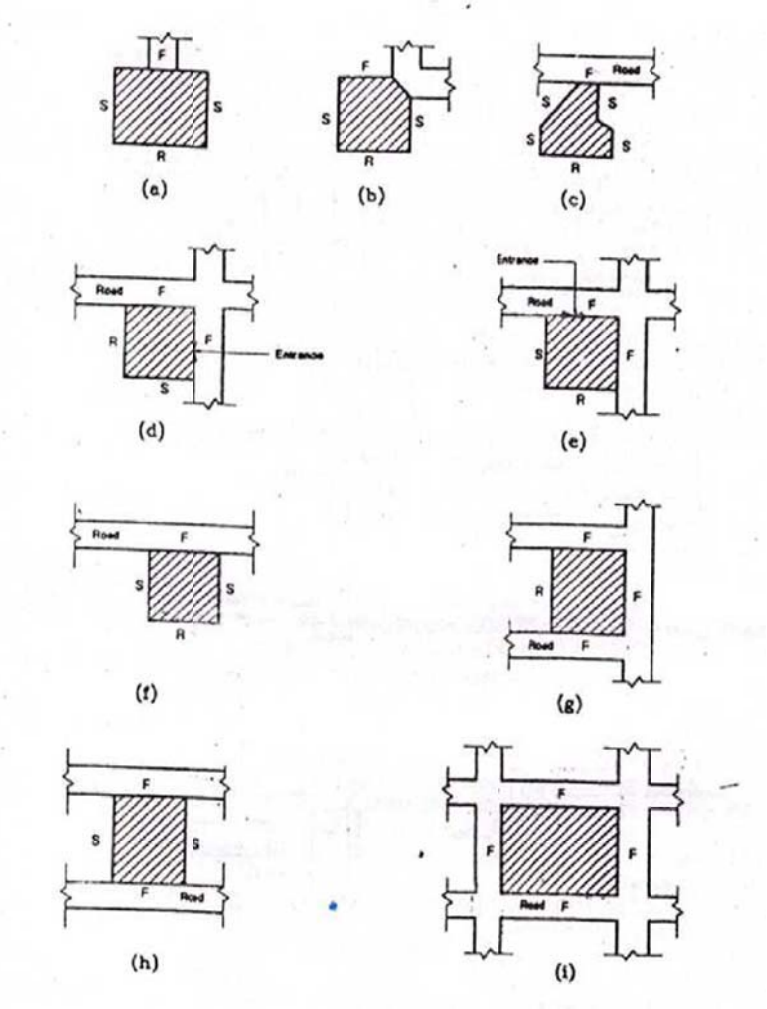


Fig. 2.1: Definition of front, side and rear in a plot
(BNBC Fig 3.1.1 Page 10314)

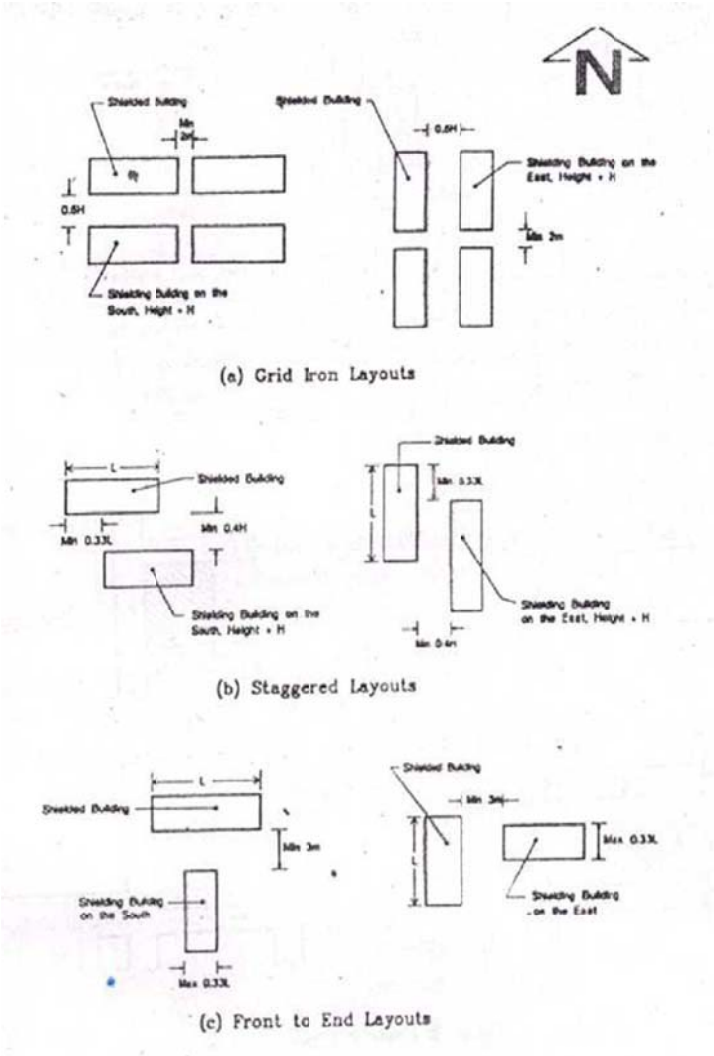


Fig. 2.2: Open Space Requirements
(BNBC Fig 3.1.2 Page 10313)

2.5 Requirements of parts of buildings

2.5.1 Ceiling heights

(BNBC §1.12.2.1 Page 10327)

a) All habitable rooms in non-air-conditioned residential and business and mercantile buildings, apart from kitchens, store rooms, utility rooms, box rooms and garages, shall have a ceiling height not less than 2.75m measured from the finished surface of the floor to the underside of the finished ceiling, or false ceiling. A maximum of one-third of the floor area of such habitable rooms may, however, have a minimum ceiling height of 2.44m. For air-conditioned rooms in such buildings, the minimum ceiling height shall be 2.44m.

b) In the case of a pitched roof without a horizontal ceiling the lowest point of the finished ceiling shall be at least 2m above the finished surface of the floor and the average height of the ceiling shall not be less than 2.44m.

c) The minimum clear headroom under the ceiling, folded plate, shell etc. and under the false ceiling or duct in an air-conditioned room shall not be less than 2.44m. The minimum clear distance between the floor below and the soffit of a beam shall not be less than 2.15m.

d) The requirements of ceiling height for buildings of occupancy other than residential and business & mercantile shall be as provided in Table 2.12.

Table 2.12 Requirements of ceiling heights

Occupancy	Minimum ceiling height
Educational, Institutional, Health Care, Assembly.	3 m for non-air-conditioned and 2.6 m for air-conditioned buildings.
Industrial, Storage, Hazardous.	3.5 m for non-air-conditioned and 3.0 m for air-conditioned buildings.

(BNBC Page 10327)

Note:
In existing RMG buildings the floor height of industrial and storage facilities with no air-conditioning duct shall be minimum 2.9m and when used as a storage facility there shall be a minimum clearance of one-third the floor height from the ceiling to the top of the storage stack.

2.5.2 Staircase

(BNBC §1.12.5 Page 10329)

The minimum width of the staircase for various occupancies shall be as specified in Table 2.13.

Note:
For existing RMG buildings a performance-based determination of the width of the staircase shall be adopted, but in no case the width of the staircase shall be less than 0.9m.

Combination of the riser and the tread dimensions shall be such that the sum of the riser height and the tread depth shall be between 400 mm and 425 mm with a minimum tread depth of 215 mm and a

maximum riser height of 215 mm. The tread depth may include any nosing and any increase due to slant riser faces. The variation between depths of adjacent treads and heights of adjacent risers shall not exceed 5mm. The difference between the largest and the smallest riser or between the largest and the smallest tread shall not exceed 2 per cent of the respective average dimensions in any flight of stairs.

The number of steps in a single flight shall be limited to 15.

Note:
For existing RMG factory buildings the number of steps in a single flight of RCC stair may exceed 15.
For existing RMG factory buildings the stair treads shall be of nominal uniformity. The difference between the largest and the smallest riser shall not exceed 25mm. Any riser height or tread depth not at the top or bottom step in a stair run exceeding more than 12.5 mm difference from the adjacent step shall be modified to be within this tolerance. For existing stairs that do not meet these tread and riser dimensions and will require extensive rework of the stairway, a full detailed analysis of the tread and riser dimensions can be submitted to the Authority for review and approval of an alternate corrective action plan.

The minimum clear headroom between flights of a staircase shall be 2.15m. The clear headroom may be reduced to 2.03m for not more than three flights in any staircase.

The minimum clear height of any passage below a landing providing access to non-habitable and service spaces shall be 2.03m. The minimum clear height of all other passages and spaces below a landing shall be 2.15m.

Handrails shall have a minimum height of 0.9m measured from the nose of stair to the top of the handrail. When children are likely to use the stairs, the balustrade design shall incorporate adequate child safety measure.

Table 2.13 Limiting dimensions of the staircase

Occupancy	Minimum width of stair (m)
A. Residential buildings	
A1 Detached single family dwelling	1.0
A2 Flats or apartments	1.15
A3 Mess, boarding house and hostel	1.25
A4 Minimum standard housing	See BNBC Appendix A
A5 Hotels and lodging houses	1.25
B. Educational buildings	1.5
C. Institutional buildings	1.5
D. Healthcare buildings	2.0
E. Assembly buildings	2.0
F. Business and mercantile buildings	
F1 Offices	1.5
F2 Small shops and markets	1.5
F3 Large shops and markets	2.0
F5 Essential services	1.5
All other buildings	1.25*

(BNBC Table 3.1.13 Page 10330)

(Refer to Note in Section 2.5.2)*

2.5.3 Mezzanine floor

(BNBC §1.12.6 Page 10331)

The total area of mezzanine floors in a building shall not exceed one-third the plinth area of the building. The area of the mezzanine floors shall be included in calculating the FAR.

The clear headroom both over and under the mezzanine floor shall be at least 2.2 m.

The lighting and ventilation of the space both over and under the mezzanine floor shall not be obstructed in any way.

Construction of a mezzanine floor shall conform to the requirements of the floor in which it is constructed but the fire resistance rating need not exceed one hour for unenclosed mezzanines.

2.5.4 Basement

(BNBC §1.12.11 Page 10332)

Any underground floor of a building wholly or partially below formation level shall be called a basement and shall satisfy the requirements of the following sections.

The walls and floors of the basement shall be damp-proof and waterproof. The basement shall be protected against surface water and drainage waste intrusion.

The basement shall have natural lighting and ventilation or shall be artificially lighted and ventilated.

The portion of the staircase below the ground floor level shall be secluded by a firewall or fire

separation assembly having a minimum fire resistance time of 2 hours. Independent open staircase and open ramps for access to the basement from the ground floor or the street level shall be permitted.

The slope of any ramp provided shall not be steeper than 1 vertical in 8 horizontal.

The clear height of the basement below soffit of beams shall not be less than 2.03m.

The floor and the walls of the basement shall be made damp-proof.

2.5.5 Atria

(BNBC §3.1.17 Page 10390)

Atria may be provided in all groups other than Occupancy J (Hazardous Buildings) provided there are sprinkler systems installed throughout the building. Such atria shall have a minimum opening and are as specified in Table 2.14.

Table 2.14 Atrium opening and area

Height in storey	Minimum clear opening[1] (m)	Minimum area (m^2)
3-4	6	40
5-7	9	90
8 or more	12	160
[1] The specified dimensions are the diameters of inscribed circles whose centres fall on a common axis for the full height of the atrium.		

(BNBC Table 3.3.4 Page 10390)

Note:
For Atria of existing RMG factory buildings of Occupancy G2 sprinkler systems throughout the building or approved engineering alternatives such as smoke and fire resistant enclosures may be adopted.

2.6 Fire tests and fire resistance rating

(BNBC § 1.5 Page 10408)

The fire resistance rating of individual building construction components shall be determined by standard materials testing procedures listed in Appendix I.

The fire resistance rating of structural elements, which are widely used in Bangladesh, are provided in Table 2.7, as a guideline. These ratings shall be used unless tests conducted in accordance with the test procedures listed in Appendix I indicate higher fire resistance ratings, in which case the higher values may be used.

Note:
Test Standards equivalent to those listed in BNBC § 1.5 Page 10408 may also be adopted. Equivalent tests refer to the Test Standards that are not mentioned in this document, which might arise in future and are considered equivalent in their application, test methods and specifications. This equivalence shall be proved through 'technical specifications comparison document' from the Testing Laboratory and certification bodies making the equivalent claim.

2.7 Fire pathways and building services

2.7.1 Openings in separating wall

(BNBC § 2.5 Page 10411)

The openings in occupancy separation wall shall conform to the provisions set forth in Sec. 2.2.2.3.

Openings in fire separating walls and floors shall not exceed the approved limit and the opening shall be of protective type and conform to the approved provisions.

Fire separating walls shall not have opening exceeding 11.2m^2 in area and the aggregate width of all openings at any floor level shall not exceed 25 per cent of the length of the wall. When the entire storey floor area on both the sides of a fire-separating wall are covered by automatic fire suppression system, the maximum allowable opening may be doubled with a minimum distance of 0.9m between adjacent openings.

Doors and other openings in Type 1 construction (opening in a separating wall) shall be limited to 5.6m^2 in area with a maximum height of 2.75m and width of 2.1m. Wall openings shall be protected with approved fire resisting means like fire doors or steel rolling shutters conforming to approved standards. All openings in floors shall be protected by vertical enclosures extending above and below such openings. Walls of such opening enclosure shall have at least 2 hours fire resistance rating.

Openings of service lines like cables, electrical wirings, telephone cables, plumbing fixture etc. shall be protected by enclosures having a fire resistance rating of not less than 2 hours. Medium or low voltage electrical wire running through shaft or ducts shall be either armoured or cased within metal conduits.

All openings in the separating walls and doors shall be provided with minimum two hours fire resistance assemblies in Type 3 construction.

2.7.2 Smoke and heat vents

(BNBC § 2.6 Page 10411)

Smoke and heat vents shall be installed in single storied windowless buildings, underground structures, factories with large floor spaces and other areas of restricted ventilation.

The vent area and spacing of the vents shall comply with Table 2.15.

Table 2.15 Smoke and heat vent size and spacing

Use group	Hazard condition	Vent area to floor area ratio	Max spacing of vent centres
Occupancy G1	Low Hazard	1:100	30 m
Occupancy G2	Moderate hazard	1:75	20 m
Occupancy H1	Low Hazard	1:100	30 m
Occupancy H2	Moderate Hazard	1:75	20 m
Occupancy J1	High Hazard	1:30	15 m
Occupancy J2	High Hazard	1:30	15 m
Occupancy K1	Low Hazard	1:100	30 m

(BNBC Table 4.2.1 Page 10412)

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.

Smoke and heat vents on roof or ceiling or wall shall normally be kept open. In case of closed vents, automatic activation of the openings by heat-responsive device rated at 38°C to 104°C above ambient shall be a requirement. The releasing mechanism shall be capable of opening the vent fully when the vent is exposed to a time-temperature gradient that reaches an air temperature of 260°C within 5 minutes. The vents shall also be capable of being opened by manual operation.

Venting requirements for Industrial and Storage buildings are referred to BNBC Appendix B Page 10468.

2.7.3 Electrical, gas and HVAC services

(BNBC § 2.7 Page 10412)

The requirements of the electrical, HVAC and gas services shall meet the provisions of BNBC Chapters 2, 3 and 8 respectively of Part 8.

Air-conditioning and ventilation systems shall be installed and maintained in such a manner that the fire, fumes or smoke do not spread from one floor or area of fire to other parts of a building through the ducts or vents.

Properly designed fire dampers shall be installed within the air-conditioning and ventilation ducts, which shall automatically close the flow of air in case of fire.

For large assembly areas, department stores and hotels with more than 100 rooms in a single block, effective means for preventing circulation of smoke through the air-conditioning ducts shall be installed. Such means shall consist of approved photoelectric or other smoke sensing control devices, as the fuses and dampers may not function during early state of a fire due to insufficient heat.

2.7.4 Surface finishes

(BNBC § 2.8 Page 10413)

Plastic, wood or other flammable materials used to trim and cover the interior and exterior facade of a

building structure have the potential of generating smoke and toxic fumes during a fire and have the potentiality of changing the nature of fire due to its ignitability as fuel.

The fire susceptibility of various types of surface finishes is determined in terms of the rate of spread of fire (Appendix I). Based on the rate of spread of fire, the surface finish materials shall be classified into 3 classes:

Class I	Surfaces of low flame spread: Flame does not effectively spread more than 300 mm in the first 1.5 minutes with an ultimate value of 600 mm.
Class II	Surfaces of medium flame spread: Flame does not spread effectively more than 300 and 850 mm in the first 1.5 and 10 minutes respectively.
Class III	Surfaces of rapid flame spread: Flame spreads effectively more than 300 and 850 mm in the first 1.5 and 10 minutes respectively.

Interior finish of walls and ceilings shall have a flame spread rating not greater than those in Table 2.17 for various occupancy classes.

2.7.5 Wired glass panels

Wired glass panels shall comply with the following requirements:

a) Thickness of the glass shall not be less than 6 mm.
b) Embedded wire netting mesh in the glass shall not be more than 25mm mesh.
c) The sashes or frames or both shall be entirely made up of iron or any other approved metal. The frame shall be securely fixed into the wall (except panels of internal doors).
d) Setting of the panels of glass shall be achieved by rebates or grooves of not less than 6 mm width or depth keeping due allowance for expansion. The glass shall be secured to the frame by hard metal fastenings. Lead, cement or putty may be used for weatherproofing.
e) Where wired glass panels are labelled as protective openings, they shall conform to the size limitations shown in the Table 2.18.

2.7.6 Fire lifts

(BNBC § 2.11 Page 10416)

Fire lifts shall be used in buildings more than 20m in height. Fire lifts, where used shall be fully automated from the ground level with approved wiring and switches and shall have a minimum capacity of 8 persons.

Fire lifts may be operated by the inhabitants of the buildings except during fire. During fire, only firemen shall operate such lifts.

Table 2.16 Acceptable flame spread rating classes of interior finish

Use group		Vertical exits and passageways	Corridors providing exit access	Rooms or enclosed areas
A1 -	Detached single family dwelling	III	III	III
A2 -	Flats or Apartments	I	I	I
A5 -	Hotels and lodging Houses	I	I	I
B -	Educational	I	I	I
C1 &	- Institutional, Residential &	I	I	III*
C2	Custodial	I	I	I
C3 -	Institutional - Incapacitated	I	I	I
C4 -	Institutional - Restrained	I	I	I
D -	Health Care	I	I	I
E1 -	Large assembly with fixed seats	I	I	I
E2 -	Small assembly with fixed seats	I	I	I
E3 -	Large assembly without fixed seats	I	I	I
E4 -	Small assembly without fixed seats	I	I	I
F -	Business & Mercantile	I	II	II
G -	Industrial	I	II	II
H -	Storage	III	II	III
J -	Hazardous	I	II	III
* Class II may be adopted if the area is covered by an automatic fire suppression system				

(BNBC Table 4.2.2 Page 10414)

Table 2.17 Size limitations of wire glass panels

Fire rating/opening	Max height in m	Max width in m	Max area in m
3 hours (not permitted)	--	--	--
1 1/2 hour door in exterior walls (not permitted)	--	--	--
1 1/2 hour fire rating	0.85	0.25	0.065
3/4 hour fire rating	1.4	1.4	0.85
Fire windows	1.4	1.4	0.85

(BNBC Table 4.2.3 Page 10419

Fire lifts shall be equipped with approved intercommunication (including two way voice communication) with the fire command station or control room on the ground floor lobby of the building.

Number and location of fire lifts in a building shall be decided on the basis of total occupant load, floor area and compartmentation.

2.8 Special hazards

The various occupancy groups are exposed to fire hazards of different nature and intensity, detailed below under two relevant occupancy classes.

2.8.1 Special Hazards in Occupancy G: Industrial
(BNBC § 2.12.7 Page 10419)

a) No apparatus generating flames capable of igniting flammable vapour shall be permitted within a room or part of a building using or storing volatile flammable liquid. Rooms or parts of a building using or storing such flammable liquid shall be covered by exhaust ventilation system.

b) Boiler rooms and areas containing heating plants shall be effectively segregated from the rest of the occupancy.

c) Adequate protective measures shall be taken against hazards associated with distribution and use of electricity and gas in accordance with the provisions of BNBC Chapters 2 and 8 of Part 8.

d) Automatic sprinkler or other protections like installation of vents shall be made in all buildings of Occupancy G2 (Moderate Hazard Industries).

e) The machine layout shall be congenial to safe fire practice.

2.8.2 Special hazards in Occupancy H: Storage
(BNBC § 2.12.8 Page 10419)

a) No apparatus generating flames capable of igniting flammable vapour shall be permitted within a room or part of a building using or storing volatile flammable liquid. Rooms or parts of a building using or storing such flammable liquid shall be covered by exhaust ventilation system.
b) Boiler rooms and areas containing heating plants shall be effectively segregated from the rest of the occupancy.
c) Adequate protection shall be taken against hazards associated with distribution and use of electricity and gas in accordance with the provisions of BNBC Chapters 2 and 8 of Part 8.
d) Automatic sprinkler or other protections like installation of vents shall be made in all buildings of Occupancy H2 (Moderate Fire Risk Storage).

2.9 Means of escape
(BNBC Page 10421)

A means of escape shall be a continuous and unobstructed way of exit travel from any point in a building to a street, the roof of a building or a designated area of refuge. The path of travel along a means of escape

may consist of three parts: (a) the exit access, (b) the exit, and (c) the exit discharge. That portion of the means of escape that leads to the entrance of an exit and is included in the measure of travel distance to reach an exit shall be termed the exit access. The exit itself shall be considered to be that portion of the means of escape that is protected from the area of incidence and provides a safe path to the exit discharge. The exit discharge shall comprise any portion of the travel between the termination of exit and the exterior or the area of refuge.

The parts of the means of escape may consist of any of the following exit components:

a) A doorway, corridor or passage leading to an exterior or interior staircase, smoke proof and fireproof enclosure, ramp, balcony, fire escape or combination thereof, having direct access to the street, the roof of a building or any designated refuge area which affords safety from fire or smoke from the area of incidence;
b) A horizontal exit from the affected building to an adjoining building or an area of refuge at the same level which provides safety from fire and smoke from the area of incidence and the areas communicating therewith.

Lifts, escalators and moving walks shall not be regarded as components of means of escape.

Note:
For existing RMG factory buildings the roof of the building shall not be designated as a refuge area.

2.9.1 General requirements
(BNBC 3.3 § Page 10421)

All buildings constructed for human occupancy or storage shall be provided with adequate exit facilities to permit safe and quick unaided escape of the occupants in the event of fire or other emergency.

An exit shall at no time be used for any purpose that would interfere with its use as a means of escape.

Exits and exit access corridors shall not be used as supply or return air ducts.

Where changes in elevation not exceeding 300 mm exist in exits or exit access corridors, ramps shall be used. At exterior doors not required to be used by handicapped or aged people, a maximum step down of 200mm shall be permitted.

All exits shall be clearly visible and exit access corridors and passages leading to the exit shall be marked and signposted to guide the occupancy traffic. Exit signs in public places used during the hours of darkness and those in areas required to have more than one exit or exit access shall be illuminated in accordance with the provisions of BNBC §1.5 of Part 8.

The owner or lessee of all new and existing buildings shall be responsible for the safety of all occupants. If in any existing building, the exit facilities are deemed inadequate in view of the requirements of this guideline, the Authority may order additional provisions to be incorporated in the building in order to minimize hazard to life of the occupants.

2.9.2 Location and arrangement of exits
(BNBC § 3.4 Page 10422)

All exits shall be easily discernible and accessible from the areas served by them.

Exit from any room or space shall not open into an adjoining or intervening room or area except where such adjoining room or area is an accessory to the area served, is not a hazardous occupancy and provide a

direct escape to the designated exit area.

No portion of an exit route shall pass through a room that may be subject to locking or be intervened by a door that may be locked when the building is occupied.

All exits shall be so located and arranged that they provide continuous and unobstructed means of escape to the exterior of the building leading to a street or to other designated areas of refuge.

2.9.3 Occupant load
(BNBC § 3.5 Page 10422)

2.9.3.1 Design occupant load

The occupant load for which the exit facilities are to be provided shall be established by the largest number computed by the provisions of (a), (b) and (c) below:

a) The actual number of occupants for whom the area served by the exits is designed;
b) Number of occupants computed at the rate of one occupant per unit of floor area as prescribed in Table 2.18.
c) The number of occupants in any area as computed by the provisions of (a) or (b) above plus the number similarly computed for all spaces that discharge through this space in order to gain access to the exit.

2.9.3.2 Fixed seats

The occupant load for an assembly or educational area having fixed seats shall be determined by the seating capacity of the area. For fixed seats without dividing arms, the capacity shall be taken as one person for every 500 mm of seat.

2.9.3.3 Maximum occupant load

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

Note: The occupant load shall be calculated for the existing RMG buildings as specified in the Bangladesh Labor Act 2006 (as stated in the note provided with Table 2.18).

2.9.3.4 Mezzanine floors

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

2.9.3.5 Roofs

Roofs used as assembly, educational or other areas of human occupancy shall be provided with exit facilities for the required occupant load.

Note:
According to Bangladesh Labor Act 2006 "Without prejudice to the generality of the provisions of sub-section (1), there shall be provided for every worker employed in a work-room at least 9.5 m of space in the establishment". The Occupant Load shall be calculated considering a minimum of 2.3m2 per occupant for existing RMG buildings.

2.9.4 Capacity of exit components
(BNBC § 3.6 Page 10423)

The capacity of means of exit shall be adequate for the occupant load of the area served thereby. The required width of each exit component shall be computed on the basis of the exit width per occupant prescribed in Table 2.19, subject to the minimum width of each such component specified in Sec. 2.9.5 - 2.9.10.

Table 2.18 Occupant load for various occupations

Occupancy	Unit of floor area in m^2 per occupant
A Residential	18 gross
B Educational	
Class room	2 net (see also Sec 2.10.3)
Preschool	3.5 net
C Institutional	12 gross
D Health Care	
In patient areas	15 gross
Out-patient areas	10 gross
E Assembly	
With fixed seats	See Sec 3.5
Without fixed seats	0.7 net
Standing space only	0.3 net
With table and chairs	1.5 net
F Business and Mercantile	
Office space	10 gross
Shopping/sales area	3 gross
G Industrial	10 gross
H Storage	30 gross
J Hazardous	10 gross

(BNBC Table 4.3.1 Page 10423)

2.9.5 Corridors and passageways
(BNBC § 3.7 Page 10424)

Direct route of access to required exits shall be provided through continuous passageways, corridors or aisles that are maintained free of obstructions. As far as practicable, occupants commencing exit travel at any point along the corridor or passageway shall be lead to an exit irrespective of their direction of travel. The length of a dead end in which no exit door is available shall not exceed 10m.

The minimum required width of corridors and passageways shall be determined on the basis of the

occupant load in accordance with the provisions of BNBC § 3.6, but it shall not be less than the most restrictive of the following:

a) 1.1m where serving an occupant load of more than 50.
b) 0.9 m where serving an occupant load of 50 or less.
c) 2.4 m in Health Care buildings (Occupancy D) where movement of beds is necessary.
d) 1.8 m in Educational buildings (Occupancy B) where the occupant load is more than 150.

Table 2.19 Required exit width per occupant

Occupancy	Buildings without sprinkler system (mm per person)			Buildings thoroughly sprinkled (mm per person)		
	Stairways	Ramps & Corridors	Doors	Stairways	Ramps & Corridors	Doors
A Residential B Educational F1, F2, Business & F4 Mercantile G Industrial H Storage	8	5	4	5	4	4
C1, C2, Institutional C3	10	5	4	5	5	4
C4 Institutional	8	5	4	8	5	4
D Health Care	25	18	10	15	12	10
E Assembly F3 Business and mercantile	10	7	5	7	5	5
J Hazardous	8	5	4	8	5	4

(BNBC Table 4.3.2 Page 10424)

The width of exit corridors and passageways shall not be less than the aggregate of the required width of doors leading from them towards the exterior.

The minimum clear height of the corridors and passageways shall not be less than 2.4 m. All exit access corridors shall have a fire resistance rating of one hour or more.

Door assemblies opening on to the exit access corridors shall be fire doors having a fire resistance rating of at least 20 minutes when tested in accordance with the international standards specified in Appendix I.

2.9.6 Assembly aisles

(BNBC § 3.8 Page 10425)

Assembly buildings that contain seats, tables, equipment or displays shall be provided with aisles, free of obstructions, leading to the exit.

Exit access aisles may be level or ramped with slopes not exceeding 1 in 8. The clear width of level or ramped aisles shall be obtained at the rate of 5mm per person, subject to the minimum specified below.

Seats on both sides of the aisle	1 m
Seats on one side of the aisle	0.9 m

The minimum clear gap between rows, measured as the clear horizontal distance between the back of the row ahead and the nearest projection of the row behind shall be 300mm. For chairs having automatic or self-rising seats, the measurement shall be made with the seats in the raised position; for non-automatic seats the measurement shall be taken with the seats in the down position.

For rows of seats served by aisles or doorways at both ends, the number of seats per row shall not exceed 100. The minimum clear gap between rows shall be increased beyond 300 mm by 7mm for each seat in excess of 15, but the clear gap need not exceed 550 mm.

For rows of seating served by an aisle or doorway at only one end of the row, the path of travel shall not exceed 10 m from any seat to the aisle or doorway. The minimum clear gap between rows shall be increased beyond 300mm by 15mm for each seat in excess of 7, but the clear gap need not exceed 550mm.

2.9.7 Doorways

(BNBC § 3.9 Page 10426)

Each occupant of a room or space shall have access to at least one exit or exit access door. The occupant load per exit door and the travel distance up to that door shall not exceed the values specified in Table 2.20.

Where either the occupant load or the travel distance exceeds the values specified in Table 2.18, at least two exit doors shall be provided.

The width of a doorway shall not be less than 1m and the height not less than 2m.

No sliding or hanging door shall be used as a means of exit.

All exit access doors shall be of a side-swinging type. When the occupant load exceeds 50, or in a hazardous occupancy, the doors shall swing outward from the room or in the direction of travel. Swinging of the door shall not constrict the width of the corridor below 0.9m measured at the most critical position.

Exit doorways shall not open directly on a flight of stairs. A space of width not less than the width of the doorway shall be maintained immediately outside the doorway. The space shall be at the same level as that of the floor the door serves.

Table 2.20 Maximum occupant load and travel distance for spaces with one exit door

Occupancy		Maximum occupant load	Maximum travel distance (m)
A	Residential		
B	Institutional	12	23
C	Healthcare		
D	Educational		
E	Assembly		
F	Business and mercantile	50	23
G	Industrial		
H	Storage	30	30
J	Hazardous	5	8

(BNBC Table 4.3.3 Page 10426)

Revolving doors shall not be used as a means of exit in assembly, educational or institutional buildings or in spaces with an occupant load of 200 or more. In all other cases revolving doors shall not constitute more than half of the total required exit door width. No power-operated revolving door that cannot be operated manually in the event of power failure shall be permitted.

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

Note:
For existing RMG buildings a performance-based determination of the width of the doorway shall be adopted, but in no case the width of the doorway shall be less than 0.9m.

2.9.8 Stairways

(BNBC § 3.10 Page 10426)

The required width of exit stairways shall be computed in accordance with the provisions of Sec. 2.9.4, but it shall not be less than the minimum widths specified in Table 2.21.

Note:
For existing RMG buildings a performance-based determination of the width of the staircase shall be adopted, but in no case the width of the staircase shall be less than 0.9m.

Table 2.21 Minimum widths of exit stairways

Occupancy	Minimum width of stairway (m)
A Residential	
A1, A2	1.0
A3, A4	1.5
A5	0.75
B Educational	
Occupant load up to 15	1.5
Occupant load more than 150	2.0
E Assembly	
E1, E3, E5	2.0
E2, E4	1.5
All others	1.5

(BNBC Table 4.3.4 Page 10427)

The least dimension of landings and platforms in exit stairways shall not be less than the required width of stairway, except that the landing between two stair flights in a straight run shall not be required to be wider than 1.2 m in the direction of travel.

The rise and tread dimensions and the headroom requirements shall conform to the provisions BNBC §1.12.5 of Part 3.

Spiral and winding stairways shall be permitted as an element of a means of escape only within a dwelling unit and from a mezzanine floor not more than 25m2 in area. The minimum width of all such stairways shall be 650mm with each tread having a minimum depth of 200mm at a distance of 300mm from the narrower end. All treads shall be identical. The rise shall not be more than 225mm with a permissible tolerance of 5mm between adjacent risers and 10mm between the largest and the smallest risers.

Stairways serving as means of escape shall have continuous guards and handrails on both sides. Where the width of the stair exceeds 2.2m, intermediate handrail shall be provided so that no point on the stair is farther than 1m from the handrail.

All exit stairways shall be constructed of materials that conform to the type of construction of the building, except that solid wooden handrails shall be permitted for all types of construction.

An exit stairway shall not be built around a lift shaft unless the enclosure of the lift shaft is solid and made of a 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 ground, are separated from the building interior by fire resistive assemblies or walls and are constructed of non-combustible materials.

2.9.9 Ramps

(BNBC § 3.11 Page 10427)

The minimum width of exit ramps shall not be less than that required for corridors specified in Sec 2.9.5.

The slope of an exit ramp shall not exceed 1 in 8, but for slopes steeper than 1 in 10 the ramp shall be surfaced with approved non-slip material or finished such as to effectively prevent slipping.

Guards or handrails shall be provided on both sides of ramps having slope steeper than 1 in 15.

Note:
For existing RMG buildings handrails shall be provided in cases where the difference in levels between two adjacent floors exceed 0.75m

2.9.10 Horizontal exits
(BNBC § 3.12 Page 10428)

The connection between an area of the building that the horizontal exit serves and the area of refuge or another building shall be provided with protected openings in two-hour fire resistance rated walls, or by open-air balcony or bridge.

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

The width of a horizontal exit shall not be less than 1m.

The slope of the horizontal exit shall not exceed 1 vertical in 10 horizontal. No steps shall be used in horizontal exits.

Where the horizontal exit serves as an exit from only one side, all doors shall swing in the direction of escape travel. Where exit from both sides may be required, the doors shall have two leaves opening in opposite directions, or there shall be adjacent doors opening in opposite directions. The doors shall be open-able at all times when the building is occupied without the use of a key.

The discharge area of a horizontal exit shall be either public spaces or private to the occupants of the building. The capacity of the area of refuge or building on the refuge side shall be computed as the minimum net floor area excluding stairways, shafts etc. The required capacity of refuge shall be 0.28m2 per occupant. In the case of patients confined to bed in hospitals and clinics etc., the required capacity of refuge shall be 2.8m^2 per bed.

2.9.11 Smoke-proof enclosures
(BNBC § 3.13 Page 10428)

A smoke-proof enclosure shall consist of an interior stairway conforming to Sec 2.10.8 and an exterior balcony or a ventilated vestibule.

All exit stairways serving occupants located more than 23m above the ground shall be protected by a smoke proof enclosure.

The minimum width of a vestibule shall not be less than 1.1m or less than the width of the corridor leading to the vestibule. The minimum length of a vestibule in the direction of escape travel shall be 1.8m.

The minimum fire resistance rating of the walls separating the smoke proof enclosure from the area of incidence shall be four hours with no openings other than the required fire doors for exit.

All doors in smoke proof enclosure shall be self closing type or they shall be fitted with automatic closing devices triggered by the fire detection system installed at the floor side entrance to the enclosure. The activation of fire detection system at any door in any floor shall activate the automatic door closers of all the doors at all levels of the smoke proof enclosure.

When access to the stairway is through a vestibule instead of an open exterior balcony, the vestibule shall have adequate natural ventilation. Each vestibule shall have a minimum area of opening of 1.5m2 in an exterior wall facing a courtyard, street or public way wider than 6m.

Note:
In all existing RMG factory buildings all exit stairways serving occupants located above the ground floor shall be smoke proof with fire resistant walls and door.

Note:
Basement, ground floor and high-risk areas (such as storage areas for chemical, fuel, etc.) should be separated from the stairways by smoke proof enclosures. Vestibule shall be provided in storage areas or high-risk areas that open directly into smoke proof stairways.

Note:
The minimum fire resistance rating of the walls separating the smoke proof enclosure from the area of incidence shall be 2 hours with no openings other than those required for fire doors for exit. The fire rating of the fire doors for exit shall not be less than that of the minimum fire resistance rating of the walls of the smoke proof enclosure.

2.9.12 Number of exits
(BNBC § 3.14 Page 10429)

The requirements of the number of exits specified in this subsection shall apply to buildings of all occupancy groups unless a more restrictive requirement for any occupancy is provided in BNBC Part 4.

Only one means of exit shall suffice for the buildings specified in Table 2.22 provided that they do not have more than one floor below the level of exit discharge.

For all other buildings the required number of exits shall depend on the occupant load as specified below:

Occupant load 500 or less	Minimum 2 exits
Occupant load 501 to 1000	Minimum 3 exits
Occupant load more than 1000	Minimum 4 exits

All buildings more than 6 storeys or 20 m in height and all buildings having a floor area larger than 500 m2 on each floor, used as educational, institutional, assembly, industrial, storage or hazardous occupancy or a mixed occupancy involving any of these, shall have a minimum of two staircases. The staircases shall be of the enclosed type and shall lead directly to the exterior or the designated area of refuge.

2.9.13 Length of travel
(BNBC § 3.15 Page 10429)

Exits shall be arranged in such a manner that the travel distance from any point in the area served shall not exceed the following values:

Table 2.22 Buildings served by one means of exit

Occupancy	Maximum number of storeys	Other restrictions
All	1	Maximum occupant load 100 and maximum travel distance 25 m
A1	2	Maximum occupant load 30
A2	6	Maximum 12 dwelling units
A3	4	Maximum 50 occupants per floor and maximum travel distance 25 m
A4	6	Maximum 50 occupants per floor and maximum travel distance 25 m
A5	2	Maximum occupant load 50
B, C	2	Maximum occupant load 200
D	2	Maximum occupant load 50
F, G, H	2	Maximum occupant load 100 and maximum travel distance 25 m

(BNBC Table 4.3.5 Page 10429)

Occupancy A, B, C, D, E, J	25m
Occupancy F, H	30m
Occupancy G	45m

Wherever more than one exit are required in a building they shall be placed as remote as possible from each other. As far as practicable, exits shall be arranged in such a manner as to provide refuge to a person irrespective of the direction of travel from any point in the area served.

Note:
For existing RMG factory buildings equipped with an automated alarm system, portable fire-fighting system and appropriate standpipe and hose system throughout the entire building the length of travel shall not exceed 60m. Where the existing RMG factory building is covered entirely with automated sprinkler system along with appropriate warning system and portable fire extinguishers the length of travel shall not exceed 122m.

2.9.14 Means of exit signs and illumination
(BNBC § 3.16 Page 10430)

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.

2.9.14.1 Location

Exit signs shall be installed at stair enclosure doors, horizontal exits and other required exits from the storey. When two or more exits are required from a room or area, exit signs shall be installed at the required exits from the room or area and where otherwise necessary to clearly indicate the direction of escape.

2.9.14.2 Graphics

The colour and design of lettering, arrows and other symbols on exit signs shall be in high contrast with their background. Words on the signs shall be at least 150mm high with a stroke of not less than 20mm.

2.9.14.3 Illumination

Signs shall be internally or externally illuminated by two electric lamps or shall be of an approved self-luminous type. When the luminance on the face of an exit sign is from an external source, it shall have an intensity of not less than 5.0 foot-candles from either lamp. Internally illuminated signs shall provide equivalent luminance.

2.9.14.4 Source of power

Supply of power to one of the lamps for exit signs shall be provided by the premises' wiring system. Power to the other lamp shall be from storage batteries or an on-site generator set and the system shall be installed in accordance with the provisions of BNBC Chapter 2, Part 8.

2.9.14.5 Floor-level exit signs

The signs shall be on the floor-level in contrasting colour showing the exit direction. The sign at the exit door shall be adjacent to the door with the closest edge of the sign within 100 mm of the doorframe.

2.9.15 Exit requirements for Occupancy G: Industrial

In addition to the provisions specified in Sec. 2.9.1 through 2.9.14, industrial buildings shall meet the requirements specified in this section.

At least two exits shall be provided for each floor including basement of an industrial building.

2.9.16 Exit requirements for Occupancy H: Storage

In addition to the general requirements as specified in Sec. 2.9.1 through 2.9.14, storage facilities shall satisfy the requirements detailed in this section.

All structures that are used as storage and have more than 1400 m2 of floor area or where more than 10 persons are normally present shall have at least two separate means of exit.

During operational hours, the door locks of a storage building shall be kept in such a way that these can be unlocked easily during a fire or emergency.

The parking garages shall have at least two separate means of exit.

Note:
The door locks of a storage building shall be checked by a factory official every hour and electronically record the checking time.

Part 3: Equipment and in-built facilities

3.1 Scope

The provisions of this part shall control the design, installation and management of equipment and in-built facilities required for firefighting within a building and its premises. The regulations of this part shall be applicable for all building (whether the system will be required by the guideline or by owner's request) and the provisions stated herein shall not cover the fire fighting requirements outside the building premises.

3.2 Fire protection plumbing

3.2.1 Water requirement for interior fire protection
(BNBC § 4.2.1 Page 10435)

The minimum quantity of water for sprinkler and hose use within the building according to occupancy classification shall be in accordance with Table 3.1 or on the basis of the hydraulic design of the system.

3.2.2 Water sources for fire protection
(BNBC § 4.2.2 Page 10435)

Water required for interior fire protection of a building shall be supplied from one or a combination of the following sources.

a) **Direct connection to water main:** For continuous water supply (public water supply system or independent system only for fire protection) with sufficient quantity and pressure to feed fire fighting equipment during peak demand period, direct connection of fire fighting system to the water main may be adopted.
b) **Roof gravity tanks:** For water supply system with inadequate quantity or pressure during peak demand period but with sufficient pressure to feed roof tank, a roof gravity tank shall be provided to feed fire-fighting equipment.
c) **Storage tank**: For water supply system with inadequate pressure to feed fire fighting equipment or roof gravity tank, the building premises shall have a ground (or underground) tank to store water for fire fighting.

Table 3.1 Fire protection flow requirements

Building type	Sprinkler system (l/min.)*	Standpipe and hose System (l/min.)*	Duration** (minute, min.)
Light hazard- I	1000	1000	30
Light hazard- II	1900	1900	50
Ordinary hazard- I	2650	1900	75
Ordinary hazard - II	3200	1900	75
Ordinary hazard - III	4800	1900	75

Notes:
* Values will be for one riser serving floor area of 1000 m2
** These durations shall be for a building up to the height of 51 m. For greater height of 51-102m and above 102 m, the duration will be 1.25 times and 1.5 times of the specified values respectively.
Light hazard – I : Occupancy groups, A1, A2, A4
Light hazard – II : Occupancy groups, A3, A6, A7, A8, B, C, D, E2, E4, E7, F1 & F2
Ordinary hazard – I : Occupancy groups, E1, E3, E5, F3, F4, F5, F6, F7, G1 & G4
Ordinary hazard- II : Occupancy groups, G2 & H1
Ordinary hazard- III : Occupancy groups, G3 & H2
Extra hazard : Occupancy group, j - 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

(BNBC Table 4.4.1 Page 10436)

The
system only for firefighting purpose may be designed with automatic fire pump. The water supply system for domestic use and fire protection may be designed with roof gravity tank and manually controlled pump.

The water stored in storage tank for firefighting operation shall not be used for other purposes.

The ground storage tank shall be easily accessible to fire engine of Fire Department. In absence of space available for fire engine, the cover slab of ground storage tank shall be designed to withstand a vehicular load of local fire engine.

3.2.3 Individual water sources
(BNBC § 4.2.2.4 Page 10439)

In absence of public water supply system, the building premises shall have individual water sources. The individual water sources with adequate yield during peak demand period will serve as a fire service ground tank. Otherwise, the water required for specified flow as shown in Table 3.1 shall have to be stored in a storage tank.

In the absence of a public water supply, the individual water source shall be used to supply water in a distribution system. The following water sources may be used for individual water supply purposes: drilled well, dug well, driven well, spring, infiltration gallery.

3.2.4 Design considerations for standpipe and hose system
(BNBC § 4.2.3 Page 10439)

The fire protection system shall be designed for their effective use either by amateur or trained fire fighting personnel or both.

All standpipes in standpipe system shall be sized so that they will provide a minimum flow specified in Table 3.1. In standpipe system with more than one standpipe, the supply piping shall be sized for the minimum flow specified in Table 3.1 for the first standpipe plus 1000 litre per minute for each additional standpipe. The total number of such additional standpipes shall not be more than 8. All standpipe risers shall be connected through a gate valve with a main of size equal to that of the largest riser.

The minimum pressure for standpipes supplying a 50mm or larger hose shall be at least 300 kPa. For standpipe supplying first aid hose (38mm nominal) may have a minimum pressure of 200 kPa.

The size (diameter) of standpipes for various building height may be as shown in Table 3.2 or hydraulically designed to provide the required flow as specified above and pressure as mentioned above at the topmost outlet.

The water supply required for combined system (for partial automatic sprinkler and Fire Department hose) shall be calculated in accordance with that specified above plus an amount equal to the hydraulically calculated sprinkler demand or 550 litre per minute for light hazard occupancy groups or 1900 litre per minute for ordinary hazard occupancy groups.

The size of the pipes of combined system shall be at least 150 mm or hydraulically designed to provide the required flow and pressure mentioned earlier.

Table 3. 2 Standpipe sizes

No. of storey	Building height (m)	Size of standpipe (mm)
Up to 5	Up to 17	75*
Up to 10	Up to 33	100
10 to 20	33 to 63	150
20 to 54	63 to 165	200
* This size may be used only for occupancy groups A1, A2 and A4		

(BNBC Table 4.4.2 Page 10442)

The hose shall be connected to the standpipe within 1.5m from the floor. Hose station shall be easily accessible for inspection and testing.

The hose connection to a standpipe for large stream shall be at least 100mm nominal and that of small stream may be 63mm or 50mm on each floor. The size of first aid hose shall be 38 mm nominal. The hose length shall not be more than 30m.

The static pressure in standpipe shall not exceed 650kPa at hose outlet. Where pressure-reducing valves are used, the design of pressure reducing valve shall be so that the pressure with the flowing stream shall not exceed 650kPa.

Different piping materials and fittings for standpipe system presented in Tables 111.1 and in Appendix III shall conform to the standard or one of the standards cited therein. The standard requirements for other materials not provided in these tables shall be subject to the approval of the Authority.

The standpipe riser shall be supported at the top and at the lowest level. The riser shall also be provided with support at the alternate level in between top and bottom level of the standpipe riser. The support shall be of adequate strength to support the water-filled pipe load and an additional load of 110 kg. The horizontal standpipe shall have hangers with spacing not more than 5m. The hanger shall be able to carry a load of five times the weight of the water-filled pipe and an additional load of 110 kg.
There shall be Siamese connection to the standpipe or to the delivery pipe of the gravity roof storage tank. The Siamese connection shall be easily accessible to fire engine.

The system shall be provided with adequate drainage piping to discharge under pressure. The drainpipe shall not discharge into sanitary sewer.

All control valves shall be designed to withstand the pressure specified in Sec 3.2.7.2.

3.2.5 Design considerations for sprinkler system

(BNBC § 4.2.4 Page 10444)

The pipe schedule sizing to supply different number of sprinklers for their different uses may be in accordance with Tables 3.3 and 3.4.

Each sprinkler shall serve a maximum ceiling area specified in Table 3.5 for different types of building according to their uses.

The recommended pressure for sprinkler will be 100kPa.

Water supply piping and fittings for sprinkler system shall conform to the standard or one of the standards cited against them in accordance with Tables in Appendix IV. The standard requirements for other pipe materials not provided in these tables shall be subject to the approval of the Authority.

The sprinkler system shall be provided with adequate support or made flexible to prevent pipe breakage during earthquake.

Table 3.3 Size of water supply steel pipe to sprinklers

Pipe size mm (inch) nominal	No. of sprinkler connection for light hazard	No. of sprinkler connection ordinary hazard	No. of sprinkler connection ordinary extra hazard
25(1)	2	2	1
32 (1 1/4	3	3	2
38 (**1 1/2**)	5	5	5
50(2)	10	10	8
63 (2 1/2)	30	20	15
75 (3)	60	40	27
88 (3 1/2)	100	65	40
100 (4)	NL**	100	55
125 (5)	-	160	90
150 (6)	-	275	150
200 (8)	-	400***	225***
** No limit.			
***One sprinkler system riser or combined system riser shall serve the floor area not more than 4850m^2 for light and ordinary hazardous occupancy and 2325m^2 for extra hazardous occupancy			

(BNBC Table 4.4.5 Page 10444)

Table 3.4 Size of water supply copper pipe to sprinklers

Pipe size mm (inch) nominal	No. of sprinkler connection for light hazard	No. of sprinkler connection ordinary hazard	No. of sprinkler connection ordinary extra hazard*
25 (1)	2	2	1
32 (1 ¼)	3	3	2
38 (1 ½)	5	5	5
50 (2)	12	12	8
63 (1 ½)	40	25	20
75 (3)	65	45	30
88 (3 ½)	115	75	45
100 (4)	NL**	115	65
125 (5)	-	180	100
150 (6)	-	300	170
200 (8)	-	***	***
* Definition of these terms are given in BNBC Table 4.4.1 Page 10436 ** No limit. *** One sprinkler system riser or combined system riser shall serve the floor area not more than 4850 m^2 for light and ordinary hazard occupancy and 2325m^2 for extra hazard occupancy			

(BNBC Table 4.4.6 Page 10445)

Table 3.5: Ceiling area for a sprinkler

Building type	Light hazard** Area, m^2	Ordinary hazard** Area, m^2	Extra hazard** Area, m^2
Roof or floor on trusses, girders or beam	20(4.5*)	12(4.5*)	8.4(3.5*)
With high piling	-	9.3(3.5*)	8.4(3.5*)
Open wood joists	12(4.5*)	12(4.5*)	8.40.5*)
With high piling ***	-	9.3(3.5*)	8.40.5*)
Other type of	15.6(4.5*)	12(4.5*)	8.4(3.5*)
construction with high piling ***	-	9.3(3.5*)	8.40.5*)
Notes: * Maximum distance in m between sprinklers and between line of piping ** The definitions of these terms are given in BNBC Table 4.4.1 Page 10436 ***Storage facilities that permit closely piled materials over 4.5m or materials on rack over 3.6m.			

(BNBC Table 4.4.7 Page 10445)

The hanger in sprinkler system shall be designed to carry a load equal to five times the weight of the water-filled pipe plus an addition load of 110kg.

The support shall be designed to support a load equal to the weight-filled pipe plus additional load of 110kg.

There shall be Siamese connection to the sprinkler system located outside the building and accessible to the Fire Department connection.

All risers shall be connected through a gate valve with a main of size equal to that largest riser.

The sprinkler system shall be provided with adequate drainage arrangement. The drainpipe shall not discharge into sanitary sewer.

All control valves and fittings shall be able to withstand the pressure specified in Sec 3.2.7.2.

Table 3.6: Piping for sprinkler system

Material	Standard
Copper and copper-alloy	ASTM B32, ASTM B75 ASTM B88, ASTM B25
Steel	ANSI B36.10, ASTM A53 ASTM A120, ASTM A 135, ASTM A795

(BNBC Table 4.4.8 Page 1044

3.2.6 Fire pump

(BNBC § 4.2.6 Page 10446)

The fire pump shall be so designed that it shall satisfy the required pressures and flow for firefighting equipment at the highest and most remote part of the protected premises during their peak demand hour or for roof storage tank. The pump shall be housed in a readily accessible position in a building of non-combustible construction. The pump shall be adequately protected against mechanical damage.

A manually controlled pump may be used to feed water into gravity overhead tank with fire reserve. There shall be provision for standby fire pump driven by a compression ignition (diesel) engine or electric pump with own generator.

The fire fighting equipment directly fed by fire pump shall be designed with automatic fire pump. Once the pump starts it shall run continuously until stopped manually. The pump shall be fully operational within 30 seconds after starting. There shall be provision for manual starting. The pump shall be compression ignition engine or electricity driven with own generator. Where priming is necessary, automatic priming equipment shall be provided to ensure priming with water at all times. The fire pump shall not be used for other purpose.

3.2.7 Inspection, testing and maintenance

3.2.7.1 Inspection

(BNBC § 4.2.7.1 Page 10446)

Piping and joints shall not be enclosed, concealed or covered until they have been inspected and approved by the Authority. All piping and fixtures shall be inspected for satisfactory supports and protection from damage and corrosion. All outlets shall be free from obstruction.

3.2.7.2 Testing
(BNBC § 4.2.7.2 Page 10447)

Fire protection plumbing system or part thereof shall be tested and approved after installation by the Authority.

a) Testing of standpipe system: The system shall be tested for a pressure 25% in excess of the highest working pressure for at least 2 hours. The system shall be able to maintain above test pressures. The system shall be also be tested for the required flow at the highest outlet.
b) Testing of sprinkler system: This system shall be tested for at least 2 hours for a pressure of 1000 kPa or at 350 kPa in excess of normal working pressure when normal working pressure will be more than 650 kPa. The system shall also be tested for the required flow at the highest outlet.
c) Testing of pump: The pump used for firefighting purpose shall be tested for their performance characteristics. The pump shall be restored or repaired to its original condition if their performance characteristics fall below more than 10 per cent of the supplier's test characteristic curve.

3.2.7.3 Maintenance
(BNBC § 4.2.7.3 Page 10448)

The system shall be maintained for safe operating conditions and tested at least once a year.

3.3 Fire protective signalling or fire alarm system
(BNBC § 4.3 Page 10449)

Fire protective signalling or fire alarm system, where required by the BNBC, shall specify plans and clearly delineate the locations and number of all alarm-initiating devices and alarm-indicating appliances. The plan shall also provide details of all equipment to be used, proposed zoning, list of auxiliary control functions, location of the control panel and enunciators and a complete sequence of operation for the system.

Fire protective signalling or fire alarm system, wherever required and installed shall be maintained in full operating condition.

3.4 Automatic fire and smoke detection system
(BNBC § 4.4 Page 10450)

The installation of automatic fire and smoke detection system is a necessity when the size, arrangement and occupancy of a building become such that a fire itself cannot provide adequate warning to its occupants.

The automatic fire and smoke detection system shall include, spot or line type heat sensitive detectors and optical, ionized or chemical sensitive type of smoke detectors. A guideline for selection and sitting of fire detection system is provided below.

Note:
Where the entire existing RMG factory building is covered by automatic sprinkler system with appropriate warning system the requirement for automatic fire detection and alarm system may be relaxed.

3.4.1 Detailed guidelines for selection and sitting of fire detection system
(BNBC Appendix C Page 10476)

Based on needs arising out of various situations and occupancies, judicious selection is extremely important for the reduction of fire hazards. Since heat, smoke and flame are produced during a fire, detectors responding to all these are accepted as general purpose detectors. Out of these, fixed temperature heat detectors, rate of rise heat detectors, smoke detectors of a different type can be selected as the situation demands.

3.4.2 Sitting of detectors
(BNBC § C 4 Page 10477)

Every portion of building should be covered and all effectively enclosed spaces should be considered separately based on the limits of spacing for types of detectors concerned. Rooms divided into sections by walls, partitions or storage racks up to 300 mm to the ceiling or goods stacked in defined areas shall have detectors for each section of passageway.

Hoist, elevators and similar openings, windows, doors, ventilators and inlet ducts of an air-conditioning system shall be covered by detector within 1.5m at the top for every 2m of their width or part thereof.

Detectors shall be installed at the centre of each inlet to the return duct of an air-conditioning system. Detectors shall be installed 2m apart if the inlet is continuous or oblong.

Detectors on each floor shall cover staircases.

Spacing of detectors shall be reduced up to 75 per cent from the standard spacing in case of ceilings with waffle having depth between 200 and 500mm and up to 50 per cent with depths above 500mm. Where detectors are installed in the ridges of the waffle, each waffle shall be treated as an independent compartment.

Ceiling intersected by beams more than 250mm in depth, each bay shall be considered as separate compartment and detectors shall be installed considering each bay an independent compartment.

When positioned, heat sensitive elements shall be placed between 25 and 150mm from the ceiling or underside of roof. When ceiling are crossed by beams, girders or other structural elements of 250mm or more in depth to form compartments, detectors shall be placed in each compartment. One row of detectors shall be sited along the apex of each roof or bay. Space of this row of detectors and other detectors headed to cover the area shall be determined from the designed requirement At least one detector shall be suitably positioned within 1.5m of hoists, elevators, stairways, wall holes and similar openings to the floor above. Only fixed temperature type detectors shall be used in areas like kitchen, boiler room, furnace, room etc. where sudden temperature rise may take place.

Smoke detectors are usually sited where fire may accumulate the greatest concentration of visible and invisible smoke at the highest points of enclosed areas. The detectors shall be as mounted as to place the sensing elements between 25 and 100mm from the underside of roof. Area coverage by individual detectors are same as that of heat detectors but the maximum distance between two detectors may be 20 per cent more than that recommended for heat detectors. Actual spacing depends on airflow pattern in protected area.

Note:

Detectors on each floor shall cover staircases. Where the staircases of existing RMG factory building are constructed with appropriate fire enclosures the requirements for detectors may be relaxed.

3.5 Portable fire extinguisher

(BNBC § 4.10 Page 10451)

Potable fire extinguisher shall be of an approved type and shall be installed as per manufacturer's instruction. The portable extinguisher shall be placed near the path of exit travel and it shall be easily accessible. Fire hazard areas of a building like kitchen, public area, storage, electrical distribution point etc. shall be installed with portable fire extinguishers. Portable fire extinguisher shall be installed in private and public buildings as per specification and requirements of BDS 825: 1991 (BDS 825: 91).

3.6 Specific requirements for various occupancies

3.6.1 Scope

(BNBC § 5.1 Page 10452)

The provisions of this section shall control the installation of fire detection and fixed fire fighting arrangement in low-rise buildings of different occupancy groups. The term 'Low rise Building' shall include all structures that are not taller than 20 m from the finished ground level and do not have more than six floors.

3.6.2 Occupancy G: Industrial

(BNBC § 5.8 Page 10455)

In addition to the general provision covered under Part 3 of this guideline, the following requirements for Occupancy G shall be complied with.

3.6.2.1 Occupancy G1: Low Hazard Industries

(BNBC § 5.8.1 Page 10455)

Manually operated electric fire alarm system shall be installed along with portable fire extinguishers.

3.6.2.2 Occupancy G2: Moderate Hazard Industries

(BNBC § 5.8.2 Page 10455)

a) Area up to 750m^2 shall be installed with automatic fire alarm system along with portable fire extinguishers.
b) Area above 750m^2 shall be fitted with automatic sprinkler and/or automatic fire alarms system along with portable fire extinguishers.

Note:
Individual floor area above 750m^2 shall be fitted with automatic sprinkler system with appropriate warning system or automatic fire alarms system along with portable fire extinguishers and standpipes and hose system.

3.6.3 Occupancy H: Storage

(BNBC § 5.9 Page 10456)

In addition to the general provisions covered above the following requirements for Occupancy H shall be complied with.

3.6.3.1 Occupancy H1: Low Fire Risk Storage
(BNBC § 5.9.1 Page 10456)

Manually operated electric fire alarm system shall be installed. Depending on the type of materials to be stored, other detection and fire fighting system shall be provided as per direction of the Authority.

3.6.3.2 Occupancy H2: Moderate Fire Risk Storage
(BNBC § 5.9.2 Page 10456)

Automatic fire alarm system shall be installed. Depending on the type of stored materials other fire detection and fire fighting arrangement shall be provided as per direction of the Authority.

3.7 Special requirements of buildings more than 20 metres high
(BNBC Appendix D Page 10481)

Construction of all load-bearing components like stairways, corridors and facades shall be of non-combustible materials.

Internal staircase walls shall be made of bricks or reinforced concrete with a minimum of two hour fire rating.

The crown and landings of a staircase shall be ventilated to atmosphere with 0.5 m openings in the external walls and crown. Because of difficult location or other compelling reasons, if it becomes impossible to ventilate the staircase, a positive pressure of 50 pa shall be maintained inside the staircase by any approved means. Pressure sensitive Automatic Fire Alarm System shall be installed in the staircase. Stair roof shall be 1 m above the surrounding roof level. Use of glazing or fire bricks in the stair shall not be permitted.

Materials used for inner finish shall be restricted to Class I rating of flame spreadability.

3.7.1 Lifts
(BNBC § D 3 Page 10481)

Lifts installed in tall buildings shall comply with the following requirements over and above those listed under BNBC Chapter 5, Part 8.

Walls enclosing the lift core shall have a fire resistance rating of 2 hours. Lift shaft shall have a top vent area of not less than 0.2 m2.

The room containing the motor operating the lift shall preferably be placed at the roof of the lift core and shall be separated from the rest of the lift core by a floor wall having same fire rating as that of the lift core walls.

Landing doors in lift core shall have at least half an hour fire resistance rating.

Not more than four independent lifts can be assembled together in one lift-bank core and the core walls of individual lifts shall have a fire resistance rating of at least two hours.

Lift car doors shall have a fire resistance rating of at least one hour.

For lifts in buildings above 20m in height, collapsible gates shall not be permitted. Instead solid doors of

fire resistance rating equal to that of BNBC § A 3.5 shall be installed.

Grounding switch of the lifts hall be provided at ground floor level so that fire personnel can bring the lifts to ground level at the time of emergency.

Telephone or other voice communications facilities shall be provided in lifts installed in buildings of 20m or more in height. The communication system, in such cases shall be connected to ground command station.

Appropriate slope in floor shall be provided to avoid water entering the lift shaft during fire fighting.

Suitable signs shall be erected and maintained at appropriate positions on all floors of a high-rise building showing the floor plan and exit stairways. Cautions regarding use of lifts during a fire shall be inscribed in the signs.

3.7.2 Fire lifts

(BNBC § D 4 Page 10482)

One or more lifts shall be exclusively designed and maintained for the use of firemen is case of emergency. The lifts shall be so designed and maintained as to be able to reach upper floors and are directly accessible to every dwelling or lettable floor space on each floor by fire personnel.

The lift or lifts shall have a load carrying capacity of 545 kg (8 persons) with a minimum floor area of 1.4 m2 and auto close doors.

Power supply of the fire lift shall be separated from the main source supplying the building.

In case of power failure from normal supply, it shall be so designed as to trip automatically to alternate supply of power. In tall apartment complexes such trip-over could be accomplished by manually operated changeover switch. Other alternative could be an electric wiring which shall be so designed as to bring the lift car to ground level with door open in case of power failure.

Fire lifts shall be operated on a two-button switch system. A two-button switch is placed adjacent to the lift at floor level and kept in a glass-covered box. When the switch is on landing call points become inoperative and the lift is controlled from the car. When the switch is off the lift returns back to normal operation and can be used by occupants at normal times.

On landing doors at each floor, the sign "FIRE LIFT" shall be painted conspicuously in such sizes as to be easily noticeable by occupants or users of the lift.

Irrespective of height lift speed shall be such as to reach the top floor from ground level in one minute.

3.7.3 Service ducts

(BNBC § D 5 Page 10482)

Any service duct must comply with the following provisions:

a) Services ducts, if any, shall be enclosed by a two-hour rated firewalls and doors. Ducts having area more than 1 m^2 shall be closed at each floor level except the passage of pipes etc. across the floors. The passage gaps of pipes, cables, etc. shall be suitably sealed.
b) A vent opening at the crown of the service shaft shall be provided with an opening, the size of

which shall be between 25 and 50 per cent of the duct area.

c) Air-conditioning or other service shafts shall be located as far away as possible from the exits of a building.

3.7.4 Refuse chutes

(BNBC § D 6 Page 10483)

Refuse chutes shall be enclosed by wall of fire resistance rating of at least two hours and shall extend at least 1m above roof level and shall be open to atmosphere. Chutes in no case shall be located within the staircase enclosure. Inspection panels and doors to refuse chutes shall be at least one hour fire resistance rating.

3.7.5 Basements

(BNBC § D 8 Page 10483)

Each basement shall be independently ventilated. Venting shall be achieved by grills, breakable stall board lights or pavement lights or by way of shafts of aggregates having cross-sectional area of not less than 2.5 per cent of floor area spread evenly around the perimeter of the basement. Alternatively airflow inlet at floor level and smoke outlet at ceiling level may be provided. Inlets and extracts may be terminated at ground level with stall boards and pavement light, but ducts for conveyance of fresh air to floor shall have to be laid. Stall boards and pavement lights shall be so positioned as to be easily accessible by fire brigade personnel.

Basement staircase shall be encased and placed near the outer edge of the basement with materials of two hours fire resistance. The stair shall be separated from the basement in such a way that smoke from a fire in the basement shall not enter the ground and upper floors. Communication with the basement in case of emergency shall be maintained through a lobby provided with a fire resisting self-closing door of one-hour fire resistance.

Single intake duct may serve all the floors of a multi-storey basement, but separate smoke outlet duct or ducts shall be provided for each basement or basement compartment.

For lower basement floors, mechanical extractors for smoke venting shall be provided. The system shall operate automatically by heat sensitive elements or sprinklers. Devices with manual operation may also be installed. The following features shall also be considered:

a) Ventilating ducts shall be constructed with the brick masonry or cement concrete work as far as possible. Fire dampers shall be provided when these ducts cross the transformer or electrical switchboard areas.
b) Kitchen using gas, departmental stores and shops shall not be allowed to operate in basement or sub-basement.
c) Openable windows on external walls shall be fitted with such locks that can be opened by fireman axe.
d) Floor area exceeding 750m^2 shall be compartmented by fire separation walls with two hour fire ratings. Floor areas provided with sprinklers may be increased by 50 per cent. In long buildings distance between firewalls shall not exceed 40m.

3.7.6 Boiler location and boiler rooms

(BNBC § D 11 Page 10486)

Boilers shall be allowed to be installed away from escape route but shall not be allowed in sub-basement.

Boiler room shall be situated on the periphery of the factory building and shall have a four hour fire resistance wall. Floor shall be sloped to a catch pit.

For fresh air supply to the boiler room, it shall be fitted with air inlets and smoke exhaust system directly open to the atmosphere.

Entry to boiler room shall be through a two-hour fire resistance composite door.

Furnace oil tank in an adjacent room shall be separated by a four hour fire resistance wall. Entrance to this room shall be controlled by double composite doors. To prevent spread of accidental spillage of furnace oil, a suitable curb shall be erected at the entrance door opening.

3.7.7 Staircase and corridor lights

(BNBC § D 12 Page 10486)

Staircase and corridor lights shall comply with the following provisions.

The staircase and corridor lighting shall be connected to a separate independent circuit so that at times of emergency the fire fighting personnel can operate the same from an easily accessible location on the ground floor disregarding individual control of light points. The circuit shall be equipped with a miniature circuit breaker type of switch.

To avoid connection to two sources of supply at the same time, lighting installed in the staircase and corridor shall be suitably mounted on a double throw switch. To terminate standby supply, double throw switch shall be installed in the service room.

Staircase and corridor lighting shall also be connected with an alternate supply.

Staircase and corridors shall be provided with emergency lights.

3.7.8 Electrical services

(BNBC § D 13 Page 10486)

Electrical services shall confirm to the following provisions.

The electric distribution cables and wiring shall run through separate ducts. The duct shall be sealed with non-combustible materials at every floor level having the same fire resistance rating of that of the duct. Low and medium voltage wiring running in shafts and false ceiling shall run in separate conduits.

The duct carrying the electric cable shall not contain any other services like water mains, telephone lines, intercom lines, gas pipes, etc.

Electric power supply to water pumps, lifts, staircases, corridor lighting and blowers to keep pressure system running shall directly be provided through main switch gear panel. Power lines shall be laid in separate conduit pipes, so that fire in one circuit will not affect the others. Master switch circuit elements shall be clearly labelled.

Openings and inspection panel doors in the shaft shall be fitted with airtight fire doors having fire rating of at least 2 hours.

Medium and low voltage power lines in the shaft and within false ceiling shall run within metal conduits. 220V wiring for lighting and other services above false ceiling shall have 660V grade insulation. The false ceiling and all the materials and fixtures used its suspension shall be of non-combustible materials.

Electricity supply from the utility service providers and alternate supply cables shall lead to an independent well ventilated room, the Substation, on the ground floor for the purpose of termination for eventual distribution into the building. The door fitted in the Substation room shall be at least 2 hours fire resistance rated.

If the power authority agrees to install meters on upper floors, the authority and consumer cable lines shall be segregated by a partition in the duct. Meter rooms on upper floors shall not open on staircase and shall be directly ventilated to open air outside.

3.7.9 Standby generator

(BNBC § D 14 Page 10487)

The standby generator shall comply with the following.

A standby electric generator shall be installed to supply power for staircase and corridor lighting, fire lifts, standby fire pump, pressurization fans and blowers, smoke extraction and damper systems in case of failure of normal electricity supply.

Note:
During emergency the generator shall provide backup power for at least one hour.

The generator shall be capable of taking starting currents of all the machines and circuits stated above simultaneously.

When the standby pump is connected to diesel engine for supply of power, the pump may be withdrawn from standby generator supply.

For emergency, if supply is available from a separate sub-station with appropriate transformer, the provision of generator may be waived with the approval of power authority.

3.7.10 Transformers

(BNBC § D 15 Page 10487)

Transformers shall conform to the following provisions.

Without proper oil drainage arrangement, a sub-station or a switch station along with accompanying machines having more than 2000 litres of oil shall not be located in the basement of the building in normal circumstances. Transformers, when housed below ground level (sub-basement), shall be in a separate four-hour fire rated room located on the periphery of the sub-basement floor. The entrance to this room shall have a fire-resisting door of two hour fire rating. To prevent spread of accidental spillage of oil, a suitable curb shall be erected at the door opening. Direct access preferably from outside shall be provided to the transformer room. Switchgears and transformer bays shall be separately housed with a four-hour fire rated wall in between.

When housed in sub-basement, transformer rooms shall be equipped with automatic high velocity water spray system.

When a transformer is housed in complete segregation by a four-hour fire rated wall all around and has direct access from outside, the transformer room may be protected by CO2 (carbon dioxide), BCF (Bromo-chlorodifluoromethane) or BTM (Bromo- triflouromethane) fixed system.

When the transformer is on the ground level, the room shall be completely segregated from rest of the premises by four-hour fire rated walls all around. Oil filled transformers shall not be housed above ground level.

Where aggregate oil capacities of all machines do not exceed 200 litres, they shall be provided with a catch pit. When the aggregate capacity exceeds 200 litres, an RCC tank capable of holding the entire need shall be provided at lower level to collect the oil from catch pit in case of emergency. The connection between catch pit and tank shall be of non-combustible construction and provided with a flame arrester.

3.7.11 First aid fire fighting appliances
(BNBC § D 16 Page 10488)

First aid fire fighting appliances shall be provided on all floors, basements, etc. as required by the authority. Location and distributions of fire fighting appliances shall also be as required by the authority.

Note:
First aid hose system (38mm nominal) shall be provided (Ref. Fire Service Standard #9) in addition to fire aid fire fighting appliances in existing high-rise RMG buildings. In addition 50mm or larger hose connection facility shall be provided.

3.7.12 Fire alarm system
(BNBC § D 17 Page 10488)

Fire alarm systems shall comply with the following provisions:

All buildings with a height of more than 20 m shall be equipped with manually operated electrical fire alarm system and automatic fire alarm system.

Manually operated electrical alarm system shall be installed in a building with single or multiple call boxes located on each floor.

3.7.13 Command station
(BNBC § D 18 Page 10489)

All buildings above 23m in height shall have a command station on the entrance lobby with suitable public address system having communication to all floors as well as facilities to receive messages from all floors. The command station shall be equipped with detailed floor plans along with clearly demarcated locations of fire detection and fighting devices and through the panel board able to detect fire alarm from any floor. The command station shall be manned with properly trained personnel having responsibility of maintenance and operating fire-fighting facilities within the building.

3.7.14 House keeping
(BNBC § D 20 Page 10489)

To reduce or minimize fire hazard, good housekeeping within and outside shall be strictly maintained by the occupants and owner of the building.

3.8 Fire drills

(BNBC § A 3 Page 10457)

Fire drills must be conducted quarterly (four times a year) in existing buildings as detailed under the Fire Safety Plan (BNBC § A 4.7 and A 4.8) for the first two years from the data of enforcement of this Code. For new buildings, the period of two years shall be counted from the beginning of occupancy of the building. After this initial period of two years, fire drills must be conducted twice a year in all buildings.

All occupants of the buildings shall participate in the fire drill and the building service employees including fire warden and his/her staff shall actively help the inmates in the process of drill. The very old, convalescent patients or otherwise incapacitated inmates are not obliged to actively take part in the exercise, except the fire warden and his staff and family members of such person shall chalk out a clear plan as to how to evacuate in a real emergent situation with such incapacitated persons.

A record of such drills shall be kept in writing for at least three years for the inspection of fire brigade whenever called for.

3.9 Prohibition of smoking and naked lights

There shall be a notice posted prohibiting smoking and use of naked lights (without protective covers) in any place where they would be dangerous, or where the Inspector may require, and all other reasonable precautions against fire shall be taken, in Bengali and in English languages.

Note:
This provision does not prevent lights in storage area where lights with protective covers shall be installed.

3.10 Fire fighting apparatus - Factory Rules 1979

(Factories Rules 1979, S.R.O 101/78/LSWVI/11(4)/78 § 52 & 53 Page 1545 - 46)

Fire fighting apparatus and water supply for fire fighting shall follow the Factory Rules 1979 provided in Appendix IV of this guideline.

Part 4: Standards of Electrical and Electronic Engineering Installations

4.1 Purpose

The purpose of this standard is to make sure that the electrical and electronic installations in buildings are safe (i) for persons, (ii) for the buildings and (iii) for the contents of the buildings, from electrical hazards arising from the use of electricity for light, heat, power, automation, control, communications and similar other purposes.

4.2 Scope

The provisions in this chapter set minimum standards for electrical and electronic engineering installations in occupancy type G2 buildings. It also covers installations of conductors that connect to the supply of electricity. In addition, it includes general requirements relating to lighting protection of buildings.

Electrical and electronic engineering installations include normal and standby power supply system, lighting and illumination, fans cooling/heating system, supply system for the lifts, telecommunications systems, data communication systems, fire alarm system, CCTV monitoring system, access control system, burglar alarm system. Electrical wiring/cabling form a major part in the above-mentioned installation works.

4.3 References

The documents listed in this section are referenced in this Standard and the portions thereof are considered part of the requirements of this Standard to the extent of each such reference.

a) Bangladesh National Building Code (BNBC) (2006)
b) Electricity Act, 1910
c) Electricity Rules, 1937
d) Fire Service Rules, 1961
e) Relevant Bangladesh Standards (BDS)

4.4 Electrical wiring and cabling

(BNBC §2.5, Page 11242)

4.4.1 Electrical connections

Separate branch circuits shall be provided for the installation, which need to be separately controlled. These branches should not be affected by failure of other branch circuits. The number of final circuits required and the points supplied by any final circuits shall comply with

a) The requirement of over current protection
b) The requirement for isolation and switching
c) The selection of cables and conductors

All final circuits shall be wired- using looping wiring system no joint box shall be used.

Separate branch circuits shall be provided from miniature circuit breaker (MCB) or fuse distribution boards (FDB) for general lighting automatic and fixed appliances with a load of 500 watt or more and plug receptacles. Each automatic or fixed appliance shall be served by an individual circuit.

Individual branch circuits must have spare capacity to permit at least 20% increase in load before reaching the level of maximum continuous load current permitted for that circuit.

At least one spare circuit must be allowed in the distribution board for each five circuits in use.

Size of wire to be used in a branch circuit shall be at least one size larger than that computed from the loading if the distance from the over current protective device to the first outlet is over 15m.

When the distance from the over current protective device to the first socket outlet on a receptacle circuit is over 30m the minimum size of wire used for a 15A branch circuit shall be 4mm2 (7/0.036).

The use of common neutral for more than one circuit shall not be permitted.

Circuits with more than one outlet shall not be loaded in excess of 50% of their current carrying capacity.

Connections between conductors and between conductors and other equipment shall provide durable electrical continuity and adequate mechanical strength and protection.

4.4.2 Wiring

Surface/exposed wiring shall be run-either horizontally or vertically, and never at an angle. Battens on ceiling shall be run parallel to the edges in either orthogonal direction, and not at an angle.

In case of concealed wiring, the wires shall be encased in metallic (GI) or non-metallic (PVC) conduits that are buried in roof or floor concrete and in brick/concrete wall. The conduits in the walls shall be run horizontally or vertically, and not at an angle. Conduits in concrete slabs shall be placed at the centre of thickness and supported during casting by mortar blocks or 'chairs' made of steel bare or any other approved means. All conduits shall be continuous throughout their lengths.

Underground cables for electrical distribution in the premises/garden/compound of the building shall be encased in GI or PVC pipes and laid in earth trenches of sufficient depth. Armoured cables need not be encased in conduit except for crossings under road, footpath, walkway or floors.

Wiring for connections to machines shall be carried in steel pipes or cable tray hung from the ceiling or in concrete or steel cable tray running over the floor.

4.4.3 Wiring for lights

Lighting fittings shall be supported by suitable pipe/conduits, brackets fabricated from structural steel, steel chains or similar materials depending upon the type: and weight of the fittings.

The use of fittings wire shall normally be restricted to the internal wiring of the lighting. When the fittings wire is used as wiring for the fittings the sub circuit load shall terminate in a ceiling rose or box with connectors, from which they shall be carried into the fittings.

4.4.4 External influences

4.4.4.1 Ambient temperature

Wiring system components including cables and wiring accessories shall be installed or handled only at temperatures within the limits stated in the relevant product specification or as given by the manufacturers.

4.4.4.2 External heat sources

In order to avoid the effects of heat from external sources one of the following methods or an equally effective method shall be used to protect wiring systems:

- Shielding;
- Placing sufficiently far from the source of heat;
- Selecting a system with due regard for the additional temperature rise which may occur;
- Local reinforcement or substitution of insulating material.

4.4.4.3 Presence of water

Wiring systems shall be selected and erected so that no damage is caused by the ingress of water. The completed wiring system shall comply with the IP degree of protection relevant to the particular location.

4.4.5 Selection and erection to minimize the spread of fire

The risk of spread of fire shall be minimized by the selection of appropriate materials and erection.

Wiring systems shall be installed so that the general building structural performance and fire safety are not reduced.

Cables not complying, as a minimum, with the flame propagation requirements, if used, be limited to short lengths for connection of appliances to permanent wiring systems and shall in any event not pass from one fire-segregated compartment to another.

Parts of wiring systems other than cables which do not comply, as a minimum, with the flame propagation requirements but which comply in all other respects with standards for wiring systems shall, if used, be completely enclosed in suitable non-combustible building materials.

4.4.6 Conduits and conduit fittings

Non-metallic conduits and conduit fillings shall be of heavy wall water grade type. All bends shall be large radius bends. The cross-section of the conduit shall remain circular at the bend and the internal diameter shall not be reduced. PVC pipe fittings shall be sealed with PVC solvent cement or by using glue or gum paste of approved quality. Conduits installed in floors shall have a slope of at least 1:1000 towards floor mounted pool box or cable duct.

4.4.7 Socket and plug

Each 15/20A socket outlet for air-conditioner, water cooler, etc. shall be provided with its own individual fuse with suitable discrimination with backup fuse or miniature circuit breaker (MCB) in the distribution/ sub-distribution board. The socket outlet need not necessarily embody the fuse as an integral part of it.

Each socket outlet shall also be controlled by a switch which should normally be located immediately

Table 4.1 Maximum permissible weight to which twin flexible cords may be subject

Nominal cross-sectional area of twin flexible cord (mm^2)	Number and diameter (mm) of wires	Maximum permissible weight (kg)
0.5	16/0.2	2
0.75	24/0.2	3
1.0	32/0.2	5
1.5	48/0.2	5.3
2.5	80/0.2	8.8
4	128/0.2	14

BNBC Table 8.2.3, Page. 11240

adjacent thereto or combined therewith.

The copper earth wire for 5A socket outlets shall not be smaller in size than 14 SWG and the phase wire to the socket outlet shall be through the switch.

4.4.8 Lighting fittings

In industrial premises lighting fittings shall be supported by suitable pipe/conduits, brackets fabricated from structural steel, steel chains or similar materials depending upon the type and weight of the fittings. Where a lighting fitting is to be supported by one or more flexible cords, the maximum weight to which the twin flexible cords may be subject are shown in Table 4.1.

No flammable shade shall form part of lighting fitting unless such shade in such shade is well protected against all risks of fire. Celluloid shade or lighting fitting shall not be used under any circumstances.

4.4.9 Layout and installation drawings

An electrical layout drawing shall be prepared after proper locations of all outlets for lamps, fans, fixed and transportable appliances, motors etc. have been selected.

Power and heating sub-circuits shall be kept separate and distinct from lighting and fan sub-circuit. All types of wiring whether concealed or surface shall be as near the ceiling as possible.

Circuits in 3-phase installations shall be balanced.

Conductors shall be so enclosed in earthed metal or incombustible insulating materials so that it is not possible to have ready accesses to them unless the points between which a voltage exceeding 240 volts may be present are 2m or more apart. In case such points are kept apart the means of access shall be marked to indicate the voltage present.

Where terminals or other fixed live parts between which a voltage exceeding 240V exists are housed in separate enclosures or items of apparatus which although separated are within reach of each other a notice shall be placed in such a position that anyone gaining access to live parts is warned of the magnitude of the voltage that exists between them.

Layout drawings shall indicate the relevant civil and mechanical details.

4.4.10 Conductor and cables

4.4.10.1 Conductors

Conductors shall be of copper or aluminium.

Conductors for power and lighting circuits shall be of adequate size to carry the designed circuit load without exceeding the permissible thermal limits for the insulation.

Phase and neutral wires shall be of the same size.

4.4.10.2 Flexible cables and flexible cords

Flexible cable or cords shall not be used as fixed wiring unless contained in an enclosure affording mechanical protection. Flexible cords may be used for connections to portable equipment.

4.4.10.3 Cable ends

All stranded conductors having nominal cross-sectional area 6mm2 and above shall be provided with cable sockets. For stranded conductors of cross-sectional area below 6 mm2 and not provided with cable sockets, all strands at the exposed ends of the cable shall be soldered together or crimped using suitable sleeve or ferrules.

4.4.10.4 Cable joints

Cable joints are to be realised through porcelain/PVC connectors with PIB tape wound around before placing the cable in the box.

4.4.10.5 Expansion joints

Conduits shall not normally be allowed to cross expansion joints in a building. Where such crossing is found to be unavoidable special care must be taken to ensure that conduit runs and wring are not in any way put to strain or are not damaged due to expansion/ contraction of the building structure.

4.4.11 Sub-distribution boards

4.4.11.1 Enclosures

Sub-distribution boards shall be located as close as possible to the electrical load centres.

Enclosures for sub-distribution boards located inside the building shall be dust-proof and vermin-proof using sheet steel fabrication of a minimum thickness of 20 SWG. The boards shall be safe in operation and safe against spread of fire due to short circuit.

Table 4.2 provides recommended sizes of enclosures for sub-distribution boards containing miniature circuit breakers or fuses.

Table 4.2 Recommended enclosure sizes for MCBs and fuses

Dimensions (mm)			No. of MCBs or fuses
Height	Width	Depth	
350	390	120	Up to 12
480	390	120	Up to 24
610	390	120	Up to 36
740	390	120	Up to 48

(BNBC Table 8.2.7, Page. 11245)

4.4.11.2 Wiring of sub-distribution boards

The total load of the consuming devices shall be distributed in wiring a sub-distribution board as far as possible evenly between the numbers of ways of the board leaving the spare way(s) for future extension.

Cables shall be connected to terminals only by soldered or welded lugs, unless the terminal are of such form that it is possible to securely clamp them without cutting away the cable strands.

4.4.12 Service entry

Overhead service connection to a building shall be achieved with covered conductor. The overhead service connection shall be led into buildings via roof poles or service masts made of GI pipe having a gooseneck bend at the top and installed on the outer wall.

Underground service cables shall be laid in conformity with the requirements of wiring of concealed wiring.

Power and telecommunication or antenna cables shall be led in separately.

4.5 Electrical service shaft and bus duct

(BNBC §2.5.6, Page 11246)

4.5.1 Service shaft

Buildings over six storeys or 20m high shall have a minimum of one vertices vertical shaft of 200mm x 400mm size for every 1500m2 floor areas.

Free and easy access to the electrical shaft room in each floor must be available for operation, maintenance and emergency shut downs.

Vertical cables other than electrical cables shall be placed at a sufficient distance from the nearest electrical cable. A vertical separating brick wall between electrical and non-electrical wall is preferable.

Vertical service shaft for electrical risers must not be placed adjacent to the sanitary shafts. They should be placed at significant separation in order to ensure that the vertical service shaft for electrical risers remains absolutely dry.

4.5.2 Bus duct

Bus ducts should be used for exposed work or where concealing is not of a permanent nature. The bus duct shall be laid with minimum numbers of bends for distribution system. Typical rating of feeder bus ducts for 3-phase, 3-wire or 4-wire system shall range from 200 amperes to 3000 amperes. Concrete horizontal ducts of suitable size shall be provided along the roads for a group of buildings to be fed by a single substation.

Floors of the duct area shall be constructed in such a way so that the empty space after putting the cables/bus-bar trunking/pipes/conduits in position the remaining open space is filled up with RCC slab(s) or any other non-inflammable material so that fire or molten PVC cannot fall from one floor to the next lower floor(s). For this purpose arrangements need to be made during the main floor casting.

4.5.3 Sealing of shaft and duct

Where a wiring system passes through elements of building construction such as floors, walls, roofs, ceilings, partitions or cavity barriers, the openings remaining after passage of the wiring system shall be sealed according to the degree of fire resistance prescribed for the respective element of building construction before penetration.

Wiring systems that penetrate elements of building construction having specified fire resistance shall be internally sealed to the degree of fire resistance of the respective element before penetration as well as being externally sealed.

4.6 Electrical substation

(BNBC §2.6, Page 11247)

Necessity and capacity of the electrical substation shall be set by regulations in the Electricity Act or by the relevant electrical utilities.

To arrive at the capacity of the substation required, a load factor of 70% shall be applied to the estimated load of the building, unless future expansion requirements dictate that a higher figure be considered.

4.6.1 Substation location

The substation shall be installed on the lowest floor level. Location of substation in the basement floor should be avoided. Direct access from the street for installation or removal of the equipment shall be provided.

The floor level of the substation or switch room shall be above the highest flood level of the locality. Suitable arrangements should exist to prevent the entrance of storm or floodwater into the substation area.

In case of building complex, or a group of buildings belonging to the same organization, the substation should preferably be located in a separate building and should be adjacent to the generator room, if any.

In case the electric substation has to be located within the main building for unavoidable reasons, it should be located on ground floor.

For transformers having large oil content (more than 2000 litres), soak pits are to be provided.

The minimum height of the substation room shall be 3.6 m. The minimum area required for substation and transformer rooms for different capacities are given in Table 4.3.

Table 4.3 Area required for transformer room and substation for different capacities

Capacity of transformer (kVA)	Transformer room area (m^2)	Total substation area (with HT, LT panels and transformer room but without generators) (m^2)
1x50	12	42
1x250	13	45
2x250	26	90
1x400	13	45
2x400	26	90
3x400	39	135
2x630	26	90
3x630	39	135
2x1000	26	90
3x1000	39	135

(BNBC, Table 8.2.8, Page 11249)

4.6.2 Layout of substation

The layout of the substation shall be in accordance of the power flow, i.e. from utility network to HT room, then to transformer and finally to the low voltage switchgear room. In general, the substation HT to LT Transformer shall be placed in one corner of the room so that the HT side remains away from the passage of the persons.

The HT metering panel shall be located near the exterior of the substation room near the exit gate and also shall be convenient for the HT cable entry.

The HT Panel shall be located near the exterior, just after or adjacent to the HT panel.

LT Panel shall remain at a sufficient distance from the transformer but not too far away from the transformer. The location of the LT panel should such that the riser main cable can have their way upward or outward within very short distance.

All the rooms shall be provided with partitions up to the ceiling and shall have proper ventilation. Transformer rooms shall have proper ventilation and where necessary louvers at lower level and exhaust fans at higher level shall be provided at suitable locations in such a way that cross ventilation is maintained.

Arrangement shall be made to prevent storm water entering the transformer and switch rooms through the soak pits, if floor level of the substation is low.

4.7 Equipment and accessories

(BNBC §2.7.3, Page 11251)

4.7.1 High voltage switchgear

Banks of switchgears shall be segregated from each other by means of fire resistant barriers in order to prevent the risk of damage by fire or explosion arising from switch failure. Where 3 bus-section switch is installed, it shall also be segregated from adjoining banks in the same way.

In the case of duplicate or ring main supply, switches with interlocking arrangement shall be provided to prevent simultaneous switching of two different supply sources

4.7.2 Low voltage switchgear

Switchgear and fuse gear must have adequate breaking capacity in relation to the capacity of the transformers.

Isolation and protection of outgoing circuits forming the main distribution system may be effected by means of circuit breakers, or fuses or switch fuse units, mounted on the main switchboard, the choice between alternative types of equipment will take the following points into consideration:

- In certain installations supplied with electric power from remote transformer substations, it may be necessary to protect main circuits with circuit breakers operated by earth leakage trips in order to ensure effective earth fault protection.
- Where large electric motors, furnaces or other heavy electrical equipment are installed, the main circuits shall be protected by metal clad circuit breakers or conductors fitted with suitable instantaneous and time delay over current devices together with earth leakage and backup protection where necessary.
- In installations other than those mentioned above or where overloading of circuits may be considered unlikely, HRC type fuses will normally afford adequate protection for main circuits separately as required; the fuses shall be mounted in switch fuse unit or with switches forming part of the main switch boards.
- Where it is necessary to provide suitable connection for power factor improvement capacitors at the substation bus, suitable capacitors shall be selected in consultation with the capacitor and switchgear manufacturer and necessary switchgear/feeder circuit breaker shall be provided for controlling the capacitor bank(s).

4.7.3 Transformers

In most cases oil type natural cooled transformer may be used for substations if adequate space is available to accommodate the transformer.

Dry type transformer should be installed where risk of spreading of fire is high and where flammable materials are to be kept around the substation.

Where two or more transformers are to be installed in a substation to supply a medium voltage distribution system, the distribution system shall be divided into separate sections each of which shall normally be fed from one transformer only unless the medium voltage switchgear has the requisite short circuit capacity, provision may be made to interconnect separate sections through bus couplers to cater for the failure or disconnection of one transformer.

The transformers that at any time operate in parallel shall be so selected as to share the load in proportion to their respective ratings.

When a step-up transformer is used, a linked switch shall be provided for disconnecting the transformer from all poles of the supply, including the neutral conductor.

4.7.4 Rotating machines

All equipment including cables of every circuit carrying the starting, accelerating and load currents of motors shall be suitable for a current at least equal to the full load current rating of the motor. When the motor is intended for intermittent duty and frequent stopping and starting, account shall be taken of any cumulative effects of the starting periods upon the temperature rise of the equipment of the circuit.

The rating of circuit supplying the rotors through slip ring or commutator of induction motors shall be suitable for both the starting and loaded conditions.
Every electric motor having a rating exceeding 0.376 kW shall be provided with control equipment incorporating means of protection against overcurrent.

Every motor shall be provided with means to prevent automatic restarting after a stoppage due to drop in voltage or failure. This requirement does not apply to any special cases where the failure of the motor to start after a brief interruption of the supply would be likely to cause greater danger. It also does not preclude arrangements for starting a motor at intervals by an automatic control device where other adequate precautions are taken against danger from unexpected restarting.

The frame of every stationary motor shall be connected with earth.

4.7.5 Energy meters

Energy meters shall be installed in residential buildings at such a place that is readily accessible to the owner of the building and the Authority. Installation of Digital Energy Meters at the users' premises is a requirement of the distribution Companies.

Energy meters should be installed at a height where it is convenient to note the meter reading but should not be installed at a level less than 1.5 metre above the ground.

The energy meters should either be provided with a protective covering, enclosing it completely except the glass window through which the readings are noted, or shall be mounted inside a completely enclosed panel provided with hinged or sliding doors with arrangement for locking. Earthing terminal must be provided if a metal box is used. Such an earthing terminal must be connected to the ECC.

4.7.6 Cables

The advice of the cable manufacturer with regard to installation, jointing and sealing shall be followed.

The HT cables shall either be laid on cable racks or in built-up concrete trenches/tunnel/ basement or directly buried in the ground. Standard cable laying techniques shall be used.

Methods of installation of cables and conductors in common use as specified in BNBC Table 8.2.10 shall be followed.

4.8 Main switch, switchboards and metal clad switchgear

(BNBC §2.7.5, Page 11256)

4.8.1 Main switch, switchboards

All main switches shall be either of metal clad enclosed patterns or of any insulated enclosed pattern and the switches shall be fixed at close proximity to the point of entry of supply.

The wiring throughout the installation shall be such that there is no break in the neutral wire in the form a switch or fuse unit or otherwise.

The location of the main board shall be such that it is easily accessible for firemen and other personnel to quickly disconnect the supply in case of emergencies.

Open type switchboards shall be placed only in dry locations and in ventilated rooms and they shall not be placed in the vicinity of storage batteries or exposed 10 chemical fumes.
In damp situation or where inflammable or explosive dust, vapour or gas is likely to be present, the switchboard shall be totally enclosed or made flame proof as may be necessitated by the particular circumstances.

Switchboards shall not be erected above gas stoves or sinks or within 2.5m of any washing unit in the washing rooms or laundries.

In case of switchboards being unavoidable in places likely to be exposed to weather, to drip or in abnormally moist atmosphere, the outer casing shall be weather proof and shall be provided with glands or bushings or adapted to receive screwed conduit.

Adequate illumination shall be provided for all working spaces about the switchboards when installed indoors.

All metal casings or metallic coverings containing or protecting any electrical supply line or apparatus shall be connected with earth.

4.8.2 Metal clad switchgear

Metal clad switchgear shall be mounted on hinged type metal boards or fixed type metal boards.

Hinged type metal boards shall consist of a box made of sheet metal not less than 2 mm thick and shall be provided with a hinged cover to enable the board to swing open for examination of the wiring at the back. The joints shall be welded. The board shall be securely fixed to the wall by means of rag bolt plugs or wooden plugs and shall be provided with locking arrangement and earthing stud. All wires passing though the metal board shall be protected by a rubber or wooden bush at the entry hole. The earth stud should be commensurate with the size of the earth lead(s).

Fixed type metal boards shall consist of an angle or channel steel frame fixed on the wall at the top, if necessary.

There shall be a distance of one meter clear in front of the switchboards.

4.8.3 Location of distribution boards

The distribution fuse boards shall be located as near as possible to the centre of the load they are intended to control.

They shall be fixed on suitable stanchion or wall and shall be accessible - for replacement of fuses, and shall not be more than 2m from floor level.

They shall be either metal clad type, or all insulated type. But if exposed to weather or damp situations, they shall be of the weatherproof type and if installed where exposed to explosive dust, vapour or gas, they shall be of flameproof type. In corrosive atmospheres they shall be treated with anticorrosive preservative or covered with suitable plastic compounds.

Where two of more distribution fuse-boards feeding low voltage circuits are fed from a supply of medium voltage, these distribution boards shall be:

- fixed not less than 2m apart, or
- arranged so that it is not possible to open two at a time, namely they, are interlocked, and the metal case is marked "Danger 400 Volts" and identified with proper phase marking and danger marks, or
- installed in rooms or enclosures accessible to authorized persons only.

All distribution boards must be marked "Lighting" or "Power", as the case may be, and also be marked with the voltage and number of phases of the supply. Each must be provided with a circuit list, giving diagram of each circuit that it controls and the current rating for the circuit and size of fuse element.

4.9 Standby power

(BNBC §2.6.4, Page 11249)

Provision must be made for standby power supply to avert panic, hazard to life and property or major production loss in case of interruption of electrical power supply. The standby power supply must be a petrol engine or diesel engine or gas engine generator or an IPS or a UPS.

4.9.1 Capacity of a standby generating set

The capacity of standby generating set shall be chosen on the basis of essential light load, essential air-conditioning load, essential equipment load and essential services load, such as one lift out of a bank of lifts, one or all water pumps, etc. The generator shall be capable of taking starting currents of all the machines and circuits stated above simultaneously.

The generator frame shall be earthed by two separate and distinct connections to earth.

4.9.2 Standby power for lifts

In a building, where a lift is installed, stand by power shall be provided by a self-contained generator set to operate automatically whenever there is a disruption of electrical power supply to the building.

Where only one lift is installed, the lift shall transfer to standby power within 60 seconds after failure of normal power.

Where two or more lifts are controlled by a common operating system, all lifts may be transferred to

standby power within 60 seconds after failure of normal power, or if the stand by power source is of insufficient capacity to operate all lifts at the same time, all lifts shall be transferred to standby power in sequence, shall return to designated landing and discharge their load.

4.9.3 Generator room

The generating set should preferably be housed in the substation building or should be placed adjacent to the substation room to enable transfer of electrical load with negligible voltage drop as well as to avoid transfer of vibration and noise to the main building.

The generator room should have significant amount of ventilation and fitted with a number of ceiling fans. Appropriate type and number of fire fighting equipment must be installed inside the generator room.

The generator engine exhaust should be appropriately taken out of the building and should preferably be taken out through any other side except South. The generator oil tank should be place away from the control panel side. In case of gas engine generator extra precaution must be taken regarding ventilation, leakage to prevent explosion.

Table 4.4 shows minimum generator room requirements for different sizes of generators.

Table 4.4 Area requirements for standby generator room

Capacity (kW)	Area (m^2)
1x25	20
1x48	24
1x100	30
1x150	36
1x300	48
1x500	56

(BNBC Page 11250)

4.9.4 Changeover switch of a standby generator

A standby generator is to be connected at the supply input point after the energy meter and after the main incoming switch or the main incoming circuit breaker, but through a changeover switch of appropriate rating. The rating of such a switch shall be at least 1.25 times the rating of the main incoming circuit breaker. The changeover switch shall be of such a type so that when moved to the mains position, there is no chance that the generator will be connected and vice versa.

The changeover switch may be manual type or automatic type. In both the cases the changeover switch shall be properly made so that there is no chance of loose connection or spark.

4.10 Protection of circuits

(BNBC §2.7.6, Page 11259)

Appropriate protection shall be provided at switchboards and distribution boards for all circuits and sub-circuits against short circuit and overcurrent and the protective apparatus shall be capable of interrupting any short circuit current that may occur without danger.

Where circuit breakers are used for protection of main circuit and the sub-circuits derived therefrom, discrimination in operation shall be achieved by adjusting the protective devices of the sub-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 not exceed the current rating of the smallest cable in the circuit protected by the fuse.

4.10.1 Protection against overload current

Protective devices shall be provided to break any overload current flowing in the circuit conductors before such a current could cause a temperature rise detrimental to insulation, joints, terminations or surroundings of the conductors.

The omission of devices for protection against overload is recommended for circuits supplying current-using equipment where unexpected opening of the circuit could cause danger.

4.10.2 Protection against short-circuit currents

Protective devices shall be provided to break any short-circuit current flowing in the circuit conductors before such a current could cause danger due to thermal and mechanical effects produced in conductors and connections.

4.10.3 Protection against undervoltage

Where a drop in voltage, or a loss and subsequent restoration of voltage could imply dangerous situations for persons and property, suitable precautions shall be taken.

An undervoltage protective device is not required if damage to the installation is considered to be an acceptable risk, provided that no danger is caused to persons.

4.11 Earthing

(BNBC §2.8, Page 11259)

In general all parts of equipment and installation other than live parts shall be earth potential, thus ensuring that persons coming in contact with these parts shall also be at earth potential at all times.

4.11.1 Circuit and system earthing

Circuit and system earthing shall limit excessive voltage from line surges from crossovers with higher voltage lines or turn lighting and keep non-current carrying enclosures and equipment at zero potential with respect to earth.

The value of the earthing resistance shall be in accordance with the protective and functional requirements of the installation and be continuously effective.

Where a number of installations have separate earthing arrangements, protective conductors running between any two of the separate installations shall either be capable of carrying the maximum fault current likely to flow through them or be earthed within one installation only and insulated from the earthing arrangements of any other installation. In the latter circumstances, if the protective conductor

forms part of cables the protective conductor shall be earthed only in the installation containing the associated protective device.

4.11.2 Methods of earthing

The three main elements required for an earthing system are earth conductors, earthing lead and earth electrodes.

4.11.2.1 Earth conductors

Earth conductors are the part of the earthing system that joins all the metal parts of an installation.

In all eases the grounding conductor shall be made of copper or galvanized steel or other metals or combination of metals which will not corrode excessively and, if practical, shall be without joints or splice. If joints are unavoidable, they shall be made and maintained so as not to materially increase the resistance of the earthing conductor and shall have appropriate mechanical and corrosion resistant characteristics.

Aluminium or copper clad aluminium conductors shall not be used for final connections to earth electrodes.

The earth conductor shall have a short time capacity adequate for the fault current which can flow in the grounding conductor or conductors for the operating time of the system protective device. In case of copper wire being used as earth conductors, the size of the wire shall not be less than half the area of the largest current carrying conductor supplying the circuit.

Table 4.5 gives the minimum sizes of copper earth conductors corresponding to the sizes of associated copper circuit conductors. No size smaller titan 14 SWG shall be used anywhere as earth conductor.

Table 4.5 Minimum cross-sectional area of copper earth conductors in relation to the area of associate phase conductors

Cross-sectional area of phase conductor(s) (mm^2)	Minimum cross-sectional area of the corresponding earth conductor (mm^2)
Less than 16	Same as cross-sectional area of phase conductor but not less than 14 SWG
16 or greater but less then 35	16
35 or greater	Half the cross-sectional area of phase conductor

(BNBC, Table 8.2.11, Page 11261)

4.11.2.2 Earth lead

The earth conductor shall be brought to one or more connecting points according to size of installation; the copper wire earthing leads shall run from there to the electrodes.

Earthing lead can either be of copper wire or of copper strands.

Earthing leads shall be run in duplicate down to the earth electrode so as to increase the safety factor of the installation. Copper wire used as earthing lead must not be smaller than 8 SWG (12 mm2).

4.11.2.3 Earth electrodes

The earth electrode shall as far as practicable penetrate into permanently moist soil preferably below ground water table. The resistance of the electrodes shall not be more than one ohm.
The following types earth electrodes are recognized:

- Copper rods
- Copper plates
- Galvanised iron pipes

The following is a guideline for electrode size:

- Copper rods shall have a minimum diameter of 12.7mm,
- GI pipes shall have a minimum diameter of 50mm,
- Copper plates shall not be less than 600mm x 600mm in size, with 6mm thickness.

4.12 Lightning protection

(BNBC §2.9, Page 11262)

A building shall have protection against lightning depending on the probability of a stroke and acceptable risk levels. Steps shall be taken for an objective assessment of the risk and of the magnitude of the consequences of lightning strikes following BNBC Part 8, Section 2.9. The marginal Risk Index shall be 40. Structures higher than 53m require protection in all cases.

A complete lightning protection system shall consist of air termination network, down conductors and earth termination.

4.12.1 Air termination network

The air termination network is that part which is intended to intercept lightning discharges. It consists of vertical and horizontal conductors arranged to protect the required area. No part of the roof should be more than 9m from the nearest horizontal conductor except that an additional 0.3 m may be added for each 0.3m or part thereof by which the part to be protected is below the nearest conductor.

4.12.2 Down conductor

The down conductor is the conductor that runs from the air termination to the earth termination. A building with a base area not exceeding 100 m2 shall be provided with one down conductor. For a large building there shall be one down conductor for the first 100m2 plus a further one for every 300m2 or part thereof in excess of the first 100 m2. Alternatively, for a larger building one down conductor may be provided for every 30m of perimeter. The number chosen can be the smaller of the numbers given by these alternative methods of calculation.

The material used for lightning conductors must be aluminium or copper. The criterion for design is to keep the resistance from air termination to earth to a minimum.

4.12.3 Earth termination

The earth termination is that part which discharges the current into the general mass of the earth. The total resistance of an electrode for a lightning protection system must not exceed 10 ohms.

The lightning protection system ground terminals shall be bonded to the building or structure grounding electrode system.

Recommended dimensions for various components of lightning arrester are given in Table 4.6. Larger conductors should however be used if the system is unlikely to receive regular inspection and maintenance.

Table 4.6 Sizes of the components of lightning protection systems

Components	**Minimum dimensions**
Air terminations	
Aluminium and copper strip	20mm x 3mm
Aluminium, aluminium alloy, copper and phosphor bronze rods	10 mm dia
Standard aluminium conductors	19 strands of 2.5mm
Standard copper conductors	19 strands of 1.8 mm
Down conductors	
Aluminium and copper strip	20mm x 3mm
Aluminium, aluminium alloy and copper rods	10mm dia
Earth terminations	
Hard drawn copper rods for driving into soft ground	12mm dia
Hard drawn or annealed copper rods for indirect driving or laying in ground	10mm dia
Phosphor bronze for hard ground	12mm dia
Copper clad steel for hard ground	10mm dia

(BNBC, Table 8.2.14, Page 1271)

External metal on a building should be bonded to the lightning conductor with bonds at least as large as the conductor.

4.13 Illumination of exit signs and means of escape

(BNBC §1.15, Page 11231)

4.13.1 Exit signs

All required exit signs must be illuminated continuously at all times.

Exit signs may be illuminated either by lamps external to the sign or by lamps contained within the sign. The source of illumination shall provide not less than 50 lux at the illuminated surface with a contrast of not less than 0.5. Approved self-luminous signs that provide evenly illuminated letters having a minimum luminance of 0.2cd/m^2 may also be used.

4.13.2 Means of escape lighting

The means of escape in buildings requiring more than one exit shall be equipped with artificial lighting continuously during the period when the use of the building requires the exits to be available.

The intensity of illumination at floor level by means of escape lighting shall not be less than 10 lux.

The illumination of exit signs and the lighting of the means of escape and exit access shall be powered by an alternate or emergency electrical system to ensure continued illumination for a duration not less than 30 minutes after the failure of primary power supply.

Note:
The aisles shall be illuminated with escape lighting to a level of not less than 2.5lux at floor level.

Note:
The following sections on "Fire Alarm" and 'Fire and Smoke Detection Systems" have been included in both Part 3 and Part 4 of this guideline as these are integral parts of both Equipment and Electrical Fire Safety Installation.

4.14 Fire protective signalling or fire alarm system

(BNBC § 4.3 Page 10449)

Fire protective signalling or fire alarm system, where required by the BNBC, shall specify plans and clearly delineate the locations and number of all alarm-initiating devices and alarm-indicating appliances. The plan shall also provide details of all equipment to be used, proposed zoning, list of auxiliary control functions, location of the control panel and enunciators and a complete sequence of operation for the system.

Fire protective signalling or fire alarm system, wherever required and installed shall be maintained in full operating condition.

4.15 Automatic fire and smoke detection system

(BNBC § 4.4 Page 10450)

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

Where the entire existing RMG factory building is covered by sprinkler system with appropriate warning system the requirement for automatic fire alarms may be relaxed.

The automatic fire and smoke detection system shall include, spot or line type heat sensitive detectors and optical, ionized or chemical sensitive type of smoke detectors. A guideline for selection and sitting of fire detection system is provided below.

4.15.1 Detailed guidelines for selection and sitting of fire detection system

(BNBC Appendix C Page 10476)

Based on needs arising out of various situations and occupancies, judicious selection is extremely important for the reduction of fire hazards. Since heat, smoke and flame are produced during a fire, detectors responding to all these are accepted as general purpose detectors. Out of these fixed temperature heat detectors, Rate of Rise Heat Detectors, Smoke Detectors of different type can be selected as the situation demands.

4.15.2 Sitting of detectors

(BNBC § C 4 Page 10477)

Every portion of building should be covered and all effectively enclosed spaces should be considered separately based on the limits of spacing for types of detectors concerned. Rooms divided into sections by walls, partitions or storage racks up to 300 mm to the ceiling or goods stacked in defined areas shall have detectors for each section of passageway.

Hoist, elevators and similar openings, windows, doors, ventilators and inlet ducts of an air-conditioning system shall be covered by detector within 1.5m at the top for every 2m of their width or part thereof.

Detectors shall be installed at the centre of each inlet to the return duct of an air-conditioning system. Detectors shall be installed 2m apart if the inlet is continuous or oblong.

Detectors on each floor shall cover staircases. Where the staircases of existing RMG factory building are constructed with appropriate fire enclosures the requirements for detectors may be relaxed.

Spacing of detectors shall be reduced up to 75 per cent from the standard spacing in case of ceilings with waffle having depth between 200 and 500mm and up to 50 per cent with depths above 500mm. Where detectors are installed in the ridges of the waffle, each waffle shall be treated as an independent compartment.

Ceiling intersected by beams more than 250mm in depth, each bay shall be considered as separate compartment and detectors shall be installed considering each bay an independent compartment.

When positioned, heat sensitive elements shall be placed between 25 and 150mm from the ceiling or underside of roof. When ceiling are crossed by beams, girders or other structural elements of 250mm or more in depth to form compartments, detectors shall be placed in each compartment. One row of detectors shall be sited along the apex of each roof or bay. Space of this row of detectors and other detectors headed to cover the area shall be determined from the designed requirement At least one detector shall be suitably positioned within 1.5m of hoists, elevators, stairways, wall holes and similar openings to the floor above. Only fixed temperature type detectors shall be used in areas like kitchen, boiler room, furnace, room etc. where sudden temperature rise may take place.

Smoke detectors are usually sited where fire may accumulate the greatest concentration of visible and invisible smoke at the highest points of enclosed areas. The detectors shall be as mounted as to place the sensing elements between 25 and 100mm from the underside of roof. Area coverage by individual detectors are same as that of heat detectors but the maximum distance between two detectors may be 20 per cent more than that recommended for heat detectors. Actual spacing depends on airflow pattern in protected area.

4.16 Inspection and testing

(BNBC 2.11, Page 11273)

4.16.1 General

Every installation shall, on completion and before being energized, be inspected and tested. The methods of test shall be such that no danger to persons or property or damage to equipment occurs even if the circuit tested is defective.

4.16.2 Periodic inspection and testing

Periodic inspection and testing shall be carried out in order to maintain the installation in a sound condition after putting it into service. Where an addition is to be made to the fixed wiring of an existing installation, the latter shall be examined for compliance with the recommendations of the Code.

4.16.3 Checking conformity with the Bangladesh Standard

The individual equipment and materials that form part of the installation shall generally conform to the relevant Bangladesh Standard (BDS) wherever applicable. If there is no relevant Bangladesh standard specification for any item, these shall be approved by the appropriate authority.

4.16.4 Insulation tests

Insulation resistance test shall be made on all electrical equipment, using a self- contained instrument such as the direct indicating ohm-meter of the generator type. DC potential shall be used in these tests and shall be as follows or an appropriate Meggar:

Circuits below 230 volts	500 volts Meggar
Circuits between 230 volts to 400 volts	1000 volts Meggar

The minimum acceptable insulation resistance value is 5 mega ohms for LT lines. Before making connections at the ends of each cable run, the insulation resistance measurement test of each cable shall be made. Each conductor of a multi-core cable shall be tested individually to all other conductors of the group and also to earth. If insulation resistance test readings are found to be less than the specified minimum in any conductor, the entire cable shall be replaced.

All transformers, switchgears etc. shall be subject to an insulation resistance measurement test to ground after installation but before any wiring is connected. Insulation tests shall be made between open contacts of circuit breakers, switches etc. and between each phase and earth.

4.16.5 Earth resistance test

Earth resistance tests shall be made on the system, separating and reconnecting each earth connection using earth resistance meter.

The electrical resistance of the earth continuity conductor together with the resistance of the earthing lead measured from the connection with the earth electrode to any other position in the completed installation shall not exceed 1 ohm.

Where more than one earthing sets are installed, the earth resistance between two sets shall be measured by means of resistance bridge instrument. The earth resistance between two sets shall not exceed 1 ohm.

4.16.6 Operation tests

Current load measurement shall be made on equipment and on all power and lighting feeders. The current reading shall be taken in each phase wire and in each neutral wire while the circuit or equipment is operating under actual load conditions. Clamp on ammeters may be used to take current readings without interrupting a circuit. All light fittings shall be tested electrically and mechanically to check whether they comply with the standard specifications. Fluorescent light fittings shall be tested so that when functioning no flickering or choke singing is felt.

4.16.7 Inspection of the installation

On completion of wiring competent personnel shall carry out a general inspection in order to verify that the provisions of this Code and that of the Electricity Act of Bangladesh have been complied with. A certificate may be issued on satisfactory completion of the work in a format as shown in Appendix C. Items to be inspected are detailed in the following sections.

14.6.7.1 Inspection of substation installations

In substation installations, it shall be checked whether:

- The installation has been carried out in accordance with the approved drawings;
- Phase to phase and phase to earth clearances are provided as required;
- All equipment are efficiently earthed and properly connected to the required number of earth electrodes;
- The required ground clearance to live terminals is provided
- Suitable fencing is provided with gate with lockable arrangements;
- The required number of caution boards, fire-fighting equipment, operating rods, rubber mats, etc., are kept in the substation;
- In case of indoor substation sufficient ventilation and draining arrangements are made;
- All cable trenches have covers of non-inflammable material;
- Free accessibility is provided for all equipment for normal operation;
- All name plates are fixed and the equipment are fully painted;
- All construction materials and temporary connections are removed;
- Oil level, bus bar tightness, transformer tap position, etc. are in order;
- Earth pipe troughs and cover slabs are provided for earth electrodes/earth pits and the neutral and LA earth pits are marked for easy identification;
- Earth electrodes are of GI pipes or CI pipes or copper plates. For earth connections, brass bolts and nuts with lead washers are provided in the pipes/plates;
- Earth pipe troughs and oil sumps/pits are free from rubbish, dirt and stone jelly and the earth connections are visible and easily accessible;
- HT and LT panels and switchgears are all vermin and damp proof and all unused openings or holes are blocked properly;
- The earth bus bars have tight connections and corrosion free joint surfaces;
- Control switch fuses are provided at an accessible height from ground;
- Adequate headroom is available in the transformer room for easy topping □ up of oil, maintenance, etc.;
- Safety devices, horizontal and vertical barriers, bus bar covers/shrouds, automatic safety shutters/door interlock, handle interlock etc. are safe and in reliable operation in all panels and cubicles;
- Clearances in the front, rear and sides of the main HT and LT and sub-switch boards are adequate;
- The switches operate freely; the 3 blades make contact at the same time, the arcing horns contact in advance; and the handles are provided with locking arrangements,
- Insulators are free from cracks, and are clean;
- In transformers, there is no oil leak;
- Connections to bushing in transformers are light and maintain good contact;
- Bushings are free from cracks and are clean;
- Accessories of transformers like breathers, vent pipe, buchholz relay, etc. are in order;
- Connections to gas relay in transformers are in order;

- In transformers, oil and winding temperature are set for specific requirements to pump out;
- In case of cable cellars, adequate arrangements exist to pump off water that has entered due to seepage or other reasons; and
- All incoming and outgoing circuits of HT and LT panels are clearly and indelibly labelled for identifications.

4.16.7.2 Inspection of Medium Voltage Installation

In Medium Voltage (MV) Installations, it shall be checked whether:

- All blocking materials that are used for safe transportation in switchgears, contactors, relays, etc. are removed;
- All connections to the earthing system have provisions for periodical inspection;
- Sharp cable bends are avoided and cables are taken in a smooth manner in the trenches or alongside the walls and ceilings using suitable support clamps at regular intervals;
- Suitable linked switch or circuit breaker or lockable push button is provided near the motors/apparatus for controlling supply to the motor/apparatus in an easily accessible location;
- Two separate and distinct earth connections are provided for the motor apparatus;
- Control switch fuse is provided at an accessible height from ground for controlling supply to overhead traveling crane, hoists, overhead bus bar trunking;
- The metal rails on which the crane travels are electrically continuous and earthed and bonding of rails and earthing at both ends are done;
- Four-core cables are used for overhead travelling crane and portable equipment, the fourth core being used for earthing, and separate supply for lighting circuit is taken;
- If flexible metallic hose is used for wiring to motors and other equipment, the wiring is enclosed to the full lengths, and the hose secured properly by approved means;
- The cables are not taken through areas where they are likely to be damaged or chemically affected;
- The screens and armours of the cables are earthed properly;
- The belts of belt driven equipment are properly guarded;
- Adequate precautions are taken to ensure that no live parts are so exposed as to cause danger;
- Installed ammeters and voltmeters work properly and are tested; and
- The relays are inspected visually by moving covers for deposits of dusts or other foreign matter.

4.16.7.3 Inspection of overhead lines

For overhead lines, every care must be taken so that:

- All conductors and apparatus including live parts thereof are inaccessible;
- The types and size of supports are suitable for the overhead lines/conductors used and are in accordance with approved drawing and standards;
- Clearances from ground level to the lowest conductor of overhead lines, sag conditions, etc. are in accordance with the relevant standard;
- Where overhead lines cross the roads suitable grounded guarding shall be provided at road crossings,
- Where overhead lines cross each other or are in proximity with one another, suitable guarding shall be provided at crossings to protect against possibility of the lines coming in contact with one another;
- Every guard wire shall be properly grounded / earthed;
- The type, size and suitability of the guarding arrangement provided shall be adequate;

- Stays cables must be provided suitably with the overhead line carrying poles as required and shall be efficiently earthed at the bottom and shall be provided with suitable stay insulators of appropriate voltages;
- Anti-climbing devices and Danger Board/Caution Board Notices are provided on all HT supports;
- Clearances along the route are checked and all obstructions such as trees/branches and shrubs are cleared on the route to the required distance on either side;
- Clearance between the live conductor and the earthed metal parts are adequate; and
- For the service connections tapped off from the overhead lines, cutouts of adequate capacity are provided.

4.16.7.4 Inspection of lighting circuits

- The lighting circuits shall be checked to see whether:
- Wooden boxes and panels are avoided in factories for mounting the lighting boards, switch controls, etc.;
- Neutral links are provided in double pole switch fuses which are used for lighting control, and no fuse is provided in the neutral;
- The plug points in the lighting circuit are all 3D pin type, the third pin being suitably earthed;
- Tamper proof interlocked switch socket and plug are used for locations easily accessible;
- Lighting wiring in factory area is enclosed in conduit and the conduit is properly earthed, or alternatively, armoured cable wiring is used;
- A separate earth wire is run in the lighting installation to provide earthing for plug points, fixtures and equipment;
- Proper connectors and junction boxes are used wherever joints are in conductors or crossover of conductors takes place;
- Cartridge fuse units are fitted with cartridge fuses only.

Appendix I: Fire tests and fire resistance rating tests

The fire resistance ratings of building assemblies and structural elements shall be determined in accordance with ASTM E 119.

The construction materials intended to be classified as non-combustible shall be tested in accordance with ASTM E 136.

Flame resistance rating of all materials used for interior finish and trim shall be tested in accordance with ASTM E 84.

The fire door assemblies shall conform to the test requirements of ASTM E 152 (Currently ASTM E2074).

The fire windows and fire shutters shall meet the test requirements of ASTM E 163 (Currently E 2010-01). Fire tests on building materials and structures, method for fire propagation for products shall also conform to British Standard 476 Part 6 & 7.

UBC Standard No. 26-3, Room Fire Test Standard for Interior of Foam Plastic Systems

To evaluate a product's ability to reduce or eliminate fuel contribution, flame spread and prevention of flashover within a room FM 4880/ NFPA 286 shall be adopted.

UBC 8-2, Room Corner Test evaluates a product's ability to reduce or eliminate fuel contribution, flame spread and prevention of flashover within a room.

FM 4975 Hydrocarbon Ceiling Test measures the rate at which fire will travel on a ceiling and shows a product's ability to prevent smoke, flame spread and heat release across an expansive ceiling area such as would be found in a large industrial building.

AS 1530.3 Flame/Smoke Rating Test standard describes methods for fire tests on building materials, components and structures.

Equivalent tests refer to the Test Standards that are not mentioned in this document, which might arise in future and are considered equivalent in their application, test methods and specifications. This equivalence shall be proved through ‘technical specifications comparison document’ from the Testing Laboratory and certification bodies making the equivalent claim.

Appendix II: Fire fighting apparatus – Factory Rules 1979

(Factories Rules 1979, S.R.O 101/78/LSWVI/11(4)/78 § 51 Page 1544)

Means of escape in case of fire

1 Each room of a factory building shall be provided with not less than two exits for use in case of fire, so positioned that each person will have a reasonably free and unobstructed passage from his work place to an exit.

2 No such exit shall be less than 3'-0" in width and less than 6'-6" in height.

3 In the case of a factory building or part of a factory building of more than one story and in which not less than 20 persons work at any one time, there shall be provided at least one substantial stairway permanently constructed either inside or outside the building and which affords direct and unimpeded access to ground level.

4 In the case of a factory building or part of a factory building in which 20 or more persons work at any one time above the level of the ground floor, or wherein explosive or highly inflammable materials are used or stored, or two separate and substantial stairways permanently constructed either inside or outside the building and which afford direct and unimpeded access to ground level.

5 Every stairway in a factory that affords means of escape in case of fire shall be provided with a substantial handrail that if the stairway has open side shall be on that side, and if the stairway has two open sides, such handrail shall be provided on both sides.

6 In the case of a building constructed or converted for use a factory, after coming into force of these rules, the following additional requirements shall apply:

   a. At least one of the stairways shall be of fire resisting materials;
   b. Every hoist way or lift-way inside a factory building shall be completely enclosed with fire-resisting materials and all means of access to the hoist or lift shall be fitted with doors of fire-resisting materials;
   c. No fire escape stair shall be constructed at an angle greater than 45° from the horizontal;
   d. No part of a factory building shall be at a distance (along the line of travel) of 150' or more from any fire escape stair; and
   e. No stairway shall be less than 45" in width.

Appendix III: Product standards for firefighting systems and equipment

Table III.1: Piping for standpipe system

Material	Standard
Copper tube	ASTM B75, ASTM B88
Copper and copper-alloy tube	ASTM B251
Steel pipe	ASTM A55, ASTM A120, ASTM A135
Wrought steel or iron	ANSI B36.10

(BNBC Table 4.4.3 Page 10442)

Table III.2: Standpipe fittings

Material	Standard
Cast iron	ANSI 616.1, ANSI B16.4
Copper	ANSI B16.18, ANSI B16.22
Malleable iron	ANSI B16.3
Steel	ANSI B16.5, ANSI B16.9, ANSI B16.11, ANSI B16.25, ASTM A234

(BNBC Table 4.4.4 Page 10443)

LIST OF REGULATED FIRE SAFETY PRODUCTS/MATERIALS

Product	Acceptable Standards
1. Fire alarm panel	1. BS EN 54 Pt 2 & 4 and 2. CP10
2. Fire-rated collar	1. BS 476 Pt 20, AS 1530 Pt 4, ASTM E119, ISO 834 or NFPA 251
3. Fire pump	1. AS 2941, UL, FM, BRE
4. Fire-rated partition (14)	
4.1 Compartment wall (1)(16)	1. BS 476 Pt 4/11 or Pt 6 & 7 and 2. BS 476 Pt 22, EN 1364-1,AS 1530 Pt 4, ASTM E119, ISO 834 or NFPA 251
4.2 Protected shaft enclosing lift (2)(16)	1. BS 476 Pt 4/11 and 2. BS 476 Pt 20, AS 1530 Pt 4, ASTM E119, ISO 834 or NFPA 251 and 3. BS 5588 Pt 5 App A & BS 5234 Pt 2 and 4. BS EN 520 (gypsum plaster board) or ISO 1896 (calcium silicate or cement board) and 5. Cyclic loading and dynamic test as specified under clause 3.3 of Building Code of Australia C 1.8
4.3 Protected shaft enclosing staircase or services (16)	1. BS 476 Pt 4/11 and 2. BS 476 Pt 22, AS 1530 Pt 4, ASTM E119, ISO 834 or NFPA 251 and 3. BS 5588 Pt 5 App A & BS 5234 Pt 2 4. BS EN520 (gypsum plaster board) or ISO 1896 (calcium silicate or cement board)
5. Fire-rated floor (1) (2)(16)	1. BS 476 Pt 4/11 or Pt 6 & 7 and 2. BS 476 Pt 21, AS 1530 Pt 4 or ISO 834
6. Fire-rated ceiling (14)	
6.1 Compartmentation (1)(16)	1. BS 476 Pt 4/11 or Pt 6 & 7 and 2. BS 476 Pt 22, AS 1530 Pt 4, ASTM E119, ISO 834 or NFPA 251
6.2 Protection to steel beams that support RC floor (1) (2)(16)	1. BS 476 Pt 4/11 or Pt 6 & 7 and 2. BS 476 Pt 23, AS 1530 Pt 4 or ISO 834
6.3 Protection to timber/ steel flooring (1) (2)(16)	1. BS 476 Pt 4/11 or Pt 6 & 7 and 2. BS 476 Pt 21, AS 1530 Pt 4 or ISO 834
7. Fire-rated enclosure/ spraying material (14)	

Product	Acceptable standards
7.1 Protection to steel structure (3) (2) (1) (16)	1. BS 476 Pt 4/11 or Pt 6 & 7 and 2. BS 476 Pt 21, AS 1530 Pt 4 or ISO 834 3. BS EN 520 (gypsum plaster board) or ISO 1896 (calcium silicate or cement board)
7.2 Protection to fire fighting system i.e. sprinkler, rising mains, hydrant etc. (1) (4) (16)	1. BS 476 Pt 4/11 or Pt 6 & 7 and 2. FSB/PSB/001 (Insulation criteria - shall not exceed 750C)
7.3 Protection to building services i.e. cables, sanitary pipes, chilled water pipes etc. (1) (16)	1. BS 476 Pt 4/11 or Pt 6 & 7 and 2. BS 476 Pt 20, AS 1530 Pt 4, ASTM E119, ISO 834 or NFPA 251
8. Smoke curtain (5) (14) (16)	1. BS 476 Pt 6 & 7 and 2. BS 7346 Pt 3
9. Fire-rated duct system, e.g. ventilation, smoke extraction and/or kitchen exhaust ducting system (1) (6) (14) (16)	1. BS 476 Pt 4/11 or Pt 6 & 7 and 2. BS 476 Pt 24, AS 1530 Pt 4, ASTM E119, ISO 834 or NFPA 251 3. BS 5588 Pt 5 App A & BS 5234 Pt 2 4. BS EN 520 (gypsum plaster board) or ISO 1896 (calcium silicate or cement board)
10. Fire extinguishing system for kitchen hood	1. UL 300
11. Fire stopping material	1. BS 476 Pt 20, AS 1530 Pt 4, ASTM E119, ISO 834 or NFPA 251, BS EN1366-3, AS4072.1, ASTM E814 or UL1479. ASTM 2307-04 (for fire stop at curtain wall only)
12. Fire-rated glass block/ partition/panel (7)	1. BS 476 Pt 22, AS 1530 Pt 4, ASTM E119, ISO 834 or NFPA 251 and 2. BS 6206 or AS2208
13. Exit sign (powered electrically)	1. SS 263 Pt 2 and 2. SS 508 Pt 1 & 2 and 3. CP 19
14. Emergency lighting (self-contained)	1. SS 263 Pt 2 and 2. CP 19
15. Battery system (for exit signs and emergency lighting)	1. CP 19
16. Self-luminous Sign (powered by radioactive material)	1. BS 5499 Pt 2 and 2. SS 508 Pt 1 & 2 and 3. CP 19
17. Fire hose reel	1. EN 671 Pt 1 and 2. CP 29
18. Fire fighting hose	1. BS 6391
19. Auditorium seats (8)	1. BS 5852, section 5 (ignition source 0,1 & 5)
20. Fire damper	1. SS 333 (includes fire-resistance test, air leakage test, spring force test and closing reliability test)
21. Fire-rated door (15)	1. SS 332 and 2. BS 6202 or AS 2208 (for glass door)
21.1 Bin/linen chute door	1. SS 332. BS 476 Pt22

Product	Acceptable Standards
22. Fire-rated lift-landing/ dump waiter door	1. BS 476 Pt 22, AS 1530 Pt 4, ASTM E119, ISO 834 or NFPA 251 or 2. EN 81-58(for lift-landing door) 3. BS 6202 or AS 2208 (for glass door)
23. Fire shutter/fire curtain	1. SS 489
24. Fire-rated hopper/hatch	1. BS 476 Pt 22, AS 1530 Pt 4, ASTM E119, ISO 834 or NFPA
25. Portable fire extinguisher	1. SS 232 Pt 1 to 6
26. Fire-rated cables	1. SS 299
27. Intumescent coating system (for protection to steel structure) (9)	1. BS 8202 Pt 2 (includes fire-resistance test and weathering tests) 2. BS 476 Pt 21, AS 1530 Pt 4 or ISO 834 (for fire-resistance test)
28. Landing valve	1. BS 5041 Pt 1
29. Breeching inlet	1. BS 5041 Pt3
30. Raised floor panel (10X11X16)	1. BS 476 Pt 4 or 11 (applicable to the core material of composite construction)
31. Material for wall/ceiling construction (10)(16)	1. BS 476 Pt 4/11/7 or Pt 6 & 7
32. Thermal insulation material (10X16)	1. BS 476 Pt 4/11/7 or Pt 6 & 7
33. Finishes material for wall/ceiling (10)(16)	1. BS 476 Pt 7 or Pt 6 & 7
34. Roof covering material (10)(16)	1. BS 476 Pt 7 or Pt 6 & 7
35. Composite panel (12) (16) e.g. cladding to external wall	1. BS 476 Pt 6 & 7 (applicable to the core material of composite construction) or 2. UBC 26-9 / NFPA 258 (for core containing plastics)
36. UPVC window frame material (13)	1. ASTM D635
37. Door closer (15)/Other hardware	1. SS 332: Clause 5

Appendix IV: Fire fighting apparatus - Factory Rules 1979

(Factories Rules 1979, S.R.O 101/78/LSWVI/11(4)/78 § 52 & 53 Page 1545 - 46)

Fire fighting apparatus and water supply

1 Every factory shall provide and maintain two fire buckets of not less than two-gallon capacity each for every 1000 sq. ft of floor area, subject to a minimum of four such buckets on each floor. Every bucket shall:
   a. Conform to appropriate Bangladesh standard specifications;
   b. Be kept in a position approved by the inspector and shall be use for no other purpose than extinguish fire; and
   c. At all times be kept full of water, except where the principal fire risk arises from inflammable liquid or other substances where water cannot be used; provided that the chief Inspector may for reasons to be recorded in writing, relax the requirements of this clause.

2 In factories having more than 1000 sq. ft. area and where fire may occur due to combustible materials other than inflammable liquids, electrical equipment and ignitable metals, soda acid or equivalent type of portable extinguishers at the rate of one for every 5000 sq. ft. of area spaced not more than 100 ft. subject to a minimum of one extinguisher shall be provided in addition to fire buckets required under sub-rule (1).

3 In factories where fire may occur due to inflammable liquids or grease or paint, the extinguishers to be provided at the scale laid down in sub-rule (2) shall consist of foam, carbon tetrachloride, dry powder, carbon dioxide, chloro- bromomethene or other equivalent type.

4 In factories where fire may occur due to electrical equipment, the extinguisher to be provided at the scale laid down in sub-rule (2) shall consist of carbon dioxide, dry powder, carbon-tetrachloride or other equivalent types.

5 In factories where fire may occur due to magnesium, aluminium or zinc dust or shavings or other ignitable metals, the use of liquids, carbon-dioxide or foam type extinguishers shall be prohibited and ample supply of clean fine, dry sand, stone dust or other inert material shall be kept for extinguishing such fires.

6 Every type of portable fire extinguisher shall be kept mounted in a position approved by the inspector: Provided that where the chief Inspector is of the opinion that owing to the adequate automatic fire fighting installations approved by any recognized fire association or fire insurance company provided in the factory building or room, the provisions of this sub-rule may be relaxed, he may issue a certificate in respect of that building or room.

7 Every fire extinguisher to be provided under sub-rule (2) shall:
   a. Conform to the appropriate standard specification;
   b. Be kept charged ready for use, properly mounted in a position approved by the Inspector and accompanied by the maker's printed instructions for its use; and
   c. Be examined, tested or discharged periodically in accordance with the maker's recommendation.

8 Every factory shall keep and maintain sufficient number of spare charges for each type of extinguisher provided in the factory with a maximum of 12 spare charges always in stock and readily available.

9 Every worker of the factory should, as far as possible, be trained in the use of portable extinguishers. At least one fourth of the numbers to be trained on the basic fire fighting techniques separately in each section of the factory.

10 Each factory shall have a trained officer who shall be responsible for the proper maintenance and upkeep of all fire fighting equipment.

11 The manager of the factory shall prepare a detailed 'Fire Safety Plan' for proper enforcement of the safety rules and for actions to be taken, in proper sequence, in the case of a fire in the factory.

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