LABS INITIATIVE

Standard for Structural, Fire & Electrical Safety in the
Ready-Made Garment and Footwear Sector in Vietnam

Version 1.4
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LABS Initiative

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Overview

The core purpose of the LABS Initiative is improving the life safety of workers in the international ready-made garment (RMG) and footwear sector. Crucial to achieving this aim is improving the structural, fire and electrical safety of RMG and footwear factories. The LABS Initiative **Standard for Structural, Fire & Electrical Life Safety in the Ready-Made Garment and Footwear Sector in Vietnam** will help guide those improvements and will contribute to a safer garment sector for workers in Vietnam.

The key objective of this Standard is to address critical life safety issues in the RMG factories. It is a minimum standard for RMG and Footwear factories, designed to address those issues which create the biggest risk to the life safety of the workers. It is based on international best practice for Fire, Electrical and Structural Engineering.

Compliance with this document does not infer compliance with any other national codes, standards or statutory requirements that may prevail and it is not intended to replace those. For those factories which are part of the LABS Initiative, while they may satisfy local codes, the minimum requirements of this Standard shall prevail, where related to life safety.

Development of the Standard

This Standard has been prepared as a response to the fact that in many countries, relevant national building codes and standards do not adequately address assessment of existing buildings. It is based on published standards prepared in Bangladesh by the Alliance and the Accord, following the Rana Plaza building collapse in April 2013. An internationally applicable "Reference Standard" has been prepared, which takes many of the lessons learned there and applies these along with international best practice. Subsequently, this reference Standard has been localised for use specifically in Vietnam, taking account of relevant Vietnamese building codes, regulations and practices.

Implementation

This Standard will be implemented by the LABS Initiative RMG and Footwear factories in Vietnam where this life safety programme is being rolled out.

TABLE OF CONTENTS

1 Part 1 Scope and Definitions 4

2 Part 2 Administration and Enforcement 11

3 Part 3 General Fire Safety Requirements 12

4 Part 4 Fire Protection Construction 26

5 Part 5 Fire Protection Systems 31

6 Part 6 Means of Egress 40

7 Part 7 Building Materials 31

8 Part 8 Structural Safety Requirements 31

9 Part 9 Construction Practices and Safety 45

10 Part 10 Electrical Safety Requirements 48

11 Part 11 Alterations / Change of Use 65

12 Part 12 Operations and Maintenance 67

Appendix A: Scope of Works for Detailed Engineering Assessment (DEA) 69

1 Part 1 Scope and Definitions

1.1 Scope

1.1.1 **Title.** Standard for Structural, Fire & Electrical Life Safety in the Ready-Made Garment and Footwear Sector in Vietnam developed by the LABS Initiative shall be referred to herein as "the Standard" or "this Standard."

1.1.2 **Danger to Life Safety from Fire.** This Standard addresses those building features needed to minimize danger to life from the effects of fire including smoke, heat, and toxic gases created during a fire.

1.1.3 **Danger to Life Safety from Electrical Issues**. This standard addresses those building features needed to minimize danger to life from electrical shock, electrocution, electrical fires and failure of power supplies to safety systems.

1.1.4 **Danger to Life Safety from Structural Collapse.** This Standard addresses and establishes minimum criteria for the evaluation and protection from danger to life from catastrophic, progressive and disproportionate building collapse.

1.2 Application

1.2.1 This Standard is the standard which shall be used in Vietnam for the LABS Initiative

1.2.2 It is based on the international overarching standard prepared for LABS Initiative, known as the Reference Standard. This provides more detail on country-specific issues such as construction practices, local materials and known deficiencies in the Vietnamese Building Codes which are relevant to the Life Safety objectives of the LABS Initiative.

1.2.3 This Standard shall apply to the construction, addition, alteration, enlargement, extension, replacement, repair, installation or movement of major equipment, use and occupancy, maintenance, removal, and demolition of all buildings and structures used for RMG and Footwear factories. This Standard shall also apply to subcontractors' buildings and structures producing RMG and Footwear for LABS affiliated brands.

1.2.4 This Standard shall apply to both new construction and existing buildings and structures as specifically outlined in this Standard.

1.3 **Purpose:** The purpose of this Standard is to establish a common set of minimum requirements that provide a uniform and effective method for assessing structural, fire and electrical safety in new and existing RMG factories utilized by LABS-affiliated vendors.

1.4 **Disclaimer:** The technical requirements of this Standard are intended for use by professional Structural Engineers, Fire Safety Engineers or Architects, and Electrical Engineers who are competent to evaluate the significance and limitation of its content and who will accept the responsibility for the application of the material it contains. The developers of this Standard and the LABS Initiative disclaim any responsibility for the stated principals and requirements and shall not be liable for any loss or damage arising from their application.

1.5 References

1.5.1 General: 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.

1.5.2 Vietnam National Building Code. Current versions of Vietnam National Construction Regulations. The following is a non-exhaustive list of codes referred to in this Standard:

1.5.2.1 QCVN 06:2010/BXD Vietnam Building Code on Fire Safety of Buildings, Hanoi 2010.

1.5.3 Vietnam National Laws and Rules. Current versions of Vietnam national laws and rules. The following is a non-exhaustive list of technical documents referred to in this Standard:
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1.5.3.1 TCVN 2622: 1995 Fire protection of buildings. Design requirements.

1.5.3.2 TCVN 3890: 2009 Fire protection equipments for building and construction - providing, installation, inspection, maintenance.

1.5.3.3 TCVN 5307:2009 Petroleum and petroleum products terminal – Design requirements

1.5.3.4 TCVN 5738:2001 Automatic fire alarm system. Technical requirements.

1.5.3.5 TCVN 6486:2008 Liquefied Petroleum Gas (LPG) – Pressurised Storage – Requirements for Design and Location of Installation

1.5.3.6 TCVN 7336: 2003 Automatic sprinkler systems. Design and installation requirements.

1.5.3.7 TCVN 8616:2010 Liquefied natural gas (LNG) - Requirements for production, storage and handling

1.5.3.8 TCVN (no number - under development): 2017 Automatic diffusion dry-powder fire extinguisher – Technical requirements and test methods.

1.5.4 ICC publications. International Code Council, 5203 Leesburg Pike, Suite 600, Falls Church, VA 22041 USA.

1.5.4.1 IBC, International Building Code, 2012.

1.5.4.2 IFC, International Fire Code, 2012.

1.5.4.3 IEBC, International Existing Building Code, 2012.

1.5.5 NFPA publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471 USA.

1.5.5.1 NFPA 10, Standard for Portable Fire Extinguishers, 2013.

1.5.5.2 NFPA 13, Standard for the Installation of Sprinkler Systems, 2016.

1.5.5.3 NFPA 14, Standard for the Installation of Standpipe and Hose Systems, 2016.

1.5.5.4 NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection, 2016.

1.5.5.5 NFPA 22, Water Tanks for Private Fire Protection, 2013.

1.5.5.6 NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, 2017.

1.5.5.7 NFPA 30, Flammable and Combustible Liquids Code, 2018.

1.5.5.8 NFPA30B, Code for the Manufacture and Storage of Aerosol Products, 2015.

1.5.5.9 NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines, 2018.

1.5.5.10 NFPA 51B, Standard for Fire Prevention During Welding, Cutting, and Other Hot Work, 2014.

1.5.5.11 NFPA 70, National Electrical Code®, 2017.

1.5.5.12 NFPA 72, National Fire Alarm and Signaling Code, 2016.

1.5.5.13 NFPA 80, Standard for Fire Doors and Other Opening Protectives, 2016.

1.5.5.14 NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems, 2018.

1.5.5.15 NFPA 92, Standard for Smoke Control Systems, 2015.

1.5.5.16 NFPA 101, Life Safety Code®, 2015.

1.5.5.17 NFPA 110, Standard for Emergency and Standby Power Systems, 2016.

1.5.5.18 NFPA 111, Standard on Stored Electrical Energy Emergency and Standby Power Systems, 2016.

1.5.5.19 NFPA 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations, 2013.

1.5.5.20 NFPA 252, Standard Methods of Fire Tests of Door Assemblies, 2017.

1.5.5.21 NFPA 257, Standard on Fire Test for Window and Glass Block Assemblies, 2017.

1.5.6 **ACI publications.** American Concrete Institute, 38800 Country Club Drive, Farmington Hills, MI 48331 USA.

1.5.6.1 ACI 228.1R, In-Place Methods to Estimate Concrete Strength, 2003.

1.5.6.2 ACI-318, Building Code Requirements for Structural Concrete and Commentary, 2011.

1.5.6.3 ACI-562, Code Requirements for Assessment, Repair and Rehabilitation for Existing Concrete Structures and Commentary, 2016

1.5.7 **AISC Publications.** American Institute of Steel Construction, One East Wacker Drive Suite 700, Chicago, IL 60601 USA.

1.5.7.1 AISC Code of Standard Practice.

1.5.8 **ASCE Publications.** American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191 USA.

1.5.8.1 ASCE 7. Minimum Design Loads for Buildings and Other Structures, 2010.

1.5.8.2 ASCE 41, Seismic Evaluation and Retrofit of Existing Buildings, 2013

1.5.9 **ASME Publications.** American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016 USA.

1.5.9.1 ASME A17.1 Safety Code for Elevators and Escalators, 2010.

1.5.10 **ASTM Publications.** ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428 USA.

1.5.10.1 ASTM A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products, 2012.

1.5.10.2 ASTM C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete,

2013.

1.5.10.3 ASTM C823, Standard Practice for Examination and Sampling of Hardened Concrete in Constructions, 2012.

1.5.10.4 ASTM – C39 /39M – 12a, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens, 2012.

1.5.10.5 ASTM- C856, Standard Practice for Petrographic Examination of Hardened Concrete, 2011.

1.5.10.6 ASTM - C295, Standard Guide for Petrographic Examination of Aggregates for Concrete, 2012.

1.5.10.7 ASTM - C457, Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete, 2011.

1.5.10.8 ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials, 2010.

1.5.10.9 ASTM E 119, Standard Test Methods for Fire Tests of Building Construction and Materials, 2010b.

1.5.10.10 ASTM E 136, Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C, 2009b.

1.5.10.11 ASTM E 814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops, 2010.

1.6.11 FM Global publications. FM Global, 270 Central Avenue, Johnston, RI 02919-4923 USA.

1.6.11.1 FM Data Sheet 7-1, Fire Protection for Textile Mills, January 2012.

1.6.11.2 FM Data Sheet 8-7, Baled Fiber Storage, April 2017.

1.6.11.3 IEC 60364-1 Fundamental principles, assessment of general characteristics, definitions

1.6.11.4 IEC 60364-4-4-41 Low voltage electrical installations Protection for safety - Protection against electric shock

1.6.11.5 IEC 60364-4-42 Low voltage electrical installations Protection for safety - Protection against thermal effects

1.6.11.6 IEC 60364-4-43 Low voltage electrical installations Protection for safety - Protection against overcurrent

1.6.11.7 IEC 60364-5-52 Electrical installation guide - Part 52: Selection and erection of electrical equipment - Wiring systems

1.6.11.8 IEC 60364-5-54 Low-voltage electrical installations - Part 5-54: Selection and erection of electrical equipment - Earthing arrangements and protective conductors

1.6.11.9 ISO 8528 Reciprocating internal combustion engine driven alternating current generating sets

2 Part 2 Administration and Enforcement

2.1 **General:** The administration of this Standard, including interface with factory owners and performance of factory compliance assessments, will be administered by the LABS Initiative.

2.2 Factory building owners shall also be responsible for compliance with Vietnam National Construction regulations and all other relevant laws and rules.

3 Part 3 General Fire Safety Requirements

The primary focus of the LABS initiative is to ensure Life Safety in RMG and Footwear factories. As such, the purpose of this section is to identify the critical fire safety measures which need to be verified by observation, testing, preliminary and detailed calculation, in order ensure an adequate level of safety to the occupants in the event of fire. It is not designed to identify all fire safety deficiencies, but to identify those issues that would have a major impact on life safety. Compliance with this minimum standard may not mean compliance with the relevant Vietnam National Construction Regulations. It is a pragmatic approach to ensure a level of Life Safety for the occupants acceptable to LABS.

3.1 Applicability of the National Building Code

This Standard utilizes the Vietnam National Construction Regulations as the applicable minimum standard for new factory construction and for all expansions or modifications to existing factories.

New factories shall comply with the more stringent requirements of this Standard and the relevant Vietnam National Construction Regulations, in particular (but not limited to): QCVN 06:2010/BXD Vietnam Building Code on Fire Safety of Buildings and TCVN guidance documents listed in 1.5.3, together with associated code updates and jurisdictional circulars as they may be issued from time to time. New factories are those which are built after the adoption of this Standard.

Existing factory buildings are those that are in current use in the Garment and Footwear industry at the time of adoption of this Standard.

Any substantial retrofit or expansion of an existing factory building shall comply with Vietnam National Construction Regulations. Where these changes impact the structure of the existing building, the compliance shall be with the spirit and intent of the Vietnam National Construction Regulations, supported by best international practice. The structural design of the new parts of the building retrofit or expansion shall comply with the requirements of Vietnam National Construction Regulations, unless modified by this Standard.

***Interpretive Guideline*:** Regardless of when a factory was constructed, the impact on the fire safety measures of any expansion must be analytically evaluated and confirmed by a qualified Architect or Engineer.

A substantial expansion will be interpreted to mean any new area, floor or roof levels, mezzanine levels, horizontal floor additions, adaptation for any new uses or add-ons to the existing building, or construction of similar new buildings.

3.2 Fire Safety of Existing Factory Buildings

Every existing factory building must demonstrate a minimum degree of fire safety as confirmed by a Preliminary Fire Safety Inspection performed by a LABS qualified Architect or Engineer.

Interpretive Guideline: The intent of Section 3.2 is that every existing factory must demonstrate a reasonable level of fire safety regardless of when it was constructed and regardless of the availability of credible fire safety documentation or permits. This Standard requires the visual assessment and on occasion, analytical confirmation of capacity of key measures for the actual in-situ conditions in the factory by a LABS-qualified Architect or Engineer. A Preliminary Fire Safety Inspection with no or limited concerns or generally acceptable findings may be accepted as evidence of a reasonable level of fire safety. For factory buildings with noted concerns or unacceptable findings from the Preliminary Fire Safety Inspection, a higher level of fire safety investigation, analysis and ongoing inspections may be required.

Existing factory buildings and components thereof shall be assessed to confirm the adequacy of the fire safety measures, both active and passive, in the buildings. An adequate level of life safety in the event of fire

will be assumed to be present if the fire safety measures provided meet all the requirements of this Standard.

Interpretive Guideline: The fire safety measures present in the building must be confirmed and documented in accordance with accepted engineering design processes by LABS-qualified Architects or Engineers.

3.3 Preliminary Fire Safety Inspection

It is recognized that some factory buildings were built in the absence of established Building Codes or their active enforcement. Some of these factories lack basic or verifiable documentation that could provide evidence of physical design characteristics such fire safety measures which could be used to readily confirm the fire safety of the buildings. Recognizing that absence of fire safety documentation does not make a factory unsafe, this Standard provides a methodology for Factory Owners who lack appropriate documentation to provide other acceptable evidence of fire safety. Even factories with fire safety documentation shall be assessed using this methodology.

The Preliminary Fire Safety Inspection shall include the following activities:

Review of available documents, either original structural documents prepared in accordance with the Vietnam National Construction Regulations or as-built documents prepared in accordance with Section 3.7 of this Standard.

(1) Visual assessment of the means of escape provided from the building, and all enclosed areas within the building.
(2) Some simple analytical assessment of occupant numbers and escape capacity
(3) Visual assessment of passive fire safety construction issues, such as separation of high risk areas from the production areas with partition walls and doors, compartmentation between floors, fire rated protection of escape routes, fire protection of the structure, etc.
(4) Visual assessment of the fire safety systems provided for life safety, such as the fire detection, early warning for all occupants, emergency lighting of escape routes, automatic fire suppression systems, etc and some basic operational testing.
(5) Visual assessment of facilities provided for fighting fires, such as portable extinguishers, fire hoses, hydrants, standpipes, etc.
(6) Visual assessment of the state of housekeeping, particularly how well escape routes are kept clear of obstacles, fire escape doors kept closed but not locked, fire loads remain stored in accordance with acceptable practice, management of temporary 'in-process' storage, etc.
(7) Review of the management procedures, permits, records of regular maintenance of all active fire safety systems, the factory emergency plan, evidence of fire drills and recorded outcomes, etc.

3.4 Results of Preliminary Fire Safety Inspections of Existing Factory Buildings

If the Architect or Engineer determines that there are major deficiencies observed during the Preliminary Inspection, he/she may recommend and/or conduct more detailed fire safety assessment, investigations or analysis.

3.5 Detailed Assessment of Existing factory Buildings

Interpretative Guideline: the purpose of this section is to outline how recommended follow-up fire safety assessment work should be carried out. Such follow-up work could include observation, testing and monitoring over a particular time period, exposing certain elements and inspecting condition and performance of systems, preparation of accurate as-built drawings as identified in the Preliminary Fire Safety Inspection.

If the Preliminary Fire Safety inspection indicates areas of fire safety concern, non-compliant doors on

escape paths, missing, damaged or distorted fire rated compartmentation elements, non-performing fire safety systems, lack of verifiable documents or other lack of compliance with the requirements of this Standard, then more detailed fire safety investigation or assessment shall be required. .

To accomplish this, the Factory Owner shall engage a Qualified Architectural or Engineering Consultant that meets the qualifications established by LABS to provide fire safety advisory services to prepare all required design confirmation and fire safety documentation.

If required, the Qualified Architectural or Engineering Consultant shall prepare as-built fire safety documents as described in the Section 3.7.

3.6 Required Fire Safety Documentation for New and Existing Factories

Every factory requires fire safety documentation that accurately describes the fire safety measures provided for the factory buildings.

Fire Safety documentation shall be maintained at the factory site and made available to third parties assessing the fire safety of the factory.

New factories and any additions or expansions shall have complete fire safety documentation including Design Report and Fire Safety Documents as required by the Vietnam National Construction Regulations.

Existing factories shall have one of the following types of documentation

(1) Complete and credible fire safety documentation prepared in general accordance with the National Construction Regulations and used as a basis for the original construction of the factory building, or

(2) As-built structural documents that accurately describe the fire safety measures as described in Section 3.7.

3.7 Requirements for As-Built Documents

3.7.1 Where existing factories lack complete design and construction documentation from the factory construction, as-built documents shall be prepared in accordance with this section.

The Factory Owner shall engage a Qualified Architectural or Engineering Consultant to prepare accurate as-built documents from first-hand knowledge and personal investigation of the actual in situ factory construction and operational conditions.

The credibility of any existing structural documentation shall be determined by the Qualified Architectural or Engineering Consultant on the basis of observations and tests at the factory.

As-built documents shall serve as the basis for any detailed fire safety analysis performed to confirm the adequacy of the fire safety measures provided.

3.7.2 As-built documents shall include, at a minimum, the following:

3.7.2.1 The as-built fire safety drawings should include:

- Cover page – including date of survey and date of completion of as-built drawings, GPS location and name of factory, names of Surveyor and Checking Engineer
- All plan drawings shall include a north arrow
- Key plans shall be used where relevant to denote clearly separate sections of the building
- The drawings should be to a relevant scale, related to the size and complexity of the building in question. Typical suitable scales are 1:50, 1:100 and 1:200 on A3 or A2 drawing sheets with A3

size as a minimum.

3.7.2.2 Scaled and dimensioned Architectural Documents, including:

- Scaled site plan showing:
  - general layout of all buildings in the complex with labels
  - location and names of adjacent streets
  - location and size of utilities, if known

- Scaled architectural floor plan for each level of each building showing:
  - Architectural detail dimension
  - Location and size of stairs
  - Location and size of elevators
  - Location of fixed walls
  - Location of corridors
  - Location of openings in floors
  - Labelled usage areas on each floor, e.g. sewing, storage, dining, rooftop, office, etc.
  - Location of major machinery and equipment
  - General layout of factory activities
  - Roof Plan showing any construction, equipment, water tanks, or tower added at roof level.

- Scaled elevations of each façade of the building showing:
  - General configuration of the building including door and window schedule
  - Location and type of façade materials
  - Accurate number of levels and any intended future vertical or horizontal expansion areas.

- Scaled cross-section of the building showing:
  - Stair location
  - Location and size of doors
  - Location and type of materials
  - Dimensions between floors
  - Accurate number of levels and any intended future vertical or horizontal expansion areas

3.7.2.3 Factory Fire Safety Drawings should use the architectural plan documents as background and should show, for every floor and roof level, if accessible:

- dedicated aisle locations
- means of escape from most remote areas to floor exits, giving maximum travel distances
- protection of evacuation paths where provided, giving fire rating for each element
- type and fire rating of all fire doors location, extent and type of any fire rated elements provided for horizontal compartmentation
- location of fire alarm initiating devices (pull or push) and manual call stations
- location, extent and type of enclosures for protection of vertical openings between floors or spaces.
- location of storage areas and type and extent of fire rated enclosures
- location of any high fire risk areas (boilers, generators, transformers, substations, etc.) and extent and type of fire rated enclosures
- location of any chemical stores and type and extent of fire rated enclosures
- location of exit signage at floor exits
- locations and type of portable fire extinguishers
- locations and type of all fire fighting systems distribution and connection points
- locations and type of all fire department emergency water connection points

3.7.2.4 Fire Safety Systems design documents should provide, for every floor and roof level, if accessible:

- Design and Specifications for the detection and alarm systems
- Single line diagrams and electrical layouts for fire detection and alarm systems
- Location and types of detectors and alarm sounders, visual warning, voice system components
- Design and Specifications for back-up power systems for detection and alarm systems
- Design and Specifications for the emergency lighting system
- Single line diagrams and electrical layouts for emergency lighting systems
- Location of luminaires, lamp types and ratings for the emergency lighting system
- Design and Specifications for back-up power systems for emergency lighting system
- Location, type and capacity of on-site water storage reservoirs
- Design of pumps (duty and standby) giving calculations for capacities and specifications of each
- Design of standpipes, fire hose systems giving sizes, pressures and flow rates
- Design and specifications of any automatic suppression system (sprinklers, dry powder, etc)
- Design of sprinkler system pumps (duty and standby) giving calculations for capacities and specifications of each

3.8 General Fire Safety requirements: The following sections describes the general fire safety requirements for building and structures based on use and occupancy, building height and area, and construction type.

Parts 3-6 cover mainly Fire Safety requirements for new and existing buildings. The objective of these measures is to limit the risk to occupants in the event of fire and focuses for that reason on the following fire safety measures:

- Automatic detection and fire alarm systems for early warning to all occupants of the building in the event of a fire in the building
- Emergency escape routes from all parts of the building protected from the effects of smoke and fire and free of obstacles that could hinder free flow of people to a place of safety
- Adequate emergency lighting on all components of the escape paths
- Separation of high fire risk areas from the production area and protection of emergency escape paths

3.9 Definitions

3.9.1 High-rise building: Structures or buildings where the highest occupiable floor is located more than 23 m (75 ft.) above the grade level around the building.

3.9.2 Building Height: The building height shall be measured from the fire brigade access level to the highest occupiable floor, excluding the roof technical floor.

3.9.3 Occupiable roof: A roof-level shall be considered occupiable where access to the roof is provided and is not limited to mechanical equipment.

3.9.4 Incidental occupancy: occupancy types other than the main purpose of the building.

3.9.5 Mixed occupancy: incidental occupancy type which does not require to be separated from the main occupancy type of the building, having regard to the limitations of this Standard.

3.9.5.1 Separated occupancy: A multiple occupancy where the occupancies are separated by fire resistance-rated assemblies.

3.10 Use and Occupancy

3.10.1 General: Buildings or portions of buildings shall be classified based on occupancy in one or more of the occupancies listed below. For spaces that are used for more than one occupancy, the space shall be classified based on all the occupancies present and shall meet the requirements of Section 3.11. All other

requirements of NFPA 5000 (2015) Section 6.1 regarding classification of occupancy and hazard of contents shall be met.

3.10.2 Industrial Occupancy: An occupancy in which products are manufactured or in which processing, assembling, mixing, packaging, finishing, decorating, or repair operations are conducted. [See NFPA 5000 (2015) Clause 6.1.12.1].

Industrial occupancies relevant to Garments and Footwear include the following:

(1) Dry-cleaning plants
(2) Factories of all kinds
(3) Laundries

Each industrial occupancy shall be classified according to its use as described in NFPA 5000 (2015) Section 29.1.2.1, see below:

3.10.2.1 General Industrial Occupancy

(1) Industrial occupancies that conduct ordinary and low hazard industrial operations in buildings of conventional design that are usable for various types of industrial processes.
(2) Industrial occupancies that include multistory buildings where floors are occupied by different tenants, or buildings that are usable for such occupancy and, therefore, are subject to possible use for types of industrial processes with a high density of employee population.

Note: Garment and Footwear factories fall under the Industrial – General Industrial Occupancy Type

Industrial Occupancy is referred to in the Vietnamese QCVN 06:2010 as Production Buildings. Garment factories correspond to Category F 5.1 according to functional fire hazards [see QCVN 06:2010 Table 6: manufacturing buildings and structures, rooms for manufacturing and testing, workshops].

Classification is further defined by Category of fire hazard and combustion characteristics.

3.10.2.2 Special-Purpose Industrial Occupancy

(1) Industrial occupancies that conduct ordinary and low hazard industrial operations in buildings designed for, and that are usable only for, particular types of operations.
(2) Industrial occupancies that are characterized by a relatively low density of employee population, with much of the area occupied by machinery or equipment.

Note: Garment and Footwear factories are typically <u>not</u> classified as Industrial – Special-Purpose Industrial Occupancy Type.

3.10.2.3 High-Hazard Industrial Occupancy

Industrial occupancies that conduct industrial operations that use high-hazard materials or processes or house high-hazard contents in excess of the maximum allowable quantities (MAQ) as permitted by NFPA 5000 Section 6.3.2.4.

Note: Industrial occupancies in which incidental high-hazard operations in low- or ordinary-hazard occupancies are protected in accordance with 3.11.5 in this Standard, are considered to be Separated occupancies hence are not required to be the basis for overall occupancy classification.

Category of fire hazard and combustion characteristics of rooms
The Vietnamese codes classify rooms, depending on the fire hazard and combustion characteristics of those, in Categories A, B, C1 to C4, D and E [see QCVN 06:2010 Table C 1].

Note: Garment and Footwear factories fall under the Category C fire hazard and combustion characteristics in accordance with the Vietnamese codes.

3.10.3 Assembly Occupancy: An occupancy

(1) used for a gathering of 50 or more persons for deliberation, worship, entertainment, eating, drinking, amusement, awaiting transportation, or similar uses; or

(2) used as a special amusement building, regardless of occupant load [see NFPA 5000 (2015) Clause 6.1.2.1]. In the Vietnamese codes, these correspond to Category F 2 according to functional fire hazards [see QCVN 06:2010 Table 6].

3.10.4 Educational Occupancy: An occupancy used for educational purposes by six or more persons for 4 or more hours per day or more than 12 hours per week [see NFPA 5000 (2015) Clause 6.1.3.1]. In the Vietnamese codes, these correspond to Category F 4 according to functional fire hazards [see QCVN 06:2010 Table 6].

3.10.5 Day-Care Occupancy: An occupancy in which four or more clients receive care, maintenance, and supervision, by other than their relatives or legal guardians, for less than 24 hours per day [see NFPA 5000 (2015) Clause 6.1.4.1]. In the Vietnamese codes, these correspond to Category F 1.1 according to functional fire hazards [see QCVN 06:2010 Table 6].

3.10.6 Residential Occupancy: An occupancy that provides sleeping accommodations for purposes other than health care or detention and correctional [see NFPA 5000 (2015) Clause 6.1.8.1]. In the Vietnamese codes, these correspond to Category F 1 according to functional fire hazards [see QCVN 06:2010 Table 6].

3.10.7 Mercantile Occupancy: An occupancy used for the display and sale of merchandise [see NFPA 5000 (2015) Clause 6.1.10.1]. In the Vietnamese codes, these correspond to Category F 3.1 according to functional fire hazards [see QCVN 06:2010 Table 6].

3.10.8 Business Occupancy: An occupancy used for the transaction of business other than mercantile [see NFPA 5000 (2015) Clause 6.1.11.1]. In the Vietnamese codes, these correspond to Category F 3.5 according to functional fire hazards [see QCVN 06:2010 Table 6].

3.10.9 Storage Occupancy: An occupancy used primarily for the storage or sheltering of goods, merchandise, products, or vehicles [see NFPA 5000 (2015) Clause 6.1.13.1]. In the Vietnamese codes, these correspond to Category F 5.2 according to functional fire hazards [see QCVN 06:2010 Table 6]. Contents of storage occupancies shall be classified as low hazard, ordinary hazard, or high hazard in accordance with NFPA 5000 (2015) Section 6.3, depending on the quantity and character of the materials stored, their packaging, and other factors, as set below:

3.10.9.1 Low Hazard Contents: Low hazard contents shall be classified as those of such low combustibility that no self-propagating fire therein can occur.

3.10.9.2 Ordinary Hazard Contents: Ordinary hazard contents shall be classified as those that are likely to burn with moderate rapidity or to give off a considerable volume of smoke.

Note: Garment factories are in most circumstances fall under the Ordinary Hazard Contents classification.

3.10.9.3 High Hazard Contents: High hazard contents shall be classified as those that are likely to burn with extreme rapidity or from which explosions are likely.

3.11 Mixed Use

3.11.1 General: Each portion of a building or structure shall be classified individually according to Section 3.10 of this Standard. When a building contains more than one occupancy, the building or portion shall comply with the applicable requirements of 3.11.2, 3.11.3 and 3.11.4.

3.11.2 Mixed (Non-separated) Occupancies: Where incidental occupancies do not occupy more than 25 percent of the area of any floor of a building, nor more than the basic area permitted by 3.12.3 in this Standard for each building and occupancy type, for the purpose of determining permitted area and number of floors, the principal occupancy type of the building shall determine the occupancy classification.

Otherwise, in buildings with incidental occupancies, where these are not separated in accordance with 3.11.3, the most restrictive requirements for each occupancy type shall be applied to the entirety of the building (including fire protection, means of egress, type of construction and allowable building height and area).

Note: No separation is required between non-separated occupancies meeting the requirement of this section.

3.11.3 Separated occupancies: Where separated occupancies are provided, new and existing occupancies shall be separated by fire-resisting enclosure from other occupancy types.

3.11.4 Incidental occupancies: Where incidental to another occupancy, areas used as follows shall be permitted to be considered part of the predominant occupancy and shall be subject to the provisions of the codes that apply to the predominant occupancy only:

(1) Mercantile, business, industrial, or storage use, regardless of occupancy level.
(2) Assembly gathering less than 50 persons.
(3) Educational for less than 6 people.
(4) Day care for less than 4 people.

3.11.5 Separation of incidental occupancies: No occupancy separation shall be required between incidental and main occupancies except where required by 3.11.5.1 through 3.11.6.3.

3.11.5.1 Daycare: Daycare occupancies which are incidental to other occupancies shall be located on the ground floor with a maximum travel distance of 9 m to a storey or final exit.

3.11.5.2 Boiler or furnace rooms: Any room or space housing boilers or other heat producing equipment shall be separated from other occupancies by a minimum 2-hour fire rated construction.

Further, the following additional aspects may be taken into account in the location of boiler room:

1. The boilers shall be installed in a fire resisting room of 120 min fire resistance rating.
2. Entry to this room shall be provided with a composite door of 60 min fire resistance rating.
3. The boiler room shall be provided with its dedicated natural or mechanical ventilation system. Mechanical ventilation system for the boiler room would be accepted with 120 min fire resistance rating ductwork, if it has interface with other mechanical areas. Ventilation system should not be allowed to be routed through electrical room area or through exit corridor/exits.
4. The oil tank for the boiler shall be provided with a dyked enclosure having a volumetric capacity of at least 10 percent more than the volume of the oil tank. The enclosure shall be filled with sand for a height of 300 mm

3.11.5.3 Generators: Generator sets shall be separated from all other occupancy areas by a minimum 2-hour construction. Fuel tanks shall be limited to a maximum 2500 L (660 gal) when located in a building with other occupancies. Exhaust shall be in accordance with NFPA 37. All exhaust systems shall discharge to the exterior of the building in a safe location.

Further, the following additional aspects may be taken into account in the location of generator room:

1. The generator room shall be provided with its dedicated natural or mechanical ventilation system. Mechanical ventilation system for the generator room would be accepted with 60 min fire resistance rating ductwork, if it has interface with other mechanical areas. Ventilation system should not be allowed to be routed through any dedicated electrical room area or through exit corridor/exits.

2. The oil tank for the generator shall be provided with a dyked enclosure having a volumetric capacity of at least 10 percent more than the volume of the oil tank (if not a in-built day-tank for fuel placed under Alternator). The enclosure shall be filled with sand for a height of 300 mm

3.11.5.4 Other Hazardous Areas Protection: It is recommended that rooms used for the housing of compressors, transformers, refrigerating machinery are located outside and remote from the main facilities. In the case this is not possible, such rooms:

(1) Shall not be located directly under, or directly adjacent to, exits (hence cannot be connected to exit corridors, etc. stairs by way of lobbies).
(2) Shall be separated by fire barriers and / or protected by automatic extinguishing systems, in accordance with NFPA 5000 (2015) Table 24.3.2.3 (reproduced in Table 3.11.5 below):

Table 3.11.5 Hazardous Area Protection

Hazardous Area Description	Separation / Protection
Boiler and fuel-fired heater rooms	1 hour and sprinklers or 2 hours and no sprinklers
Employee locker rooms	1 hour or sprinklers
Gift or retail shops	1 hour or sprinklers
Laundries	1 hour and sprinklers or 2 hours and no sprinklers
Transformers	1 hour and suppression system or 2 hours and no suppression system
Maintenance shops	1 hour and sprinklers or 2 hours and no sprinklers
Storage rooms	1 hour or sprinklers
Trash rooms	1 hour and sprinklers or 2 hours and no sprinklers

(3) Gas-fired boilers shall be protected as per clause 3.11.6 in this Standard.

3.11.5.5 Non-sprinklered Electrical Rooms:

In accordance with NFPA 13 (2016) Section 8.15.11, sprinklers can be omitted from electrical equipment rooms whilst the building is considered as sprinkler throughout, provided that:

(1) The room is dedicated to electrical equipment only.
(2) Only dry-type electrical equipment is used.
(3) No combustible storage is permitted within the room.
(4) Equipment is installed in a 2hr fire-rated enclosure including protection for penetrations (e.g. smoke ventilation should be direct to the exterior only or fire-rated ducts / fire dampers should be installed).

3.11.5.6 Miscellaneous ('In-process') storage:

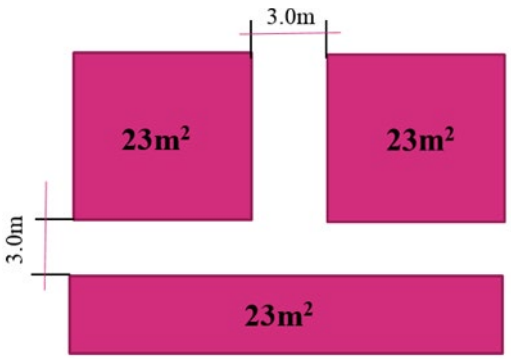
Sprinklered buildings: In process storage open to the surrounding occupancy is not required to be separated when provided with automatic sprinkler protection in accordance with Section 5.3 and meets the following requirements:

(1) The storage does not exceed 3.66m in height,
(2) It is incidental to other occupancies (see 3.11.2 and 3.11.4 above),
(3) Does not exceed 93m^2 in any one area, and
(4) Is separated by at least 7.62m from other storage areas.

Non-sprinklered buildings: In process or miscellaneous open to the surrounding occupancy is not required to be separated provided that it meets the following requirements:

(1) The storage does not exceed 2.45m in height,
(2) It is incidental to other occupancies (see 3.11.2 and 3.11.4 above),
(3) Does not exceed 23m^2 in any one area, and
(4) Is separated by at least 3.0m from other storage areas.

3. Figure 1 In-process temporary storage arrangement for non-sprinklered area



3.11.5.7 Parking. Parking of personal motor vehicles shall not be allowed in existing buildings unless the parking area is separated by 1-hour fire-resistive rated construction or automatic suppression protection is provided. In addition, parking shall only be permitted if adequate provisions for carbon monoxide detection/removal are provided, and if parking areas were originally designed or subsequently approved for the parking of vehicles by appropriate legislative parties.

3.11.6 Flammable and Combustible liquid

The storage and handling of flammable liquids or gases shall be in accordance with the following applicable standards:

(1) NFPA 30, Flammable and Combustible Liquids Code.
(2) NFPA 54, National Fuel Gas Code.
(3) NFPA 58, Liquefied Petroleum Gas Code.

Licenses required by this section must be prominently posted and kept up-to-date.

Storage of flammable and combustible liquid shall not be allowed in basements.

3.11.6.1 Laboratories housing Chemical Storage: Laboratories that use chemicals shall comply with NFPA 45,

Standard on Fire Protection for Laboratories Using Chemicals, unless otherwise modified by other provisions of this Code.

3.11.6.2 Dry-cleaning plants: Dry-cleaning plants shall be constructed in accordance with NFPA 32, Standard for Dry-cleaning Plants.

3.11.6.3 Chemical Storage: All liquid or solid chemicals should be stored in separate buildings, located outside Garment and Footwear factories.

Where such a room can only be practically located within the RMG Factory, the enclosures of the room must achieve at least 1-hour fire resistance. Such rooms shall not be located directly under, or directly adjacent to, exits (hence cannot be connected to exit corridors, etc. stairs by way of lobbies).

Automatic detection must be provided within the chemical storage room, linked to an automatic alarm system.

Chemical containers should be stored within enclosed cupboards within the storage room.

Where flammable liquids are stored, the room should be provided with spill containment, to prevent the spread of flammable liquids beyond the storage room (typically recessed at least 100mm).

Liquefied or compressed flammable gas cylinders create an explosion and fire risk because of the high pressures inside the cylinders. Gas can be released deliberately by opening the cylinder valve, or accidentally from a broken or leaking valve or from a safety device. Even at a relatively low pressure, gas can flow rapidly from an open or leaking cylinder. Flammable gases, such as acetylene, butane, ethylene, hydrogen, methylamine and vinyl chloride, can burn or explode under certain conditions. Therefore, the storage or use of such liquefied or compressed flammable gas cylinders shall be prohibited within the factory building.

The requirements of NFPA 5000 (2015) Section 8.15 shall be incorporated. Where hazardous processes or storage e.g. chemical processing or storage is of such a character as to introduce and explosion potential, an explosion venting system or an explosion suppression system specifically designed for the hazard shall be provided subject to a risk assessment by and LABS-appointed engineer.

3.12 Building Height and Areas

3.12.1 General

Buildings or parts of buildings classified in a specified occupancy group because of their use:

(1) Shall be limited to the types of construction specified in NFPA 5000 (2015) Section 7.2 (see Section 3.12.2 in this Standard).
(2) Shall comply with the height and area requirements specified in 3.12.3 below.

3.12.2 Types of Construction:

(1) Type I (442 or 332) and Type II (222, 111, or 000) construction: fire walls, structural elements, walls, arches, floors, and roofs are of approved non-combustible or limited-combustible materials. [Refer to NFPA 5000 (2015) Section 7.2.3.]
E.g. reinforced concrete and steel construction with no combustible linings, insulation, etc.

(2) Type III (211 or 200) construction: exterior walls (and structural elements that are portion of such walls) are of approved non-combustible or limited-combustible materials, and in which fire walls, interior structural elements, walls, arches, floors, and roofs are of approved non-combustible, limited-combustible, or other approved combustible materials. [Refer to NFPA 5000 (2015) Section 7.2.4.]
E.g. reinforced concrete and steel construction with approved combustible linings, insulation, etc.

(3) Type IV (2HH) construction: fire walls, exterior walls, and interior bearing walls (and structural elements that are portions of such walls) are of approved noncombustible or limited-combustible materials. Other interior structural elements, arches, floors, and roofs shall be of solid or laminated wood or cross-laminated timber without concealed spaces. [Refer to NFPA 5000 (2015) Section 7.2.5.]
E.g. construction making use of large size timber structure and no combustible materials elsewhere.

(4) Type V (111 or 000): structural elements, walls, arches, floors and roofs are entirely or partially of wood or another approved material. [Refer to NFPA 5000 (2015) Section 7.2.6.]
E.g. construction making use of timber construction of any type and size and no restrictions on the combustibility of materials elsewhere.

3.12.3 Allowable Building Height and Area

3.12.3.1 New Construction: The type of construction and the allowable building height and area of new Industrial occupancies shall be as required by the Vietnamese code requirements (QCVN 06:2010 Appendix H)

3.12.3.2 Existing Construction: The type of construction and the allowable building height and area of existing Industrial occupancies shall be as required in NFPA 5000 (2015) Table 7.4.1, with relevant extracts for Garment and Footwear factories as given in the table below:

Table 3.12.3 Allowable Building Height and Area

Type of Construction		Restriction	General Industrial	Storage, Ordinary Hazard	Mercantile	Business	All Others
Type I	442	Max. height	Unlimited				As per NFPA 5000 (2015) Table 7.4.1
		Max. area					
		Max. floors					
	332	Max. height	Unlimited				
		Max. area					
		Max. floors					
Type II	222	Max. height	48.7 m (54.8 m if sprinklered)				
		Max. area[2]	Unlimited	4459 m^2	Unlimited	Unlimited	
		Max. floors (unsprinklered)	11[1]	11[1]	11	11	
		Max. floors (sprinklered)	12	12	12	12	
	111	Max. height	19.8 m (25.9 m if sprinklered)				
		Max. area[2]	2325 m^2	2415 m^2	2000 m^2	3485 m^2	
		Max. floors (unsprinklered)	4[1]	4[1]	4	5	
		Max. floors (sprinklered)	5	5	5	6	
	000	Max. height	16.7 m (22.8 m if sprinklered)				
		Max. area[2]	1440 m^2	1625 m^2	1160 m^2	2140 m^2	
		Max. floors (unsprinklered)	2[1]	3[1]	4	4	
		Max. floors (sprinklered)	3	4	5	5	
Type III	211	Max. height	19.8 m (25.9 m if sprinklered)				
		Max. area[2]	1765 m^2	2415 m^2	1720 m^2	2650 m^2	
		Max. floors (unsprinklered)	3[1]	3[1]	4	5	

Type of Construction		Restriction	General Industrial	Storage, Ordinary Hazard	Mercantile	Business	All Others
		Max. floors (sprinklered)	4	4	5	6	
	200	Max. height	16.7 m (22.8 m if sprinklered)				
		Max. area[2]	1115 m^2	1625 m^2	1160 m^2	1765 m^2	
		Max. floors (unsprinklered)	2[1]	3[1]	4	4	
		Max. floors (sprinklered)	3	4	5	5	
Type IV	2HH	Max. height	19.8 m (25.9 m if sprinklered)				
		Max. area[2]	3112 m^2	2369 m^2	1905 m^2	3345 m^2	
		Max. floors (unsprinklered)	4[1]	4[1]	4	5	
		Max. floors (sprinklered)	5	5	5	6	
Type V	111	Max. height	15.2 m (21.3 m if sprinklered)				
		Max. area[2]	1301 m^2	1301 m^2	1301 m^2	1672 m^2	
		Max. floors (unsprinklered)	2[1]	3[1]	3	3	
		Max. floors (sprinklered)	3	4	4	4	
	000	Max. height	12.1m (18.2m if spinklered)				
		Max. area[2]	790 m^2	836 m^2	836 m^2	836 m^2	
		Max. floors (unsprinklered)	1	1	1	2	
		Max. floors (sprinklered)	2	2	2	3	

Notes:

[1] *The allowable number of floors and areas are also subject to the requirements of Section 5.3.2.2 of this Standard.*

[2] *The allowable area per storey specified in the Table shall be permitted to be increased in accordance with the frontage and sprinkler enhancement factors given in NFPA 5000 cl. 7.6.2.*

3.12.4 Automatic sprinkler system: The provision of sprinklers shall be in accordance with the allowable building height and area limitations set forth in Section 3.12.3 of this Standard, except where modified by clause 5.3.2 of this Standard.

3.13 Mezzanine

3.13.1 Definition: An intermediate level between the floor and the ceiling of any room or space, so that sufficient elevation is provided for human occupancy in the area underneath.

3.13.2 Area limitations: the aggregate area of mezzanines within a room shall not exceed 1/3rd of the open area of the room in which the mezzanines are located (note that the area of the mezzanines shall not be included in the area of the main room).

3.13.3 Openness: all portions of a mezzanine, other than walls not more than 1065mm high, columns and posts, shall be open to and unobstructed from the room in which the mezzanine is located, unless the occupant load of the aggregate area of the enclosed space does not exceed 10. However, a mezzanine having two or

more means of egress shall not be required to open onto the main area if one of the means of egress provides direct access from the enclosed area to an exit at the mezzanine level.

3.13.4 **Fire resistance requirements:** the supporting structure of the mezzanine shall be rated to not less than 1 hour in Type I and Type II (222 or 111) buildings.

Mezzanine floors in Type II (000) construction shall not be required to have a fire resistance rating

3.13.5 **Existing Construction:** In existing buildings with non-fire-rated structures complying with 0 above, the mezzanine does not need to be fire rated.

4 Part 4 Fire Protection Construction

4.1 General: This section describes the requirements for materials, systems and assemblies used for structural fire resistance and fire resistance rated construction to restrict the spread of fire and smoke both internal within a building or structure and from building to building.

Fire-resistive materials and construction shall be built in accordance with NFPA 5000 (2015) Chapter 8.

4.2 Definitions

4.2.1 Fire Barrier: A wall, other than a fire wall, having a fire resistance rating. [See NFPA 5000 (2015) clause 3.3.670.3.]

4.2.2 Fire Wall: A wall separating buildings or subdividing a building to prevent the spread of fire and having a fire resistance rating and structural stability. [See NFPA 5000 (2015) clause 3.3.670.4.]

4.2.3 Fire Compartment: A space within a building that is enclosed by fire barriers on all sides, including the top and bottom

4.2.4 Fire Resistance: The fire resistance ratings of structural elements, building components or assemblies shall be determined in accordance with the test procedures outlined in ASTM E 119 or UL 263, or any other internationally recognized LABS approved test procedures (suggested examples - BS 476, EN 13501, etc.).

4.2.5 Vertical Openings: An opening through a floor or roof.

4.2.6 Shaft: An enclosed space extending through one or more stories and connecting vertical openings through two or more successive floors of a building or through floors and roof.

4.2.7 Atrium: An atrium is an opening connecting two or more stories other than enclosed stairways, elevators, plumbing, electrical, mechanical, or other equipment that is enclosed in fire-rated enclosures. Stories do not include mezzanines that are open.

4.3 Fire resistance of structural members: The fire resistance of structural members shall be in compliance with NFPA 5000 (2015) Chapter 7 and Table 7.2.1.1 (repeated below in Table 4.3 of this Standard), for the types of construction referred to in Section 3.12.2 of this Standard.

Table 4.3 Fire Resistance Ratings for Type I through Type V Construction (hours)

Construction Element	Type I		Type II			Type III		Type IV	Type V	
	442	332	222	111	000	211	200	2HH	111	000
Exterior Bearing Walls	4	3	2*	1	0	2	2	1	0	
Interior Bearing Walls										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	2	1	0
Supporting one floor only	3	2	2	1	0	1	0	1	1	0
Supporting roofs only	3	2	1	1	0	1	0	1	1	0
Columns										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	H	1	0
Supporting one floor only	3	2	2	1	0	1	0	H	1	0
Supporting roofs only	3	2	1	1	0	1	0	H	1	0
Beams, Girders, Trusses and Arches										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	H	1	0

Construction Element	Type I		Type II			Type III		Type IV	Type V	
	442	332	222	111	000	211	200	2HH	111	000
Supporting one floor only	2	2	2	1	0	1	0	H	1	0
Supporting roofs only	2	2	1	1	0	1	0	H	1	0
Floor / Ceiling Assemblies	2	2	2	1	0	1	0	H	1	0
Roof / Ceiling Assemblies	2	1.5	1	1	0	1	0	H	1	0
Interior Nonbearing Walls	0	0	0	0	0	0	0	0	0	0
Exterior Nonbearing Walls	0**	0**	0**	0**	0**	0**	0**	0**	0**	0**

H heavy timber members.
* 1hr where exterior bearing walls support a roof only.
** Except where required to be protected as per NFPA 5000 (2015) Table 7.3.2.1.

4.4 Separation

4.4.1 General: Separation of floors, occupancies, hazards, exit enclosures shall be provided with fire rated construction fire barriers in accordance with this section.

4.4.2 Fire Barriers: Fire barriers shall be classified as 1-, 2-, or 3-hr fire-resistive rated construction.

4.4.2.1 Fire barrier shall be continuous from outside wall to outside wall, from one fire barrier to another or combination thereof and shall be continuous through all concealed spaces.

4.4.2.2 Fire barriers shall be constructed of materials meeting the testing requirements of IS/ISO 834-8 or ASTM E 119, or any other internationally recognized LABS approved test procedures.

4.4.2.3 All openings in fire barriers shall be protected with fire-resistant protective opening protection in accordance with 4.11.

4.4.3 Vertical openings: Every vertical opening between the floors of a building shall be suitably enclosed or protected, as necessary, to provide reasonable safety to occupants while using the means of egress by preventing spread of fire, smoke, or fumes through vertical openings from floor to floor to allow occupants to complete their use of the means of egress.

Openings through floors shall be enclosed with fire barrier walls, shall be continuous from floor to floor or floor to roof, and shall be protected as appropriate for the fire resistance rating of the barrier. Openings through a floor/ceiling assembly shall be protected shafts in accordance with 4.8 unless meeting the requirements of 4.4.4 or 4.4.5.

4.4.4 Services Penetrations

4.4.4.1 A shaft enclosure is not required for penetrations by pipe, tube, conduit, wire, cable and vents protected in accordance with Section 4.11.1

4.4.5 Openings Connecting Two Storeys

4.4.5.1 A shaft enclosure is not required for stairs or other floor openings connecting only two stories and is separated from floor openings serving other floors by construction as required for shafts, and does not connect to a basement area or storage or hazardous occupancies

4.5 Doors

4.5.1 Fire Doors

4.5.1.1 Fire doors shall comply with the following requirements:

1. Fire doors shall be constructed of non-combustible material having appropriate fire resistance, and two fire doors may be fitted in an opening if each door by itself is capable of closing the opening and the two doors together achieve the required level of fire resistance.
2. All fire doors shall be fitted with an automatic self-closing device, of same fire rating as of the door, which is capable of closing the door from any angle and against any latch fitted to the door.
3. Any fire door fitted within an opening which is provided as a means of escape shall be capable of being opened manually, not be held open by any means other than by an electromagnetic or electromechanical device which can be activated by the presence of smoke and/or the fire alarm system, provided that this shall not apply in the case of fire doors opening into pressurised exit staircases

4.5.2 Fire Door Specifications

4.5.2.1 Fire doors assemblies shall conform to NFPA 252, or any other internationally recognized LABS approved standard

4.5.3 Fire Door Ratings

4.5.3.1 Ratings of fire doors shall be in accordance with 4.10 in this Standard

4.6 Windows

4.6.1 Fire windows shall conform to NFPA 257, or any other internationally recognized LABS approved standard

4.7 Ducts

4.7.1 Ducts penetrating fire-resistance rated assemblies shall be protected with listed fire dampers. Dampers shall be 1 ½ -hour rated dampers when located in a 2 -hour or less fire-resistance rated assembly. Dampers shall be 3 -hour rated dampers when located in a 3 -hour or greater fire-resistance rated assembly.

4.8 Shafts

4.8.1 Fire-resistance rating

4.8.1.1 A shaft enclosure shall have a minimum fire-resistance rating of 2 -hours when connecting four stories or more and a minimum fire-resistance rating of 1 -hour when connecting three stories or less. Any associated opening protectives shall comply with the requirements in Section 4.1010 of this Standard.

4.8.2 Continuity

4.8.2.1 A shaft enclosure shall be constructed as a fire barrier and shall meet the continuity requirements of Section 4.4.2.2. of this Standard.

4.8.3 Openings

4.8.3.1 Openings in shafts shall be limited to those necessary for the purpose of the shaft. These openings shall be protected as required in Section 4.10 or 4.11 of this Standard.

4.9 Parapets

4.9.1 Parapet walls shall be provided on the exterior of all buildings where exterior walls are required to have fire

resistance as per NFPA 5000 (2015) Table 7.3.2.1), unless otherwise permitted by NFPA 5000 (2015) clause 37.1.3.1, e.g. if the building is sprinklered throughout.

1. Parapets should have the same fire resistance rating as the wall upon which they are erected.2
2. Parapets shall extend not less than 760 mm above any part of the roof that is within 3050 mm of the parapet wall

4.10 Opening Protectives and Fire Doors

4.10.1 Openings

4. in fire resistance rated walls (e.g. fire doors) shall be protected in accordance with NFPA 5000 (2015) Section 8.7 and Table 8.7.2, namely:

(1) 3 -hour fire barriers protected with 3 -hour fire protective opening assemblies
(2) 2 -hour fire barriers protected with 1.5 -hour fire protective opening assemblies
(3) 1 -hour fire barriers protected with ¾ -hour fire protective opening assemblies
(4) 1 -hour exit enclosures and vertical shafts (e.g. stairs) protected with 1 -hour fire protective opening assemblies. [Refer to 6.2.6 in this Standard for a definition of exit enclosure.]

4.11 Penetrations

4.11.1 Penetrations of fire barriers and fire walls shall be protected with a listed through- penetration firestop system tested in accordance with ASTM E814, or any other internationally recognized LABS approved test procedures.

4.12 Atrium:

4.12.1 General

4.12.1.1 This section shall apply to buildings or structures containing vertical openings linking floors and known as atrium.

4.12.2 Fire alarm system

4.12.2.1 An automatic fire alarm system shall be provided throughout all new and existing buildings containing an atrium in accordance with Section 5.9 of this Standard.

4.12.3 Separation

4.12.3.1 Enclosure of new and existing atria shall be in accordance with NFPA 5000 (2015) Section 8.12.3 (1), i.e. separated from the adjacent spaces by fire barriers with not less than a 1-hour fire resistance rating with opening protectives for corridor walls.

4.12.3.2 Glass walls and inoperable windows shall be permitted in lieu a 1-hour fire barrier where all of the following items are met:

(1) Automatic sprinklers are placed on both sides of the glass at maximum 1.83 m intervals.
(2) These sprinklers are placed no more than 305 mm from the glass to allow wetting the entire surface of the glass.
(3) The glass is of wired, tempered, or laminated glass held in place by gasketed frames allowing the glass to deflect without breaking prior to operation of the sprinklers.
(4) Sprinklers can be eliminated from the atrium side of the glass on levels where there is not a walking surface on the atrium side above the lowest level of the atrium.
(5) Doors in the glass walls are smoke-resistant and are self- or automatic-closing.

The glass is vertically continuous, not provided without horizontal elements that would prevent

the sprinklers from wetting the entire surface of the glass.

4.12.3.3 The additional requirements for atria made in NFPA 5000 (2015) Section 8.12.3 shall be complied with.

4.12.4 Engineering analysis

4.12.4.1 An engineering analysis shall be conducted to demonstrate that the building is designed to keep the smoke layer interface above the highest unprotected opening (from the atrium) to adjoining spaces, or 1830 mm above the highest floor level open to the atrium for 20 min. The results of the engineering analysis may require smoke control, separation, sprinkler protection and/or other protection features,

4.12.5 Smoke control

4.12.5.1 Smoke control required by the engineering analysis in new and existing construction shall be designed in accordance with NFPA 92 unless the requirements of 3.13.1.1 are met.

4.12.6 Exisiting buildings

4.12.6.1 Atria in existing buildings shall not be required to have a smoke control system provided the entire atrium is separated from the rest of the building by 2-hour fire- rated construction and where egress paths do not pass through the atrium and where emergency workers are not required to access the atrium.

5 Part 5 Fire Protection Systems

5.1 General: This section describes the requirements as to where fire protection systems are required and the requirements for design, installation and operation of these fire protection systems.

5.2 Definitions

5.2.1 Sprinkler System: A system that consists of an integrated network of piping designed in accordance with fire protection engineering standards that includes a water supply source, a water control valve, a waterflow alarm, and a drain. The portion of the sprinkler system above ground is a network of specifically sized or hydraulically designed piping installed in a building, structure, or area, generally overhead, and to which sprinklers are attached in a systematic pattern. The system is commonly activated by heat from a fire and discharges water over the fire area.

5.2.2 Dry Powder system: A means of applying dry powder composed of very small particles that can be automatically or manually activated to discharge through a distribution system onto or into a protected hazard. The dry powder contains added particulate material supplemented by special treatment to provide resistance to packing, resistance to moisture absorption and the proper flow capabilities. The dry powder is released by an expellant gas via pipework or directly from the storage container.

5.2.3 Standpipe: An arrangement of piping, valves, hose connections, and allied equipment installed in a building or structure, with the hose connections located in such a manner that water can be discharged in streams or spray patterns through attached hose and nozzles, for the purpose of extinguishing a fire, thereby protecting a building or structure and its contents in addition to protecting the occupants.

5.2.4 Alarm: A fire alarm system that activates the system alarm(s) and occupant notification devices.

5.2.5 Fire Hose System: A system that consists of piping, valves and hoses that can be manually activated to discharge water with the purpose of extinguishing a fire, with the hoses in a metallic cabinet or other type of enclosure and located in close proximity (or the same enclosure) to the pipe outlet connection in a conspicuous location.

5.3 Automatic Sprinkler Systems

5.3.1 General: Automatic sprinkler systems shall comply with this section.

5.3.2 Where required

5.3.2.1 New Construction: Sprinklers shall be provided in accordance with the allowable building height and area limitations set forth in Section 3.12.3.1 of this Standard, **and in addition** the following shall also be sprinklered throughout:

(1) High-rise buildings (see 3.9.1 in this Standard).
(2) As required by the Vietnamese codes QCVN 06:2010 and TCVN7336:2003.

5.3.2.2 Existing Construction: Sprinklers shall be retrofitted to existing construction where the following applies:

(1) High-rise buildings (see 3.9.1 in this Standard).
(2) For buildings with fire-rated structures where required as per clause 3.12.3.2 (and Table 3.12.3) in this Standard.
(3) In existing buildings with non-fire-rated structures, automatic sprinkler protection shall be provided throughout where the building is more than 2 stories in height and the built area exceeds 2,000 m^2 per floor.

5.3.3 Water demand: The sprinkler system water demand shall be calculated in accordance with TCVN

7336:2003 Table 2, as summarized below:

Table 5.3.3 Water Supply Requirement for Pipe Schedule Sprinkler Systems

Group of buildings and construction works	Spraying intensity in L/m²×s (mm/min), no less than		Area protected by 1 sprinkler or 1 melting lock in m²	Area to calculate water flow, foam creating solution in m²	Fire-fighting spraying time in min	Max. distance between sprinklers or melting locks in m
	Water	Foam creating solution				
Low fire rate (Light Hazard)						
Low fire rate (Light Hazard)	0.08 (4.8)	-	12	120	30	4
Average fire rate (Ordinary Hazard)						
Group I (OH 1)	0.12 (7.2)	0.08 (4.8)	12	240	60	4
Group II (OH 2)	0.3 (18)	0.15 (9)	12	240	60	4
Group III (OH3)	**	***	9	360	60	3
High fire-rate (Extra Hazard)						
High fire-rate (Extra Hazard)	Refer to TCVN7336:2003 (Table 2)					

** Spraying intensity in L/m2×s (mm/min), depending on shelf height, no less than:
Under 1m: 0.08 (4.8)
From 1m to 2m: 0.16 (9.6)
From 2m to 3m: 0.24 (14.4)
From 3m to 4m: 0.32 (19.2)

*** Spraying intensity in L/m2×s (mm/min), depending on shelf height, no less than:
Under 1m: 0.04 (2.4)
From 1m to 2m: 0.08 (4.8)
From 2m to 3m: 0.12 (7.2)
From 3m to 4m: 0.16 (9.6)
From 4m to 5.5m: 0.4 (24)

Note: Garment and Footwear factories (Textile manufacturing) falls within the Average fire rate (Group 3) i.e. OH3 classification, as per TCVN 7336:2003 Annex A.

5.3.4 **Installation requirements:** The design and installation of the sprinkler systems shall be in accordance with TCVN 7336:2003. In case of missing details or requirements, NFPA 13 guidance shall be observed. Pipe schedules shall not be used to size pipe. All systems shall be hydraulically calculated to meet the required design requirements.

5.3.4.1 **Documentation:** Installation of new automatic sprinkler systems shall be required to provide shop drawings and hydraulic calculations as outlined in NFPA 13. These drawings shall include all details as outlined in NFPA 13.

5.3.4.2 **Documentation Review:** All new sprinkler system installations in existing buildings shall be submitted for review to LABS.

5.3.5 **Acceptance testing:** Testing of the installation shall be conducted in accordance with TCVN 7336:2003 acceptance testing requirements. Documentation of all testing shall be submitted for review to LABS. Final inspection and testing of the installation shall be witnessed by LABS.

5.3.6 Supervision and Alarms

5.3.6.1 Valves: All valves controlling automatic sprinkler systems, fire pumps, and water supply systems shall be electrically supervised by a listed fire alarm system control unit.

5.3.6.2 Alarms: An approved audible device shall be connected to every automatic sprinkler system and shall be activated by waterflow equal to the flow of one sprinkler. Where a fire alarm system is installed, activation of the waterflow shall activate the fire alarm system.

5.3.7 Testing and maintenance: The maintenance of the system shall be in accordance with TCVN 3890:2009.

5.3.8 Storage protection

5.3.8.1 Storage clearance: All storage shall be maintained with a 460 mm minimum clearance from the top of storage to the sprinkler deflector.

5.3.8.2 Solid-shelves

(1) Racks: unless in-rack automatic sprinklers have been designed and installed, solid shelf racking shall not be used. A minimum of 50% openings in shelving material shall be considered open shelves. See NFPA 13 for further clarification.
(2) Shelves: shelving units not greater than 760 mm deep can have solid shelves. Back to back solid shelf units not greater than 760 mm deep each with a solid vertical barrier can have solid shelves. See NFPA 13 for further clarification.

5.3.8.3 Aisles: Minimum aisles shall be maintained free of storage and based on the design criteria used for the sprinkler system.

5.4 Automatic Dry Powder systems

5.4.1 General: Automatic Dry Powder systems shall be designed, installed and maintained in accordance with the guidance given in the Technical Guidance document 'Automatic diffusion dry-powder fire extinguisher – Technical requirements and test methods - under development' (referenced above as 1.5.3.8) and supplemented by NFPA 17 for all requirements not covered in the local code.

These automatic dry powder systems cannot be used in lieu of sprinklers where this LABS Standard requires sprinkler protection.

5.5 Standpipe Systems

5.5.1 General: Standpipe shall be designed and installed in accordance with NFPA 14.

5.5.2 Definitions

5.5.2.1 Class I standpipe system: Standpipe with 65 mm hose connections for fire department use.

5.5.2.2 Class II standpipe system: Standpipe with 40 mm hose connections for trained staff.

5.5.2.3 Class III standpipe system: Standpipe with both 65 mm hose connections for fire department use and 40 mm hose connections for trained staff.

5.5.3 Where required: Standpipe shall be provided as per the local standards or otherwise as per clause 5.5.3.1 in this Standard.

5.5.3.1 Class I standpipe systems: In accordance with NFPA 5000 (2015) clause 55.4.1, shall be provided throughout all new buildings and structures where any of the following exist:

(1) The building is four or more stories in height.
(2) The building is more than 15 m above grade plane and contains intermediate stories or balconies.
(3) The building is more than one story below grade plane.
(4) The building is more than 6.1m below grade plane.

5.5.4 Water demand:

5.5.4.1 Flow Pressure: [See NFPA 14 (2016) Section 7.8.] Hydraulically designed standpipe systems shall be designed to provide the required waterflow rate at a minimum residual pressure of 100 psi (6.9 bar) at the outlet of the hydraulically most remote 21⁄2 in. (65 mm) hose connection and 65 psi (4.5 bar) at the outlet of the hydraulically most remote 11⁄2 in. (40 mm) hose station.

5.5.4.2 Flow Rates: [See NFPA 14 (2016) Section 7.10.]
The maximum flow rate shall be 1000 gpm (3785 L/min) for buildings that are sprinklered throughout, and 1250 gpm (4731 L/min) for buildings that are not sprinklered throughout. The minimum flow rate shall be:
(1) Class I and Class III systems: 500 gpm (1893 L/min) for the hydraulically most remote standpipe, through the two most remote 21⁄2 in. (65 mm) outlets.
(2) Class II systems: 100 gpm (379 L/min) for the hydraulically most remote hose connection.

5.5.4.3 Flow Duration. [See NFPA 14 (2016) Section 9.2.] The water supply shall be capable of providing the required demand for at least 30 minutes.

Note: In accordance with NFPA 13 (2016) clause 11.1.6.3.1, where the standpipe water demand is less than the sprinkler water demand, the water tank size calculated for the sprinkler water supply alone can accommodate the standpipe system supply with no need for additional water storage.

5.5.5 Installation requirements: The design, installation and maintenance of the standpipe systems shall be in accordance with NFPA 14, including a minimum pressure of 450 kPa (65 psi) at the hydraulically most remote hose connection.

5.5.5.1 Documentation: Installation of new standpipe systems shall be required to provide shop drawings and hydraulic calculations as outlined in NFPA 14. These drawings shall include all details as outlined in NFPA 14.

5.5.5.2 Documentation Review: All standpipe system installations shall be submitted for review by LABS for review prior to commencement of installation.

5.5.5.3 Acceptance testing: Testing of the installation shall be conducted in accordance with NFPA 14 acceptance testing requirements. Documentation of all testing shall be submitted for review by LABS. Final inspection and testing of the installation shall be witnessed by LABS.

5.5.6 Location of hose connections

5.5.6.1 Class I standpipe hose connections where required by clause 5.5.3 of this Standard (i.e. with 65 mm hose connections for fire department use) shall be located in all required stairwells at each floor level including occupiable roofs.

5.6 Fire Hose Systems

5.6.1 General: Fire hose systems shall be designed and installed in accordance with TCVN 3890-2009.

5.6.2 Where required: fire hoses and internal hydrants are required so that they provide coverage to all areas within all Garment and Footwear factories, except:

(1) Those areas using or storing materials which when contacting with water can cause fire, explosion and spreading flame.
(2) Public bathrooms and laundries.

(3) Warehouses made of non-flammable materials storing non-flammable materials.
(4) Buildings and annexes of buildings where there are no domestic or production water supply pipes and the exterior fire-fighting water can be taken from an external reservoir, river or lake.

5.6.3 **Number and location:** the interior fire-fighting hydrants shall be located in an easily accessible location in the proximity of the egress routes from the building (e.g. at the stair landings, halls, corridors, lobbies, etc.) Every point in the building should be covered by at least one hydrant, except those where coverage is allowed to be omitted as listed in 5.6.2 in this Standard. The coverage should be accounted for based on a maximum distance of 45m from the fire hose outlets (internal hydrants), based on the provision of two hoses 20m long in each cabinet.

5.6.4 **Water supply for fire hoses:** each fire hose internal hydrant should be capable of providing not less than 2.5 liters per second. The systems should be capable of providing water supply to all fire hoses in any one floor of the building simultaneously. Municipal water mains can be used to supply water for fire hoses; if water flow and pressure are not often ensured, tanks sized to provide at least three-hour water supply is required.

5.7 Water supply

5.7.1 **Water Sources for Fire Protection:** Water required for interior fire protection of a building shall be supplied from one or a combination of the following sources.

5.7.1.1 **Direct Connection to Water Main:** Provided there is a public main with continuous water supply confirmed to have sufficient flow and pressure to feed firefighting equipment during peak demand periods (as per 5.3.3, 5.5.4 and 5.6.4 in this Standard), direct connection of the firefighting system to the water main might be implemented.

5.7.1.2 **Roof Gravity Tanks:** In case the water main supply is insufficient in terms of flow or pressure during peak demand periods, but with enough pressure to feed a roof tank, a roof gravity tank is permitted to be provided to feed firefighting equipment.

No new roof-mounted tanks to supply water to new standpipe or sprinkler protection installations shall be allowed without complying with the structural requirements of Part 8 of this standard.

5.7.1.3 **Storage Tank:** In the absence of roof gravity tanks or an adequate water main supply of sufficient flow and pressure to feed firefighting equipment (as per 5.3.3, 5.5.4 and 5.6.4 in this Standard), the building should have a dedicated water storage tank and pump set to feed firefighting equipment.

5.7.2 **Installation requirements:** Firefighting water supply systems shall be in accordance with the requirements of TCVN2622: 1995 and any other applicable Vietnamese codes. In the event that adequate water supply cannot be warranted off the municipal mains, the entire water supply for the suppression systems should be stored within water tanks.

5.7.2.1 **Documentation:** Installation of new fire protection water supply systems shall be required to provide shop drawings and hydraulic calculations.

5.7.2.2 **Documentation Review:** All fire protection water supply system installations shall be submitted for review by LABS for review prior to commencement of installation.

5.7.2.3 **Acceptance testing:** Testing of the installation shall be conducted in accordance with NFPA 13 acceptance testing requirements. Documentation of all testing shall be submitted for review by the IDH. A final inspection and testing of the installation shall be witnessed by LABS.

5.7.3 **Size of tanks:** Tanks shall be sized to provide the maximum required water for sprinklers / standpipe systems for the minimum duration for fire protection supply (as set in 5.3.3, 5.5.4 and 5.6.4 in this Standard).

5.7.4 **Fire department connections:** Fire department (Siamese) inlet connections shall be provided to allow fire department pumper equipment to supplement the fire protection systems. Fire department outlet connections shall be provided to allow fire department pumper vehicles to draw water from ground-level or underground water storage tanks. Connections shall match the Local Fire Services requirements.

5.7.5 **Acceptance:** Acceptance testing of the installation shall be in accordance with NFPA 20, 22, and 24 testing requirements. Documentation of all testing shall be submitted to LABS for review prior to final acceptance by the IDH. The Owner shall contact LABS prior to conducting the final acceptance testing of the fire pump installation to allow LABS to witness this test. A final inspection of the installation shall be conducted by the IDH prior to final acceptance of the installation by LABS.

5.8 **Portable Fire Extinguishers:** Portable fire extinguishers shall be installed throughout all new and existing facilities in accordance with TCVN 7435-1 (2004).

5.8.1 **Spacing:** Extinguishers shall be placed so that maximum travel distance to the nearest unit shall not exceed 15m in accordance with TCVN 3890 (2009).

5.8.2 **Mounting height:** Fire extinguisher shall be mounted at a convenient height to enable its quick access and efficient use by all in the event of a fire incidence.

Fire extinguishers having a gross weight not exceeding 18.0 kg shall be installed so that the top of the fire extinguisher is not more than 1.5 m above the floor (NFPA 10 6.1.3.8).

Fire extinguishers having a gross weight greater than 18.0 kg (except wheeled types) shall be installed so that the top of the fire extinguisher is not more than 1.05 m above the floor (NFPA 10 6.1.3.8).

5.9 **Fire Alarm and Detection**

5.9.1 **General:** Fire alarm and detection systems shall comply with this section.

5.9.2 **Definitions**

5.9.2.1 **Manual alarm:** A fire alarm system that activates the system alarm(s) and occupant notification devices by manual initiation.

5.9.2.2 **Automatic alarm:** A fire alarm system that activates the system alarm(s) and occupant notification devices by automatic initiating devices (e.g. smoke detector, heat detector, sprinkler water-flow).

5.9.3 **Where required:** Automatic **and** manual fire alarm and detection systems shall be provided throughout all new and existing buildings, regardless of occupancy type in accordance with cl.6 of TCVN 5738:2001. Initiating devices shall include either smoke or fire detection devices spaced in accordance with Cl.6 of the TCVN 5738:2001.

In existing buildings, provided that complete sprinkler protection is provided throughout including water-flow devices designed to initiate the alarm notification, the requirement for smoke and fire detection devices can be relaxed.

Note: where an automatic fire alarm is to be installed in accordance with this clause, it shall be activated by automatic detectors, sprinkler heads or manual call points interlinked with a fire alarm panel at a manned location. Battery-operated point-type smoke alarms are not permitted to serve as automatic fire alarm or detection devices.

5.9.4 **Installation requirements:** The fire detection and alarm systems shall be in accordance with the requirements of TCVN 5738:2001.

5.9.4.1 Documentation: Installation of new fire alarm and detection systems shall be required to provide shop drawings and as outlined in TCVN 5738:2001.

5.9.4.2 Documentation Review: All fire alarm installations shall be submitted for review by LABS for review prior to commencement of installation.

5.9.4.3 Acceptance testing: Testing of the installation shall be conducted in accordance with TCVN 5738:2001 acceptance testing requirements. Documentation of all testing shall be submitted for review by LABS. A final inspection and testing of the installation shall be witnessed by LABS.

5.9.4.4 Evacuation: A general alarm should be raised upon initiation of any of the following: manual alarm box (or MCP – manual call point), waterflow alarm, fire detection device or two or more automatic smoke detection devices. Notification shall be provided throughout the building for complete simultaneous evacuation (any staged evacuation policies shall be removed).

5.9.4.5 Redundancy: if an automatic fire detection system serves to initiate an automatic fire-fighting system (e.g. automatic smoke ventilation systems), the each protected point shall be controlled with two automatic fire detectors from two separate channels.

5.9.5 Monitoring: Until such time that a central station monitoring service or direct connection to the Fire Services can be set up, a person shall be assigned to contact the fire department in the event of fire alarm activation. An annunciator / fire alarm panel shall be located in a constantly attended location to alert this person.

5.9.6 Air Handling Equipment

5.9.6.1 Smoke detectors listed for use in air distribution systems shall be located as required in NFPA 90A.

5.10 Automatic and manual heat and smoke ventilation

5.10.1 New Construction: In accordance with NFPA 5000 (2015) clause 31.2.6, the underground portions of an underground structure shall be provided with approved, automatic smoke control where the underground structure has all of the following:

(1) Occupant load of more than 100 persons in the underground portions of the structure.
(2) An occupied floor level more than 9.1 m below, or more than one level below, the lowest level of exit discharge (i.e. final exit to the exterior).
(3) Combustible contents, combustible interior finish, or combustible construction

5.10.2 Smoke and heat venting systems shall be designed and installed in accordance with NFPA 92 (mechanical smoke control, etc.) or NFPA 204 (natural smoke ventilation, etc.).

5.10.3 In existing buildings, any automatic heat and smoke vents shall be converted to manual-only operation if the building is provided with an automatic suppression system.

5.11 Elevators (Lifts)

5.11.1 New construction: In accordance with NFPA 5000 (2015) clause 54.2.1, all new elevators shall conform to the fire fighters' emergency operations requirements of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators* (two-way emergency communication, emergency lighting, dual emergency power supply, recall capabilities, etc. shall be provided).

5.11.2 Existing construction: In accordance with NFPA 101 (2015) clause 9.4.3.2, all existing elevators having a travel distance of 25 ft. (7620 mm) or more above or below the level that best serves the needs of emergency personnel for fire-fighting or rescue purposes shall conform to the fire fighters' emergency operations requirements of ASME A17.3, *Safety Code for Existing Elevators and Escalators* (two-way emergency communication, emergency lighting, etc. shall be provided).

5.11.3 Shafts: All elevators shall be installed in shafts in accordance with 4.8 of this Standard.

5.11.4 Fire Department Elevators (Lifts)

5.11.4.1 Where required: In accordance with NFPA 5000 (2015) clause 33.3.7, new high-rise buildings (in accordance with 3.9.1 in this Standard) shall be provided with at least two fire service access elevators serving every floor in the building.

5.11.4.2 Recall: In all new construction, elevators with Phase 1 (emergency recall operation by fire alarm initiating devices) and Phase 2 (emergency in-car operation) capabilities in accordance with ASME A17.1 shall be provided.

5.12 Fire Department Access

5.12.1 Access Roads

5.12.1.1 Dimensional requirements: fire department access road with shall be not less than 3.50m for each lane. The minimum clearance height shall be not less than 4 m.

5.12.1.2 Road surface: the road surface shall be able to withstand a fire appliance, in accordance with the requirements of the local brigade.

5.12.1.3 Dead-end roads: single lane dead-end roads shall not be more than 150m in length. A U-turn shall be but at the end of the road, with minimum dimensions as follows: a triangle with 7 m long side, a square with 12m long sides, a circle with 10 m diameter or a perpendicular rectangle 5 m x 20 m in size.

5.12.1.4 Single-lane roads: extended segments not less than 7m m x 8 m in size shall be built along narrow single-lane roads to prevent fire department vehicles from colliding with oncoming traffic.

5.12.1.5 Building accessibility: industrial buildings shall be provided with an access road as below:
(1) From one side where the building is less than 18 m wide.
(2) From both sides where the building is more than 18 m wide.
(3) From all sides where the building is more than 100m wide.

5.12.1.6 Separation distances between access roads and buildings:
(1) Not more than 5m for building less than 12m high.
(2) Not more than 8m for buildings more than 12m but less than 28 m high.
(3) Not more than 10m for buildings more than 28 m high.

5.12.1.7 Roof accessibility: buildings more than 10m high shall have direct access to the roof from staircases, for each 200 m of circumference.

5.12.1.7.1 Roof handrails: handrails and banisters shall be installed on the roof in compliance with current regulations in buildings where:
(1) The roof slope is not more than 12% and the height up to the fascia board is more than 10m.
(2) The roof slope is more than 12% and the height up to the fascia board is more than 7m.

Note: The handrails and banisters of this type must also be arranged for the flat roofs, balconies, loggias, outside corridors, open typed stairs, stair slabs and landings which are not subject to the building height.

5.13 Emergency power

5.13.1 An emergency power system shall be provided to supply power to the below loads. Refer to Part 10 of this Standard for greater detail:
(5) Exit signs and means of egress illumination.

(6) Automatic fire detection systems.
(7) Fire alarm systems.
(8) Electrically powered fire pumps.
(9) Smoke control systems.
(10) Elevators/lifts and any other evacuation systems.
(11) Fire communication devices.

5.13.2 Battery powered signs and exit lights: Existing battery-operated or uninterruptable power supply systems can be continued to be used to supply exit signs and means of egress illumination where monthly testing of such systems is conducted and properly documented. Inspection and maintenance should be conducted in accordance with cl. 10 of the Vietnamese TCVN 3890:2009.

5.13.3 Duration: Emergency power shall be provided for a minimum duration of 60 min.

6 Part 6 Means of Egress

6.1 General

A means of escape shall be a continuous and unobstructed way of exit travel from any point in a building to a street. 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 which 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 which 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.

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

(1) 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, or any designated refuge area which affords safety from fire or smoke from the area of incidence;

(2) 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.

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.

All exit doors must be readily openable (e.g. not locked). Locking mechanisms on exit doors are allowed provided that allow easy opening of the door from inside without the use of a key.

6.2 Definitions

6.2.1 Exit: That portion of a means of egress that is separated from all other spaces of the building or structure by construction, location, or equipment as required to provide a protected way of travel to the exit discharge. Exit components include exterior exit doors at the level of exit discharge, interior exit stairways, exit passageways, exterior exit stairways and exterior exit ramps.

6.2.2 Horizontal Exit: A way of passage from one building to an area of refuge in another building on approximately the same level, or a way of passage through or around a fire barrier to an area of refuge on approximately the same level in the same building that affords safety from fire and smoke originating from the area of incidence and areas communicating therewith.

6.2.3 Exit Access: That portion of a means of egress that leads to an exit.

6.2.4 Exit Discharge: That portion of a means of egress be-tween the termination of an exit and a public way.

6.2.5 Level of Exit Discharge: The story that is either:

(1) The lowest story from which not less than 50 percent of the required number of exits and not less than 50 percent of the required egress capacity from such a story discharge directly outside at the finished ground level.
(2) where no story meets the conditions of item (1), the story that is provided with one or more exits that discharge directly to the outside to the finished ground level via the smallest elevation change.

6.2.6 Exit enclosure: Fire barriers in accordance with 4.4.2 in this Standard, arranged to provide protection from fire and smoke to an exit, so as to provide a safe way of travel to the exit discharge.

6.2.7 Area of refuge: An area that is either:

(1) A story in a building where the building is protected throughout by an approved, supervised automatic suppression system and has not less than two accessible rooms or spaces separated from each other by smoke-resisting partitions.
(2) A space located in a path of travel leading to a public way that is protected from the effects of fire, either by means of separation from other spaces in the same building or by virtue of location, thereby permitting a delay in egress travel from any level.

6.2.8 Common path limit: Distance along an egress path where no alternatives routes exist.

6.2.9 Dead-end: Secondary branches connected to a corridor, where the only exit is by way of the main corridor.

6.2.10 Travel Distance Limit: Total travel distance where alternative routes exist, including any distance along common-path or dead-end portions of the egress routes.

6.3 General Means of Egress

6.3.1 Separation of Means of Egress

6.3.1.1 Corridors: Exit access corridors serving an occupant load exceeding 30 shall be separated by walls having a fire resistance rating of 1 -hour in accordance with 4.4 in this Standard.

Corridors more than 60m long should be subdivided by at least 15min fire-resistant partitions and 15min self-closing fire doors into two segments not longer than 60m each.

6.3.1.2 Exit Stairs: Exit stairs shall be enclosed with fire-resistance rated construction as outlined below:

(1) Exit stairs connecting three or fewer stories shall be enclosed with a minimum 1-hr fire-resistance rating.
(2) Exit stairs connecting four or more stories shall be enclosed with a minimum 2-hr fire-resistance rating.
(3) Exit stairs shall be enclosed with the same fire-resistance rating as the floor penetrated but will not need to exceed 2 -hour.

6.3.1.3 Exterior exit stairs: Exterior exit stairs shall be separated from the building with the rating requirements of 6.3.1.2. The rating of the exterior wall shall extend 3.1 m beyond the ends of the stair structure. Refer to 6.14.6 in this Standard.

6.3.2 Interior Finish: The interior floor, wall and ceiling finishes should comply with the requirements of NFPA 101 (2015) Table A.10.2.2. The below classifications are in accordance with the tests defined in ASTM E 84 or ANSI/UL 723.

Table 6.3.2(1) Interior Wall and Ceiling Finishes Classification Limitations

Occupancy	Vertical Exits and Exit Passageways	Exit Access Corridors	Other Rooms and Spaces
Industrial	A or B	A, B or C	A, B or C
Storage	A or B	A, B or C	A, B or C
Mercantile	A or B	A or B	A or B (or C – walls only)
Business	A or B	A or B	A or B or C

Table 6.3.2(2) Interior Floor Finishes Classification Limitations

Occupancy	Vertical Exits and Exit Passageways	Exit Access Corridors	Other Rooms and Spaces
Any	I or II	I or II	Any

Class A: flame spread index of 0 to 25 and a smoke developed index of not more than 450 in accordance with the tests defined in ASTM E 84 or ANSI/UL 723.
Class B: flame spread index of 26 to 75 and a smoke developed index of not more than 450 in accordance with the tests defined in ASTM E 84 or ANSI/UL 723.
Class C: flame spread index of 76 to 200 and a smoke developed index of not more than 450 in accordance with the tests defined in ASTM E 84 or ANSI/UL 723.

6.3.3 **Headroom:** All means of egress shall have a minimum ceiling height of 2.3 m with projections from the ceiling not less than 2.0 m. The minimum ceiling height shall be maintained for at least 2/3 of the space or room as long as the remaining area shall be not less than 2.0 m. Headroom on stairs shall not be less than 2.0 m.

6.3.4 **Walking surfaces**

6.3.4.1 **Changes in elevation:** Abrupt changes in elevation of walking surfaces shall not exceed 6 mm unless provided with a beveled slope of 1 in 2 that do not exceed 13 mm. Changes greater than 13 mm shall meet the requirements for 6.3.5.

6.3.4.2 Walking surfaces shall be mostly level; however, shall not exceed a slope of 1 in 20 in the direction of travel unless meeting the requirements for ramps in 6.11.

6.3.5 **Changes in Level:** Changes in level exceeding 535 mm in elevation shall meet the requirements for stairs in 6.10 or ramps in 6.11.

6.3.5.1 The change in level shall be readily apparent and if not, marked with additional signage or floor markings.

6.3.6 **Slip Resistance:** Walking surfaces, including stairway treads shall be uniformly slip resistant.

6.3.7 **Guards:** Guards shall be provided in accordance with 6.13 on the open sides of means of egress components where the elevation exceeds 760 mm above the ground or floor below.

6.3.8 **Impediments to means of egress:** No locks or other devices shall be installed on a means of egress component that would prevent any occupant from having safe egress from the building or structure. 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.

6.3.9 **Reliability:** Means of egress shall be maintained continuously free and clear of all obstructions or impediments to full instant use in the case of fire or other emergency.

6.3.9.1 Furnishings, decorations: No furnishings, decorations, or other objects shall obstruct exits and access to exits. Nothing shall obstruct or impede visibility to exits.

6.4 Occupant Load

6.4.1 For determining the exits required, the number of persons within any floor area or the occupant load shall be based on the actual number of occupants declared, but in no case less than that specified in Table 6.4.2 of this Standard.

For occupancies not given in this table the occupant load shall be determined on the basis of the occupant load factors in NFPA 5000 (2015) Table 11.3.1.2 that are characteristic for the use of the space or the maximum probable population of the space, whichever is greater.

The occupant load of a mezzanine floor discharging to a floor below shall be added to that floor occupancy and the capacity of the exits shall be designed for the total occupancy load thus established.

6.4.2 The occupant load of each storey considered individually.

Table 6.4.2 Occupant Load Factor

Occupancy Use	Occupant Load Factor (m^2 per person)
Industrial - General and high hazard industrial	10.0 gross
Industrial - Special purpose	Not applicable - Maximum probable number of occupants at any material time
Storage - Mercantile occupancies	30.0 gross
Business (i.e. office)	10.0 gross
Mercantile - Sales area on street floor (i.e. shops)	3.0 gross
Day-care use	3.0 net
Assembly - Concentrated use, without fixed seating	0.65 net
Assembly - Less concentrated use, without fixed seating	1.4 net
Fixed Seating	Number of fixed seats
Other	Refer to NFPA 5000 (2015) Table 11.3.1.2

Note: Garment and Footwear factories shall have a designated occupant load factor in accordance with NFPA of 9.3 m^2 per occupant, but some references give a number of 2.3 m^2 per occupant for sewing and finishing floors. The actual occupancy levels might exceed this figure; hence occupant load should also be calculated based on the number of workstations or known amount of occupants based on factory processes. The greater of the calculated figures should be used to quantify the occupancy load.

6.4.3 Increased occupant load: The occupant load is permitted to be increased above the calculated occupant load provided that all other means of egress requirements for that higher occupant load are met.

6.4.4 Posting of occupant load: The maximum permissible occupant load shall be posted for every assembly and production floor in a facility in a conspicuous space near the main exit or exit access doorway for the space.

6.5 Egress Width

6.5.1 Minimum width of aisles: Aisles shall be provided with a minimum unobstructed clear-width of

915mm.

6.5.2 Means of egress continuity: The path of egress travel along a means of egress shall not be interrupted by any obstruction. The capacity of the means of egress shall not be reduced along the path of travel.

6.5.3 Capacity: The total capacity of the means of egress shall for any story, floor, or other occupied space shall be sufficient for the occupant load as calculated in 6.4.2.

6.5.4 Capacity Factors: The capacity factors for calculating the available capacity for each means of egress component shall be in accordance with NFPA 5000 (2015) Table 11.3.3.1 (repeated below).

Table 6.5.4 Capacity Factors

Area	Stairways (mm / person)	Corridors, doors, other level components and ramps (mm / person)
All others	7.6	5
High Hazard Contents	18	10
Board and Care	10	5

6.5.5 Sufficient Capacity: For other than existing means of egress, where more than one means of egress is required, the means of egress shall be of such width and capacity that the loss of any one means of egress leaves available not less than 50 percent of the required capacity.

6.5.6 Minimum Widths

6.5.6.1 Doors: Doors in an existing means of egress shall have an exit width in accordance with Section 6.5 of this document, but in no case less than a minimum width of 810 mm in accordance with NFPA 5000 (2015) Section 11.2.1.2.3.2.

6.5.6.2 Stairs

(1) In new construction and for newly constructed stairs, stairs shall have a minimum width of 1200 mm where the occupancy load assigned to the stair is less than 2,000 persons, and 1420 mm where the occupancy load is more than 2,000.
(2) In existing construction, 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 915 mm.

6.6 Number of Means of Egress

6.6.1 General: The number of means of egress from any floor or story shall not be less than 2 except where a single exit is permitted by 6.6.2 or where a greater number is required by 6.6.3.

6.6.2 Single exits: Only one exit shall be required in existing buildings where the occupant load and travel distance listed in Table 6.6.2 are not exceeded.

Additionally, more than one exit shall be required in:
(1) Open working platforms more than $100m^2$ in floor area.
(2) Basements more than $300m^2$ in floor area.

Table 6.6.2 Single Exit Requirements

Occupancy Type	Maximum Occupants in the Floor / Area	Common Path Distance Limitation (No automatic suppression)	Common Path Distance Limitation (Automatic suppression system)
Industrial - General	50	15 m	30 m
Industrial - Special Purpose	50	15 m	30 m

Industrial - High Hazard	50	Not permitted	Not permitted
Storage - Low Hazard	50	No requirement	No requirement
Storage - Medium Hazard	50	15 m	30 m
Storage - High Hazard	50	Not permitted	Not permitted
Other	50	Refer to NFPA 101 (2015) Table A.7.6	

6.6.3 **Number of means of egress.** The number of means of egress from any floor or story shall:
(1) Not be less than 3 when the occupant load exceeds 500 per story and;
(2) Not less than 4 when the occupant load exceeds 1000 per storey.

6.6.4 **Occupied roofs.** Occupied roofs shall be provided with the minimum number of exits required as a story.

6.6.5 **Mezzanine floors**: if there is a single means of egress off the mezzanine, the occupancy should be not more than 50 and the maximum travel distance a floor exit should not exceed 15m (or 30m with automatic suppression system).

A mezzanine having two or more means of egress shall not be required to open onto the main area if one of the means of egress provides direct access from the enclosed area to an exit at the mezzanine level.

6.7 **Travel Distance.** Travel distance to reach an exit for new and existing shall not exceed the values listed in NFPA 101 (2015) Table A.7.6, summarised below.

Table 6.7 Common path, Dead-End and Travel Distance Limits (by occupancy)

Occupancy Type	Common Path Limit (single way)		Dead-End Limit (closed corridor branch)		Travel Distance Limit (alternate ways)	
	No auto suppression system	Automatic suppression system	No auto suppression system	Automatic suppression system	No auto suppression system	Automatic suppression system
Industrial - General	15 m	30 m	15 m	15 m	61 m	76 m
Industrial - Special Purpose	15 m	30 m	15 m	15 m	91 m	122 m
Industrial - High Hazard	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	23 m
Storage - Low Hazard	Unrestricted	Unrestricted	Unrestricted	Unrestricted	Unrestricted	Unrestricted
Storage - Medium Hazard	15 m	30 m	15 m	30 m	61 m	122 m
Storage - High Hazard	Prohibited	Prohibited	Prohibited	Prohibited	23 m	30 m
Parking - Open	15 m	15 m	15 m	15 m	91 m	122 m
Parking - Enclosed	15 m	15 m	15 m	15 m	46 m	60 m
Other	Refer to NFPA 101 (2015) Table A.7.6					

Note: Total travel distance limitations for Garment and Footwear factories (Industrial - General) shall be increased from 61 m to 76 m where automatic suppression systems are installed throughout the building in accordance with this Standard.

6.8 **Egress Illumination:** All paths of egress shall be provided with illumination in accordance with Cl.10.1 of TCVN 3890:2009, i.e. an average initial illumination intensity of 10 lux and a minimum illuminating intensity at any point along escape routes not less than 1 lux.

6.8.1 **Coverage:** The exit, exit access and exit discharge systems shall be illuminated continuously. The floors of the means of egress shall be illuminated at all points, including angles and intersections, in corridors and passageways, stairwells, landings of stairwells and exit.

Escape lighting luminaires should be sited to cover the following locations:

1. Near each intersection of corridors,
2. At exits and at each exit door,
3. Near each change of direction in the escape route,
4. Near each staircase so that each flight of stairs receives direct light,
5. Near any other change of floor level,
6. Outside each final exit and close to it,
7. Near each fire alarm call point,
8. Near firefighting equipment, and
9. To illuminate exit and safety signs as required by the enforcing authority.

Note: For the purpose of this clause 'near' is normally considered to be within 2m measured horizontally

6.8.2 **Power Source:** Emergency lighting shall be powered from a source independent of that supplying the normal lighting.

6.8.3 **Performance:)** Emergency illumination shall be provided for not less than 90 minutes in the event of failure of normal lighting. Emergency lighting facilities shall be arranged to provide initial illumination that is not less than an average of 10.0 lux (lumen/m2) and, at any point, not less than 1.0 lux, measured along the path of egress at floor level and should be measured at the darkest point (midway between two light sets).

6.9 Doors and Gates

6.9.1 **Door swing type:** All doors in a means of egress shall be of the side-hinged swinging type. Roll-down, sliding, folding or rolling gates and shutters shall not be allowed to be considered as escape doors, unless an appropriate side-hinged swinging type door is fitted therein.

6.9.2 **Door swing direction:** all exit doors shall swing open towards the direction of escape, unless in rooms occupied by less than 15 people.

6.9.3 **Self-closing devices:** any fire doors and any doors fitted in stair enclosures or any type of fire-resisting partition shall be provided with self-closing devices. Doors shall stay tightly closed when not in use.

6.9.4 Locking

6.9.4.1 **General:** Doors shall not be locked in the direction of egress under any conditions. All existing hasps, locks, slide bolts, and other locking devices shall be removed unless provided for in 6.9.4.2 and 6.9.4.3.

6.9.4.2 Doors may be locked where the latch and lock are disengaged with one motion where the occupant load does not exceed 49 persons. Turning a door handle and disengaging a lock is considered two motions.

6.9.4.3 Doors may be provided with locking hardware from the ingress side provided that a panic bar is installed on any door with an occupant load exceeding 49 persons. The re-entry provisions of 6.9.5 must be met.

6.9.5 **Re-entry:** Every door in a stair enclosure serving more than 5 stories shall be provided with re-entry unless it meets the requirements of 6.9.5.1.

6.9.5.1 Stair doors may be permitted to be locked from the stair (ingress) side that prevents re-entry to the floor provided at least two floors allowing re-entry to access another exit are provided, there are not more than 4 stories intervening between re-entry floors, re-entry is allowed on the top or next to top level, re- entry doors are identified as such on the stair side, and locked doors shall be identified as to the nearest re-entry floors. When the discharge floor is determined to be a required re-entry floor using the above requirements, re-entry does not have to be provided back into the building on this level.

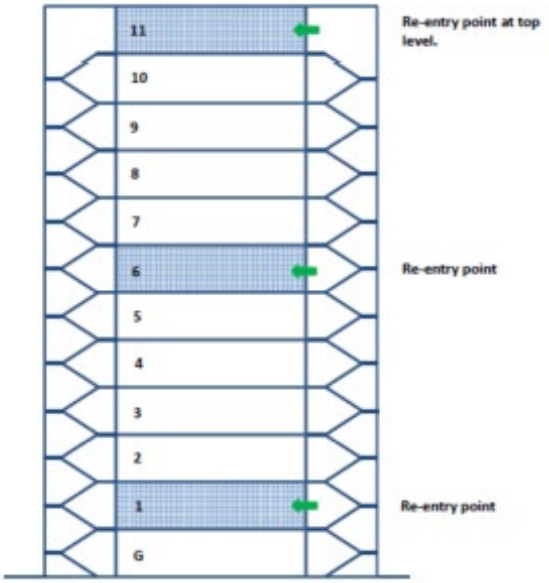


Figure 6.9.5.1(a). Required re-entry floors when starting at the top level.

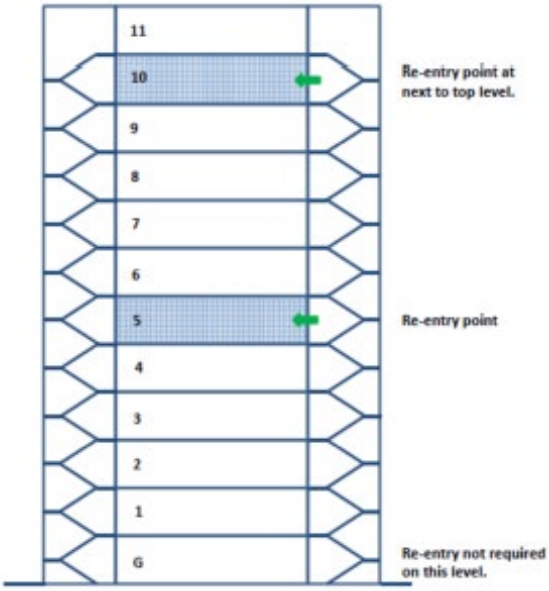


Figure 6.9.5.1(b). Required re-entry floors when starting at the next to top level.

6.9.6 **Warehouse:** Doors to storage areas of buildings shall be in compliance all the requirements in this Standard, including the locking control requirements made in 6.3.8 of this Standard.

6.9.7 **Landings:** A landing shall be provided on both sides of doors used in the means of egress. Door shall not swing out over stairs. In new buildings, every landing shall have a dimension measured in the direction of travel that is not less than the width of the stair.

6.10 Stairs

6.10.1 **New Construction:** Newly constructed stairs shall be in compliance with NFPA 5000 (2015) Section 11.2.2.

6.10.2 **Existing:** Existing stairs shall meet the requirements of this subsection.

6.10.2.1 Stairs shall be of noncombustible construction.

6.10.2.2 Landings: Landings shall be provided with same width in the direction of egress travel as the stair clear width shall be provided at each level and at intermediate landings. Existing landings that are less than the stair width, shall reduce the overall available capacity of the stair as calculated in 6.5.

6.10.2.3 Treads: Stair treads shall be of nominal uniformity.

(1) The maximum riser height for any stair shall be 215 mm.
(2) Any riser height at the top or bottom step in a stair run exceeding more than 51 mm difference from the adjacent riser height shall be modified to be within this tolerance.
(3) Any riser height or tread depth not at the top or bottom step in a stair run exceeding more than 25 mm difference from the adjacent step shall be modified to be within this tolerance.
(4) In places where there are steps, the height difference shall be not less than 450mm, with no less than three steps installed. Otherwise, a ramp in accordance with 6.11 in this Standard shall be installed.
(5) For existing stairs that do not meet these tread dimensions and will require extensive rework of the stairway, a full detailed analysis of the tread dimensions can be submitted to the Authority for review and approval of an alternate corrective action plan.

6.10.2.4 Handrails: Handrails shall be provided on both sides of each stairway.

(1) In new stairs, handrails shall be provided within 760 mm of all portions of the required egress width. Hence stairs that require an egress width more than 1520 mm according to the capacity factors in clause 6.5.4 of this Standard, shall be provided with central handrails.
(2) In existing stairs, handrails shall be provided within 1120 mm of all portions of the required egress width. Such stairs shall not have their egress capacity adjusted to a higher occupant load than permitted for a stair with a clear width of 1520mm in accordance with the factors in 6.5.4 of this Standard.

6.10.2.5 Guards: Guards shall be provided in stairs in accordance with 6.13.2 in this Standard.

6.10.2.6 Curved Stairs: Curved stairs shall not be treated as part means of egress. However, these may be used as part of exit access provided the depth of tread is not less than 280 mm at a point 350 mm from the narrower end of the tread and the smallest radius is not less than twice the stair width

6.10.2.7 External Stairs: The external staircases are the staircases provided on the external wall/facade, and shall comply with the following:

1. All external stairs shall be directly connected to the ground.
2. Where an external staircase is provided, it shall be ensured that the use of it at the time of fire is not prejudiced by smoke and flame from openings (for example, windows, doors) in the external face of the building. Care shall be taken to ensure that no external wall or window opening opens on to or close to an external stair. If such openings exist within 3.05 m from an external staircase, they shall be protected with fire rated doors/window assemblies with rating of at least 60 min.
3. The external stairs shall be constructed of non-combustible materials.
4. No external staircase, shall be inclined at an angle greater than 45° from the horizontal.
5. Handrails, to be provided on both sides, in accordance with 6.10.2.4.

6.10.2.8 Prohibited items: In staircases, it is not allowed to locate the following:

(1) Flammable gas and combustible liquid ducts.
(2) Wall cabinets, except for communication cabinets or fire-fighting cabinets.
(3) Exposed electric wires and cables (except low-voltage or emergency lighting wires).
(4) Exits from carrying lifts or freight elevators.
(5) Equipment which protrudes from wall surface at a height below 2.2m, measured from the surface of stairs and stair landings.
(6) Any functional rooms.

6.10.2.9 Stair signs: Stair designation signs shall be provided at each floor entrance from the stair to the floor. Where

text is used, both English and local language indications shall be used, and signs shall indicate the name of the stair and the floor level. Signs shall be posted adjacent to the door.

6.11 Ramps

6.11.1 Width: Ramps used in a means of egress shall not reduce the overall means of egress width. The minimum width of new ramps shall be 1120 mm. The minimum width of existing ramps shall be 760 mm.

6.11.2 Slope: New ramps shall not have a running slope greater than 1 in 12 (8 percent). Existing ramps shall not have a running slope greater than 1 in 8 (12.5 percent).

6.11.3 Handrails: Ramps shall be provided with handrails on both sides of the ramp.

6.12 Exit Signs

6.12.1 General: 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.

6.12.2 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.

6.12.3 Graphics: The color 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.

6.12.4 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.

6.12.5 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.

6.12.6 Floor-level Exit Signs: The signs shall be on the floor-level in contrasting color 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 door frame.

6.13 Handrails and Guards

6.13.1 Handrails

6.13.1.1 New handrails shall have a minimum height of 865 mm and a maximum height of 965 mm as measured from the leading edge of the tread.

6.13.1.2 Existing handrails that are less than 760 mm or greater than 1065 mm as measured from the leading edge of the tread, shall be replaced with handrails meeting the requirements of 6.10.2.4.

6.13.2 Guards: Guards shall be provided at all open sides of means of egress that exceed 760 mm above the floor or finished ground below.

6.13.2.1 New guards shall have a minimum height of 1065 mm.

6.13.2.2 Existing guards shall have a minimum height of 760 mm.

6.13.2.3 Open guards shall have intermediate rails or pattern such that a sphere 100 mm in diameter cannot pass through any opening up to a height of 865 mm.

6.13.2.4 Roofs: All occupiable roofs shall be provided with parapets or guards with a minimum height of 1065 mm.

6.14 Exit Enclosures

6.14.1 Ratings: Interior exit stairways and ramps shall be enclosed with fire barriers constructed in accordance with 6.3.1.2 of this Standard.

6.14.2 Termination: Interior exit stairways and ramps shall terminate at an exit discharge except where terminating at an exit passageway constructed in accordance with 6.15.

6.14.3 Openings: Openings into an exit enclosure other than unprotected exterior walls shall be limited to those necessary for exit access to the enclosure. In new construction, elevators shall not open into an exit enclosure (vestibules shall also be provided to separate exit enclosures from elevator access, where possible). Openings from exit enclosures to normally unoccupied spaces as storage areas, basements, transformer rooms, generator rooms, boiler rooms, and similar normally unoccupied spaces shall be provided with vestibules by using partitions of the same fire resistance of the stair.

6.14.4 Penetrations: Penetrations into and through an exit enclosure shall be prohibited with the exception of required exit doors, sprinkler piping, standpipes, electrical raceway for fire alarm equipment, and electrical conduit serving the exit enclosure.

6.14.5 Exterior walls: Exterior walls of exit enclosures shall comply with 6.14.6 of this Standard.

6.14.6 Exposures: In accordance with NFPA 5000 (2015) Section 11.2.2.5.2, where nonrated walls or unprotected openings enclose the exterior of the stairway and the walls or openings are exposed by other parts of the building at an angle of less than 180 degrees, the building exterior walls within 3050 mm horizontally of a nonrated wall or unprotected opening shall have a fire-resistance rating of not less than 1 hr. Openings within such exterior walls shall be protected by opening protectives having a fire protection rating of not less than ¾ hr. This construction shall extend vertically from the ground level to a point 3050 mm above the topmost landing of the stairway or to the roof line, whichever is lower.

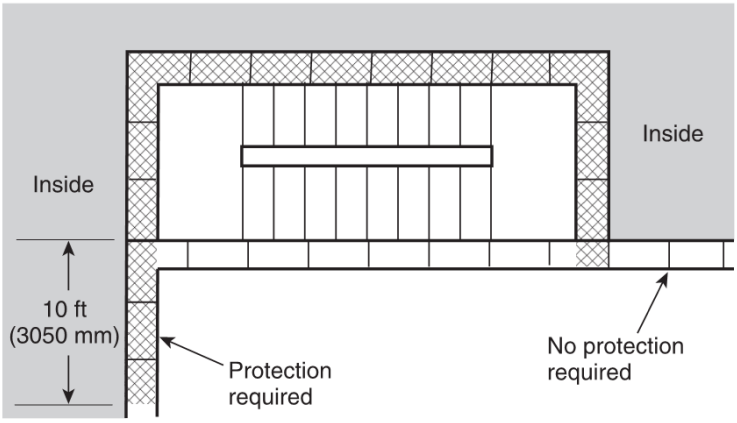


Figure 6.14.6 Staircase with Nonrated Exterior Wall Exposed by Adjacent Exterior Wall of Building.

6.15 Exit Passageways

6.15.1 Definition: An exit passageway is an exit component that is separated from other interior spaces of a building or structure by fire resistance-rated construction and opening protectives, and provides for a protected path of egress in a horizontal direction to the exit discharge or the public way.

6.15.2 General: Exit passageways shall be considered an extension of the stairs and shall not be used for any other purpose.

6.15.3 Construction: Exit passageways shall have walls, ceilings, and floors that meet the same rating requirement as the exit that is being served and shall not be less than 1 -hour fire-resistance rated construction.

6.15.4 Termination: Exit passageways shall terminate at an exit discharge.

6.16 Horizontal Exits. Horizontal exits shall comply with the requirements of NFPA 5000 (2015) Section 11.2.4.

6.17 Exit Discharge

6.17.1 General: Exits shall discharge directly to the exterior of the building unless meeting the requirements of 6.15. The exit discharge shall be at grade or provide direct access to grade. Exit discharge shall not reenter a building.

6.17.2 Egress Court: An egress court serving as a portion of the exit discharge shall be open to the sky or provided with a fire resistance rated enclosure the same as the exit enclosure. Egress courts less than 3050 mm in width (as measured from the building and the adjacent property line) shall be provided with walls having a 1-hr fire resistance rated construction for a distance of 3050 mm above the floor of the court.

6.17.3 Interior building exit discharge: A maximum of 50 percent of the number and capacity of the exit enclosures can discharge through areas on the level of exit discharge where all of the following are met:

(1) Automatic suppression protection is provided throughout the level of exit discharge or portion of the level of discharge where separated from portions of the floor with no automatic suppression system by fire barriers with the same fire resistance rating as the exit enclosure.
(2) The interior discharge is not through a storage or hazardous occupancy.
(3) The entire area of the level of exit discharge is separated from areas below by construction having a fire resistance rating not less than that required for the exit enclosure.
(4) The way to the exterior shall be free and unobstructed and shall be readily visible and identifiable from the point of discharge of the interior exit.

6.18 Trip hazards

6.18.1 General: floor surfaces at any means of egress shall be free of any obstructions where occupants might trip or harm themselves in any way during evacuation.

6.18.2 Abrupt level differences: raised thresholds and abrupt floor level changes in excess of 6.3mm shall be beveled with a slope not steeper than 1 in 2.

6.18.3 Door thresholds: except in normally unoccupied rooms, thresholds in doors used as means of egress should not have abrupt level differences more than 13mm in height.

6.18.4 Stairs treads and landings: projections or lips that could trip users are prohibited in stairs treads and landings.

7 Part 7 Building Materials

7.1 The requirements of the Vietnam Construction Regulations are adopted in their entirety. Alterations, additions, extensions or new buildings shall comprise building materials which comply with the relevant national Building Code.

7.2 Minimum Construction Material Properties in Evaluating the Structural Capacity of Existing Structural Elements

7.2.1 Actual measured or tested properties of materials may be used for elements tested in accordance with ASTM Standards.

7.2.2 Where testing has not been used to confirm actual properties and there is no sign of structural distress or deficiency in the subject member, the following minimum properties may generally be used, unless good engineering judgment indicates that lesser properties should be assumed:

7.2.2.1 Reinforced Concrete

Prior to the introduction of TCVN 5574: 1991, concrete grade may assumed to be grade M200 which is equivalent to a design compression strength of 11.2MPa.

Our recommended minimum characteristic concrete cube compressive strength figure ($f_{Rd,c}$) is15MPa.

Minimum assumed density of reinforced concrete – 24.5kN/m^3

7.2.2.2 Reinforcing Steel

Reinforcement prior to 1991 or where origin date is unknown (TCVN 5574:2012)			
Reinforcement grade	Plain bars	Deformed bars: Ribs in 1 direction	Deformed bars: Ribs in 2 directions
Yield Strength (MPa)	220	300	400
Reinforcement for years 1991 -2011 (TCVN 5574:1991)			
Reinforcement grade	CI	CII	CIII
	Plain/ Smooth	Ribs in 1 Direction	Ribs in 2 directions
		CB300V	CB400V
Yield strength (MPa)	220	300	400
Reinforcement for years since 2012 (TCVN 5574:2012)			
Reinforcement grade	CI	CII	CIII
	Plain/ Smooth	Ribs in 1 Direction	Ribs in 2 directions
Yield strength (MPa)	235	295	390

7.2.2.3 Structural Steel Plate

Structural Steel Grade	**Pre 2012**	**2012 onwards**
	CT3	**Q235**
Yield strength (MPa)	210	235
Design strength (MPa)	210	235
Material ratio	1.00	1.00

8 Part 8 Structural Safety Requirements

The primary focus of the LABS initiative is to ensure Life Safety in RMG and Footwear factories. As such, the purpose of this section is to identify the critical structural elements which need to be verified by observation, testing, preliminary and detailed calculation, in order to prevent catastrophic, progressive and disproportionate structural collapse. It is not designed to identify or prevent minor or local structural failures or non-performance issues, which would not contribute to a catastrophic failure. Compliance with this minimum Standard may not mean compliance with the relevant Vietnam National Construction Regulations. It is a pragmatic approach to preventing catastrophic structural collapses and ensuring Life Safety.

8.1 Applicability of National Building Code

8.1.1 This Standard utilizes the Vietnam National Construction Regulations as the applicable minimum standard for new factory construction and for all expansions or modifications to existing factories, unless modified by the Localised Standard in any particular country.

8.1.2 New factories shall comply with the more stringent requirements of this Standard and the relevant Vietnam National Construction Regulations, in particular (but not limited to): TCVN 4514 – 88 (Factories – Total plan areas – design standards); TCVN 4604 – 88 (Factories – Production buildings – design standards); and TCVN 4317 – 86 (Warehouses – design standards), together with associated code updates and jurisdictional circulars as they may be issued from time to time. New factories are those which are built after the adoption of this Standard.

8.1.3 Existing factory buildings are those that are in current use in the RMG and Footwear industry at the time of adoption of this Standard.

8.1.4 Any substantial retrofit or expansion of an existing factory building shall comply with Vietnam National Construction Regulations. Where these changes impact the layout or structure of the existing building, the compliance shall be with the spirit and intent of the Vietnam National Construction Regulations, supported by best international practice. The structural design of the new parts of the building retrofit or expansion shall comply with the requirements of Vietnam National Construction Regulations, unless modified by this Standard.

***Interpretive Guideline*:** Regardless of when a factory was constructed, the structural impact on the entire structure of any expansion must be analytically evaluated and confirmed by a qualified Structural Engineer. This shall include consideration of any potential effects on the lateral stability system of the existing building both in terms of additional wind loads or notional horizontal loads and the resistance to these loads by the stability system within the existing and extended structure.

8.1.4.1 A substantial expansion will be interpreted to mean any new floor or roof levels, mezzanine levels, horizontal floor additions, or similar new structure.

8.2 Structural Safety of Existing Factory Buildings

8.2.1 Every existing factory building must demonstrate a minimum degree of structural safety as confirmed by a Preliminary Structural Safety Inspection performed by a LABS qualified Structural Engineer.

Interpretive Guideline: The intent of Section 8.2 is that every existing factory must demonstrate a reasonable level of structural safety regardless of when it was constructed and regardless of the availability of credible structural documentation. This Standard requires the visual assessment and on occasion, analytical confirmation of structural capacity of key gravity and lateral load-bearing elements for the actual in-situ conditions in the factory by a LABS-qualified Structural Engineer. A Preliminary Structural Safety

Inspection with no or limited concerns or generally acceptable findings may be accepted as evidence of a reasonable level of structural safety. For factory buildings with noted concerns or unacceptable findings from the Preliminary Structural Safety Inspection, a higher level of structural investigation, analysis and ongoing inspections may be required.

8.2.2 Existing factory buildings and components thereof shall be assessed to confirm design adequacy to support all loads, including dead loads and live loads on the factory during its lifetime. Such loads shall be supported without exceeding the allowable stresses or design strengths under applicable factored loads and load combinations for the materials of construction in the structural members and connections in accordance with the provisions of the Vietnam National Construction Regulations, unless modified by this Standard.

***Interpretive Guideline*:** Structures must have analytically-determined or empirically-determined structural capacity to support all the imposed loads including occupants, equipment, water tanks, and storage loads without overstressing structural elements. The structural capacity of key elements must be confirmed and documented in accordance with accepted engineering design processes by LABS-qualified Structural Engineers.

Where the magnitude of the dead loads and live loads can be determined with a high level of assurance, the applicable load factors and combinations may be used as indicated in Section 8.12.

8.2.3 The ultimate strength design method for reinforced concrete and structural steel shall generally be the basis of assessment under this Standard. Structural safety of existing factories may be confirmed by Preliminary Structural Safety Inspection as described in Section 8.4.

8.3 Preliminary Structural Safety Inspection to Confirm Structural Safety of Existing Factory Buildings.

***Interpretive Guideline*:** It is recognized that some factory buildings were built in the absence of established Building Codes or their active enforcement. Some of these factories lack basic or verifiable documentation that could 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. Recognizing that absence of structural documentation does not make a factory unsafe, this Standard provides a methodology for Factory Owners who lack appropriate documentation to provide other acceptable evidence of structural safety. Even factories with structural documentation shall be assessed using this methodology.

8.3.1 The Preliminary Structural Inspection for gravity and wind actions shall include the following activities:

8.3.1.1 Review of available documents, either original structural documents prepared in accordance with the Vietnam National Construction Regulations or as-built documents prepared in accordance with Section 8.21 of this Standard. Comparison of these documents with actual as-built conditions, including dimensional checks of samples of structural elements. Refer to 8.13 and 8.14 for further details.

8.3.1.2 Visual assessment of as-built structure for evidence of phased construction, horizontal or vertical extensions, alterations, additions (e.g. telecom towers or advertising hoardings), increased loading, change of use, etc.

8.3.1.3 Visual assessment of all structural elements for evidence of distress, cracking, or lack of performance.

8.3.1.4 Visual and analytical confirmation of floor loading and comparison of observed loading with any existing floor load plans.

8.3.1.5 Visual confirmation of performance of foundations, including absence of settlement cracking, excessive perimeter separations or settlement, or lack of floor levelness attributable to foundation settlements.

8.3.1.6 Visual confirmation of clear and redundant load path for lateral loads, including diaphragms and vertical elements. Visual observations shall note any evidence of apparent cracking or other lack of performance of lateral systems under prior lateral loading.

8.3.1.7 In-situ non-destructive testing including reinforcement scanning, rebound hammer tests and other similar non-destructive tests as deemed appropriate by the Structural Engineer at a number of sample locations.

8.3.1.8 Local exposure of key structural elements to validate results of non-destructive testing (e.g. local removal of concrete cover to validate reinforcement scanning of main bars and links).

8.3.1.9 Simple structural calculations to assess the basic capacity of structural members, including:

- Columns and wall elements at most critical floor levels, including lowest level.
- Vulnerable or critical structural elements identified by Structural Engineer including transfer beams, hangers, cantilevers, columns with high slenderness ratio, flat slab floors, and footings with inadequate thickness.

8.3.2 The Preliminary Structural Safety Inspection for seismic actions shall be undertaken in conjunction with the Preliminary Structural Safety Inspection for gravity actions. It should include the following activities in addition to those already specified in 8.3.1.

8.3.2.1 Carry out a FEMA 154 Rapid Visual screening (RVS), in accordance with "FEMA P-154: Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook (Third edition)" published by FEMA in January 2015.

8.3.2.2 The actions which follow the completion of the RVS are detailed in the Preliminary Assessment Methodology for Vietnam.

8.3.3 The general purpose of the Preliminary Structural Safety Inspection, and any follow-up detailed structural assessment is to answer the following seven questions in the affirmative:

- Is the vertical load carrying system logical?
- Is the lateral load-carrying system apparent and does it have redundancy?
- Are key structural elements such as columns, slender columns, flat slabs, and transfer structures satisfactory?
- Is building performance in respect to foundation settlement satisfactory?
- Is the structure free from any visible structural distress (progressive cracking) in main load-carrying members?
- Is the structural strength and performance of any visible vertical or horizontal extensions acceptable?
- Are credible structural documents available?
    a) Either credible original structural document in accordance with the Vietnam National Construction Regulations or as-built documents in accordance with Section 8.20 will generally suffice.

8.4 Results of Preliminary Structural Safety Inspection of Existing Factory Buildings

8.4.1 If the Structural Engineer determines that the answer to one or more of the seven questions in Sections 8.3.3 are negative, he/she may recommend and/or conduct more detailed structural assessment, investigations or analysis.

8.4.2 The data collection forms in the manual (Basic and Optional Forms) shall be used to prepare the RVS. Seismic risk shall then be classified in accordance with the Preliminary Assessment Methodology for Vietnam.

8.5 Detailed Structural Investigation or Assessment of Existing Factory Buildings

Interpretative Guideline: the purpose of this section is to outline how recommended follow-up structural investigation or assessment work should be carried out. Such follow-up work could include observation and monitoring over a particular time period, exposing certain structural elements and

inspecting condition, localised structural capacity checks on a particular structural element, preparation of accurate as-built drawings of a full Detailed Engineering Assessment of the entire structure identified in the Preliminary Structural Safety Inspection.

8.5.1 If the Preliminary Structural Safety inspection indicates areas of structural concern, distressed, damaged or distorted structural members, lack of verifiable documents or other lack of compliance with the requirements of this Standard, then more detailed structural investigation or assessment shall be required. A more detailed structural assessment/capacity check shall be performed where this has been identified. Reasons for this would be include apparently non-engineered additions to the original structure, distress or damaged in a structural member which may impact its structural capacity or where the strength of the original structural material is questionable.

8.5.2 To accomplish this, the Factory Owner shall engage a Qualified Structural Engineering Consultant (QSEC) that meets the qualifications established by LABS to provide structural advisory services to prepare all required design confirmation and structural documentation.

8.5.3 If required, the QSEC shall prepare as-built structural documents as described in the Section 8.21.5.

8.5.4 If required, the QSEC shall prepare Factory Safe Load Plans as described in Section 8.10.

8.5.5 If required, the QSEC shall conduct additional detailed structural condition assessments and investigations to determine the adequacy of specific structural elements, distressed structural members, or other conditions identified in the Preliminary Structural Safety Inspection.

8.5.5.1 In this case, the QSEC shall state assumptions regarding strength and properties of key construction materials. Unless confirmed otherwise by testing of in-situ conditions in accordance with applicable ASTM test procedures, the QSEC shall determine the material properties using Section 7.2.

8.5.5.2 Where required, for determination of in-situ concrete strength, ACI 214 and 562 shall be used in conjunction with concrete core tests. Non-destructive methods may be applied where there is documented calibration of these methods in the relevant country.

8.5.5.3 For the detailed assessment, all concrete reinforcement shall be determined from use of ferroscanning equipment.

8.5.5.4 Where required, for determination of structural steel strength, AISC 360-16 shall be used.

8.5.6 The installations of Telecoms towers, water tanks or similar structures on the roof top of any existing RMG factory building shall be critically examined against induced forces as per the Vietnam National Construction Regulations using the usual load factors. Such structures must be removed from the building if they are found to adversely affect the safety of the structure.

8.5.7 On occasion, the Preliminary Structural Safety Inspections will identify a serious structural issue or a number of issues which shall require preparation of a Detailed Engineering Assessment (DEA). This encompasses the entire building and has the following principal requirements:

- Acquiring accurate as-built information for the building
- Structural analysis
- Development of retrofit options where required – for agreement with the Factory and LABS Initiative.
- Detailed design of agreed retrofit option

The DEA shall be carried out by a QSEC, which should be a separate firm from that which carried out the Preliminary Structural Safety Inspection. The full requirements for a DEA are included in Appendix A.

For reinforced concrete structures, reference shall be made to Clause 9.2 and 9.3 of TCVN5574: 2012 for

additional information on assessment and strengthening.

8.6 Remediation of Deficient or Overloaded Structural Elements

8.6.1 If the Preliminary Structural Safety Inspection or subsequent more detailed structural investigations determine that a structural member has inadequate structural capacity under applied loads, the factory Owner shall take more appropriate steps to remediate by implementing one of the following methods:

8.6.1.1 The applied loads may be reduced to acceptable levels if possible by removal and limitation of structure, equipment, utilities, or floor loading, or

8.6.1.2 Overloaded structural elements may be strengthened using properly designed, documented, and installed strengthening and retrofit. For reinforced concrete structure, reference shall be made to Clause 9.3 of TCVN5574: 2012 for the design of the strengthening measures.

8.6.2 All load reductions and retrofits shall be designed and supervised by a QSEC and may be subject to technical review by LABS prior to implementation.

8.6.3 All installation of retrofit shall be carried out by construction firms experienced in the materials and techniques of structural retrofit. See Section 8.30.

8.7 Phased Construction: When a building or structure is planned or anticipated to undergo phased construction, structural members therein shall be investigated and designed for any additional stresses arising due to such effect.

***Interpretive Guideline*:** Temporary or permanent loads due to construction phasing must be anticipated and analytically confirmed by a QSEC prior to any expansion.

8.8 Restrictions on Loading: The Factory Owner shall ensure that the live load for which a floor or roof is or has been designed, will not be exceeded during its use.

8.9 Factory Load Manager: For any factories with more than one floor (including mezzanines), the Factory Owner shall ensure that at least one individual (the Factory Load Manager) is located onsite full time at the factory, is trained in the operational load characteristics of the specific factory. The Factory Load Manager shall serve as an ongoing resource to RMG & Footwear brands/vendors and be responsible to ensure that the factory operational loads do not at any time exceed the factory floor loading limits as described on the Factory Safe Load Plans.

8.10 Floor Loading Plans (Safe Load Plans): In every factory building, Safe Load Plans shall be prepared, by a QSEC, for each suspended floor and roof level (if roof is accessible). These Safe Load Plans shall document the actual maximum operational loading allowable. Safe Load Plans shall include the items described in Section 8.21.5.4. The Safe Load Plan for each suspended floor and roof shall be permanently and conspicuously posted on that floor and roof access point. Safe Load Plans are subject to review and approval by LABS. Sample load plan is included in Figure 8.20.

8.11 Floor Load Markings: In areas of factory buildings used for storage of work materials and work products, walls, columns, and floors shall be clearly marked to indicate the acceptable loading limits as described on the relevant Safe Load Plan.

8.12 Load Factors and Load Combinations for Structural Analysis

8.12.1 In analysing the structural adequacy of existing factories, the load factors and load combinations described below shall be used in accordance with TCVN.

*Ultimate limit state (**ULS**) for check strength and overturning stability*

ULS-01 : 1.1 (SW + SDL) + 1.2 LL
ULS-02 : 1.1 (SW + SDL) ± 1.2 WL
ULS-03 : 1.1 (SW + SDL) + 1.08 LL ± 1.08 WL
ULS-04 : (SW + SDL) + 0.8 LL ± 1.0 EQx ± 0.3 EQy *(x direction)*
ULS-05 : (SW + SDL) + 0.8 LL ± 1.0 EQy ± 0.3 EQx *(y direction)*

*Serviceability limit state (**SLS**) for checking deflection and cracking*
SLS-01 : (SW + SDL) + LL
SLS-02: (SW + SDL) ± WL
SLS-03: (SW + SDL) + 0.9 LL ± 0.9 WL

Table 8.1: Load Factors and Load Combinations
SW = Self Weight Dead Load
SDL = Superimposed Dead Load
LL = Live Load
WL = Wind Load from any direction
E = Seismic Load

8.13 Member Sizes and Properties for Structural Analysis

8.13.1 Where practical, all structural analysis of existing structures shall consider actual in-situ material strengths as measured by non-destructive and destructive testing in conformance with applicable ASTM testing protocols. Where factory conditions dictate that in-situ testing cannot be carried out, minimum construction material properties as set-out in Section 7.2.2. shall be used. In addition, characteristics of structural members should be verified as follows;

- Dimensions of members shall be established at critical sections
- Locations and sizes of reinforcement shall be determined by measurement. It shall be permitted to base reinforcement locations on available drawings if field-verified at representative locations to confirm the information on the drawings
- An established equivalent fc' characteristic concrete cube compressive strength shall be based on analysis of results of credible cube tests from the original construction or tests of cores removed from the part of the structure where strength is in question
- The method for obtaining and testing cores shall be in accordance with ASTM C42

8.14 Confirmation of Actual Dead Loads

8.14.1 As a requirement to use the load factors and load combinations stated in 8.12.1, dead loads shall be confirmed by measurement as follows:

8.14.1.1 Slab thicknesses shall be measured at mid-span of representative slab spans on each floor, where possible, using any existing floor openings. Where local floor openings do not exist, the QSEC shall consider how best to determine floor slab thickness by measurement.

8.14.1.2 Dimensions of representative sampling of beams shall be field measured.

8.14.1.3 Dimensions of representative sampling of columns shall be field measured.

8.14.1.4 Construction materials of walls shall be confirmed by representative exploration.

8.14.1.5 Fixed service equipment and other permanent machinery, such as generators, water tanks, production equipment, electrical feeders and other machinery, heating, ventilating and air-conditioning systems, lifts and escalators, plumbing stacks and risers etc. may be considered as dead load whenever such equipment is supported by structural members and weights are confirmed by manufacturer's data sheets provided by Factory Owner for each piece of equipment.

8.15 Confirmation of Actual Operational Live Loads

8.15.1 As a requirement to use the load factors and load combination stated in 8.12.1, operational live loads shall be confirmed by measurement as follows:

8.15.1.1 For stored work materials, each type of material shall be weighed and measured.

8.15.1.2 For stored work products, each size of boxed or packaged material shall be weighed and measured.

8.15.1.3 For other types of live load, confirmation shall be accomplished in the most appropriate means in the judgment of the QSEC.

8.15.1.4 The live loads used for the structural design of floors, roof and the supporting members shall be the greatest applied loads arising from the intended use or occupancy of the building, or from the stacking of materials and the use of equipment and propping during construction, but shall not be less than the minimum design live loads set out by the provisions of this section. For the design of new structural members for forces including live loads, requirements of the relevant sections Vietnam National Construction Regulations (in particular Volume II, Section III, Chapter 10) shall also be fulfilled.

8.16 Minimum Floor Design Live Loads

8.16.1 Minimum floor design live loads for the review of sewing and cutting floors during the Preliminary Structural Safety Inspection shall be 2.0 kN/m^2 (200daN/m^2) subject to review of in-situ factory conditions by the QSEC.

8.16.2 Where density of operations, storage of materials, or equipment weights require live load capacity in excess of 2.0 kN/m^2 (42psf), the Preliminary Structural Safety Inspection shall consider the actual required live load.

8.16.3 If the approved design documents for the factory construction do not explicitly confirm that the required load capacity exists, then the floor load capacity in the factory shall be analytically confirmed and certified with accompanying plans and calculations, in accordance with the Vietnam National Construction Regulations. This certification, plans and calculations shall be prepared by QSEC as part of the follow up to the Preliminary Structural Safety Inspection.

8.16.4 The Vietnam National Construction Regulations specify a minimum imposed floor loading of 4.0kN/m^2

(400daN/m^2) as applicable to new factory buildings.

8.17 Confirmation of Actual Construction Material Properties

8.17.1

8.17.2 Where practical, all Preliminary Structural Safety Inspections and follow-up detailed structural investigation and assessment will prefer actual in-situ material strengths as measured by non-destructive and destructive testing in conformance with applicable ASTM testing protocols.

8.17.3 Where field conditions allow and are acceptable in the judgment of the QSEC, presumed minimum material strengths and characteristics may be used as stated in Section 7.2.

8.18 Design for Lateral Loads

8.18.1 Every building, structure or portions thereof shall be designed to resist lateral loads due to notional, wind or seismic loads in compliance with the forces, Load Factors and Load Combinations as stated in the Vietnam National Construction Regulations. Specifically, the wind loading shall be assessed according to TCVN 2737-1995 (Loads and Actions) *and* TCXD 229-1999 (Dynamic Wind code) as required, and the seismic load shall comply with TCVN 9386-2012

8.18.2 A redundant structural system with clear load path to foundations to resist lateral loads is required in all existing factories. If such a load path does not exist, or if the factory has been vertically expanded, the lateral-resisting capacity of the factory shall be analytically confirmed and strengthened as required to resist lateral loads.

8.18.3 Any of the lateral loads prescribed in the Vietnam National Construction Regulations, considered either alone or in combination with other forces, whichever produces the most critical effect, shall govern the design.

8.18.3.1 As noted in 8.3.2, the Preliminary Structural Safety Inspection will include a Rapid Visual Screen (RVS) of the seismic characteristics according to the methodology of FEMA 154. This shall identify the requirement to carry out further seismic analysis and assessment work.

***Interpretive Guideline*:** The requirements to carryout seismic strengthening may not be mandatory. These recommendations are included as advisory only, with the ultimate decision to proceed left with the Factory Owner.

8.18.4 Importance Factor for all factory buildings and ancillary buildings shall be 1.0, unless hazardous materials are stored in the building. In that case, the importance factor shall be 1.5.

8.19 Seismic Bracing of Key Non-Structural Elements

8.19.1 The following non-structural elements suspended from, attached to, or resting on the structure shall be adequately anchored and braced to resist seismic forces:

- Parapets
- Canopies
- Unrestrained masonry
- Steam pipes
- Gas pipes
- Chemical or process pipes
- Storage racks
- Water tanks
- Other suspended equipment weighing more than 1.8kN that in the opinion of the QSEC presents a danger to workers in an earthquake.

8.19.2 Seismic bracing for non-structural elements shall be designed using the requirements of TCVN9386-2012

***Interpretive* Guideline:** This requirement applies to both new and existing factories. It is intended to ensure that falling non-structural elements in a seismic event do not create life safety hazards or hindrances to building egress.

8.20 Required Structural Documentation for New and Existing Factories

8.20.1 Every factory requires structural documentation that accurately describes the factory structure.

8.20.2 Structural documentation shall be maintained at the factory site and made available to third parties assessing the structural safety of the factory.

8.20.3 All structural documentation shall be prepared and signed by the QSEC responsible for the preparation of the documents.

8.20.4 New factories and any additions or expansions shall have complete structural documentation including Design Report and Structural Documents as described in Vietnam National Construction Regulations.

8.20.5 Existing factories shall have one of the following types of documentation

8.20.5.1 Complete and credible structural documentation prepared in general accordance with Vietnam National Construction Regulations and used as a basis for the original construction of the factory building, or

8.20.5.2 As-built structural documents that accurately describe the structural elements as described in Section 8.21.5.

8.21 Requirements for As-Built Documents

8.21.1 Where existing factories lack complete design and construction documentation from the factory construction, as-built documents shall be prepared in accordance with this section.

8.21.2 The Factory Owner shall engage a (QSEC) to prepare accurate as-built documents from first-hand knowledge and personal investigation of the actual in situ factory construction and operational conditions.

8.21.3 The credibility of any existing structural documentation shall be determined by the QSEC on the basis of observations and tests at the factory.

8.21.4 As-built documents shall serve as the basis for any detailed structural analysis performed to confirm the capacity of structural elements and load plans.

8.21.5 As-built documents shall include, at a minimum, the following:

8.21.5.1 The as-built structural drawings should include:

- Cover page – including date of survey and date of completion of as-built drawings, GPS location and name of factory, names of Surveyor and Checking Engineer
- All plan drawings shall include a north arrow
- Key plans shall be used where relevant to denote clearly separate sections of the building
- The drawings should be to a relevant scale, related to the size and complexity of the building in question. Typical suitable scales are 1:50, 1:100 and 1:200 on A3 or A2 drawing sheets with A3 size as a minimum.

8.21.5.2 Scaled and dimensioned Architectural Documents, including:

- Scaled site plan showing:
  - general layout of all buildings in the complex with labels
  - location and names of adjacent streets
  - location and size of utilities, if known

- Scaled architectural floor plan for each level of each building showing:
  - Architectural detail dimension
  - Location and size of stairs
  - Location and size of elevators
  - Location of fixed walls
  - Location of corridors
  - Location of openings in floors
  - Labelled usage areas on each floor, e.g. sewing, storage, dining, rooftop, office, etc.
  - Location of major machinery and equipment
  - General layout of factory activities
  - Roof Plan showing any construction, equipment, water tanks, or tower added at roof level.

- Scaled elevations of each façade of the building showing:
  - General configuration of the building including door and window schedule
  - Location and type of façade materials
  - Accurate number of levels and any intended future vertical or horizontal expansion areas.

- Scaled cross-section of the building showing:
  - Stair location
  - Location and type of materials
  - Dimensions between floors
  - Accurate number of levels and any intended future vertical or horizontal expansion areas

8.21.5.3 Scaled and dimensioned Structural Documents as follows:

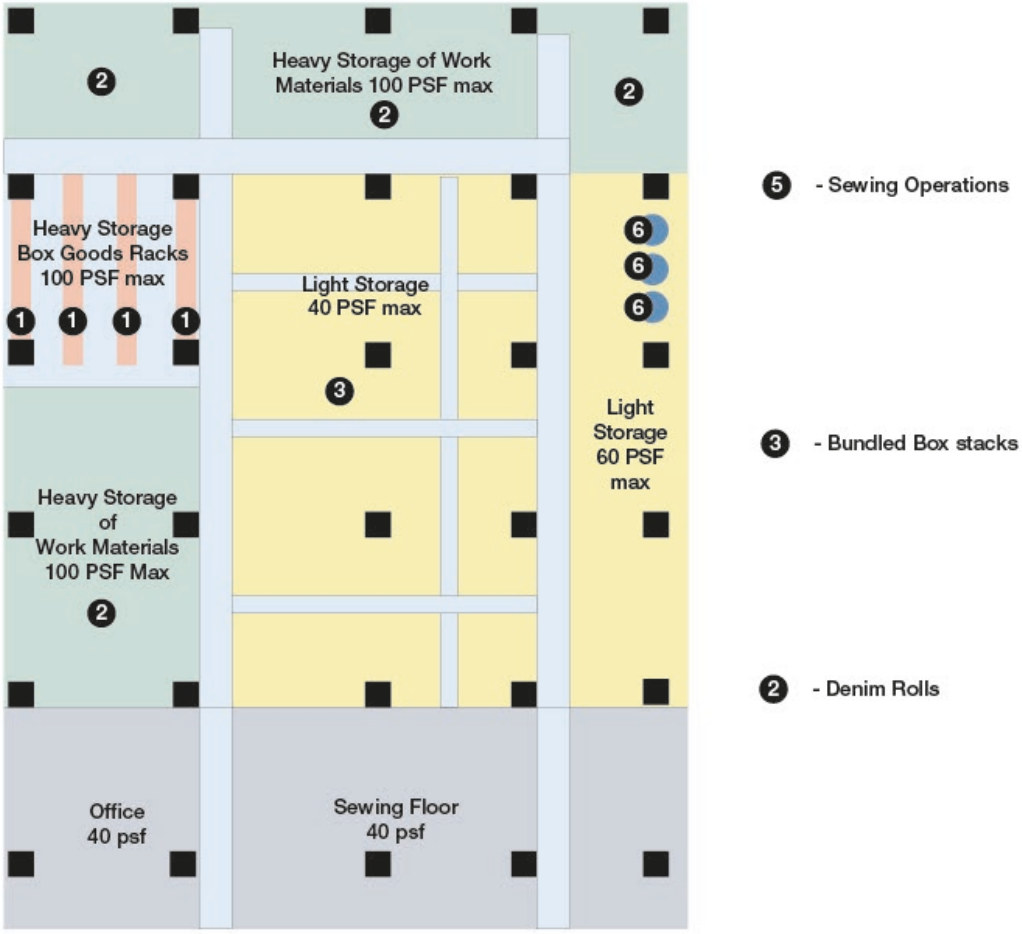
- Floor Plan for each level showing:
  - measured locations of columns and walls
  - reinforcement details (rebar size and layout) for any columns determined using scanning device or physical investigations.
  - confirmed construction type of walls, e.g. masonry or cast concrete
  - general size and layout of beams
  - thickness of slabs
  - general size and location of major floor openings
- Foundation Plan showing general layout and type of foundations, if known. It should be specified whether elements have been assumed or have been verified by site inspection.
- Roof Plan – including beam and column schedule, any additional structures at roof level such as sheds, steel structures, partially completed levels/structures etc. and existing super-imposed dead loading
- Building section(s) showing all constructed floors, dimensions between floors, and intended future vertical or horizontal expansion, if any.
  - Building sections shall indicate location and extent of any mezzanines, suspended storage areas, or partial floors.

8.21.5.4 Factory Layout and Load Documents for every floor and roof level, if accessible, showing:

- scaled layout of work stations
- operating equipment
- dedicated aisle locations
- type and extent of storage areas
- type and weights of stored work materials and/or stored work products at maximum density
- Factory layout and loading documents should use the architectural plan documents as background.

Factory Layout and Load Plans shall be coordinated with the structural plans.

An example of factory layout and loading documents is included in Figure 8.20.



Typical Floor Loading for this Floor:

No	Type	Item	Max PSF Load	Description
1	HS	Box Goods Rack	120	W36" x H72", Max 6 boxes high, 15kg/box
2	HS	Denim Rolls Storage	150	13" dia, 72" long, 150 kg/roll. 6 high max
3	LS	Bundled Box Storage	40	Max 48" high, 24" aisle each bay
4	Light	Office	40	W36 x H72, 6 boxes high, 15 kg/box
5	Light	Sewing Tables	40	Typical sewing tables
6	Special	Water Tank	N/A	4000 lbs, 60" dia, 84" tall, 5000 gal

Notes:
HS - Heavy Storage
LS - Light Storage

Floor x Load Plan:

Factory Name: _____ Prepared by: _____
Date Approved: _____ Approved by: _____

Figure 8.20. Example factory layout and loadings

8.21.6 Factory Equipment Schedule, including:

- Type of each piece of factory equipment including generators, washing machines, driers, etc.
- Include plan dimensions and weight of each piece of equipment.

8.22 **Notification to LABS of Planned Modifications to LABS Affiliated Factories**. Prior to the implementation of any substantial structural expansion, alteration, or repair of an existing factory utilized by LABS-affiliated brand/vendor(s), the Factory Owner shall notify LABS Initiative of his intent.

8.23 **Construction Observation**

8.23.1 Construction observation of all new construction, including new factory buildings, expansions of existing factory buildings, and repairs of existing factory buildings, shall be performed by a QSEC. This construction observation role by the QSEC is in addition to any 3rd party or Authority construction monitoring that may be required.

8.23.2 Construction observation shall include, but not be limited to, the following:

8.23.2.1 Specification of an appropriate testing and inspection schedule prepared and signed with date by the responsible person;

8.23.2.2 Review of testing and inspection reports;

8.23.2.3 Regular site visits to verify the general compliance of the construction work with the structural drawings and specifications, and

8.23.2.4 Preparation of reports to document the results of observations and testing, including resolution of non-conforming construction.

8.23.3 The quality and completeness of new construction, expansions, alterations, and repairs must be confirmed by independent observation and testing during construction.

8.24 **Temporary Construction Loads on Existing Factories**. All loads required to be sustained by an existing factory structure or any portion thereof due to placing or storage of construction materials and erection equipment including those due to operation of such equipment shall be considered as temporary construction loads.

8.24.1 Provisions shall be made in design to account for all stresses due to such loads.

8.24.2 When an existing factory will be expanded, all temporary construction loads shall be analytically confirmed and documented by the QSEC who is responsible for the design of the expansion works.

Interpretive Guideline: Temporary construction loadings on an existing factory during an expansion or other construction operations must not be allowed to endanger the life safety of building occupants through overloading elements of the factory. Construction loadings must be properly reviewed and managed.

8.25 **Changes to Foundation Loads**

8.25.1 Application for construction of a new building or structure, and for the alteration of permanent structures which require changes in foundation loads and their distribution shall be accompanied by a statement describing the soil in the ultimate bearing strata, including sufficient records and data to establish its character, nature and load bearing capacity. Such records shall be certified by a QSEC in accordance with Section 8.1.

8.25.2 Prior to vertical expansion of an existing factory, a QSEC shall provide analytical confirmation and documentation that the foundations supporting the factory have adequate capacity to safely support the

additional loads due to the expansion. The assessment shall take into account the effects of both vertical load and horizontal loads and shall include checks for stability against overturning, sliding and uplift using appropriate factors of safety as required for design of new works, all in accordance with the Vietnam National Construction Regulations.

8.26 Retrofitting of Deficient Structural Elements

8.26.1 When a structural member is identified to have inadequate structural capacity and the applied loadings cannot or will not be reduced to allow the structural member to be acceptable, then structural retrofitting may be accomplished in accordance with this section.

8.26.2 Structural retrofitting shall be properly designed using industry-standard methods.

8.26.3 Retrofitted elements must be strengthened to provide adequacy under all anticipated loads using the load factors specified in 8.12.1.

8.26.4 Where columns are strengthened the load path through floors and joints must be carefully considered.

8.26.5 All retrofitting shall be overseen by the responsible QSEC.

8.27 Durability and Maintenance

8.27.1 Factory Owner shall address all areas where maintenance is required, including areas with efflorescence, dampness, and corrosion.

8.27.2 Standing water on rooftop or other locations shall not be permitted.

8.27.3 Roofs shall be sloped to drain with minimum drainage of 1%.

8.27.4 Drains shall be provided at low points.

8.27.5 All exposed reinforcement (kept for possible future expansion) shall be protected from weathering effect and rust by using approved protective covering.

8.28 Qualification of QSEC

8.28.1 Subject to approval by LABS, the QSEC firm shall have appropriate qualifications and an established track record in the completion of detailed structural assessments and the preparation of remediation measures for strengthening of existing buildings.

8.28.2 In addition, the minimum qualification and experience of the individual engineer nominated as the QSEC shall be as follows:

- Shall hold a Bachelor's degree in Civil/ Structural Engineering from a university recognized by the national engineering institute or equivalent international professional qualifications.
- Shall have a minimum 10 years of structural design experience.
- Shall hold a valid License to Practice as an Engineer in the Discipline of Civil and Industrial Engineering, issued by the Ministry of Construction. Equivalent international qualifications such as Membership of the Institution of Structural Engineers will also be recognized as fulfilling this requirement.
- Ideally experience of at least three existing building assessments in the last two years

These requirements are to ensure that the QSEC is suitably qualified to check, approve and certify an Existing Building Assessment Report. For the avoidance of doubt, certification shall comprise an official company stamp from the QSEC firm and the signature of the suitably qualified Engineer who will retain responsibility for the existing building report.

8.29 Required Statement of Design Responsibility

The Factory Owner's QSEC shall provide written evidence of design responsibility, including calculations, design report, documents and site observations as appropriate, for each of the following situations:

8.29.1 Structural investigations or design confirmations of structural distress or suspected deficiencies

8.29.2 Structural strengthening or improvements to comply with requirements

8.29.3 Structural expansions or modifications to existing factories

8.29.4 Structural repairs of existing structural elements

8.30 Qualifications of Retrofitting Construction Firms

8.30.1 All firms used for construction of structural retrofitting elements shall be experienced and competent construction firms with a minimum of five years of experience in this area.

8.31 Qualifications of Testing Laboratory

8.31.1 Where testing of in situ structural elements or materials or construction materials is required to confirm strength or other characteristics, this testing shall be performed in accordance with applicable ASTM specifications by a qualified testing laboratory that meets the requirements of Section 8.27. The Testing Laboratory shall meet the basic requirements of ASTM E 329 and shall provide to LABS evidence of current accreditation from the American Association for Laboratory Accreditation, the AASHTO Accreditation Program, the "NIST" National Voluntary Laboratory Accreditation Program, or an equivalent national certification program.

8.31.2 The Testing Laboratory shall be approved by the relevant Building Control authorities to perform Special Inspections and other tests and inspections as outlined in the Vietnam National Construction Regulations.

8.31.3 Tests and inspections shall be conducted in accordance with specified requirements, and if not specified, in accordance with the applicable standards of the American Society for Testing and Materials or other recognized and accepted authorities in the field.

8.32 Qualifications of Welding Inspectors

8.32.1 Inspectors performing visual weld inspection shall meet the requirements of AWS D1.1 Section 6.1.4. Inspectors shall have current certification as required by the Vietnam National Construction Regulations.

8.32.2 Inspectors performing nondestructive examinations of welds other than visual inspection (MT, PT, UT, and RT) shall meet the requirements of AWS D1.1, Section 6.14.6.

9 Part 9 Construction Practices and Safety

Interpretive Guidelines: *For the purposes of this Standard, the primary concern is the protection of the existing structural safety and its occupants during subsequent construction, especially with overhead construction to vertically expand a factory. Those who expand factories must take extra care to avoid structural overloading with shoring loads, equipment loads, temporary stacking of materials, or building beyond the original design intent. This may be a significant concern as factories are expanded, in particular where the building remains occupied. Temporary storage of construction materials, especially hazardous or explosive materials, is also of concern and must be addressed. QCVN 06_2008/BXD Vietnam Fire Code, QCVN 18_2014/BXD National technical regulation on Safety on Construction and relevant standards shall be followed from design and construction stage.*

9.1 **Permit and Approvals:** All construction including extension, alteration and demolition shall require a permit from the Authority, in accordance with the Vietnam National Construction Regulations. Permits shall also be obtained from relevant organizations for service connections and other facilities. The construction work shall conform to the plan approved by the Authority. The owner shall make arrangements for obtaining the required approvals. All new work or alteration shall be planned, designed, supervised and executed by competent professionals of relevant discipline. The design for the new work or alterations shall be subject to the appropriate Approval procedure as determined specifically for each project; this may include the need for a 3rd Party Reviewer.

9.1.1 When existing LABS-affiliated factories are planned for expansion, LABS shall be notified in advance of the start of construction.

Interpretive Guideline: *The LABS Initiative wishes to be kept informed of major alterations to factories used by LABS-affiliated brands/ vendors. Notification should include full documents describing the planned improvements, including Design Report confirming the structural adequacy of the existing factory to safely support the alteration. Notification should be made at least 60 days in advance of planned start of construction.*

9.2 **Professional Services and Responsibilities:** The responsibility of professionals with regard to planning designing and supervision of building construction work, etc. and that of the owner shall be in accordance with the Vietnam National Construction Regulation and other applicable Laws and regulations. All Structural Engineers employed as responsible Structural Engineers for new design and for design confirmations shall be LABS-qualified in accordance with Section 8.28. Employment of trained workers shall be encouraged for building construction activity.

9.3 **Construction of all Elements:** Construction of all elements of a building shall be in accordance with good practice, such as Vietnam National Construction Regulations IBC 2015 Part 33, NFPA 241, and others as applicable.

9.4 **Construction Stage Loading:** No structure, temporary support, scaffolding, other devices and construction equipment shall be loaded in excess of its safe working capacity.

Interpretive Guideline: *The structural capacity and safety of shoring, formwork, restoring, temporary works and construction storage of materials should be confirmed by a QSEC.*

9.4.1 **Temporary Works Loading:** Scaffolds, formwork, temporary works and components thereof shall be capable of supporting without failure, at least two times the maximum intended load. The following loads shall be used in designing the formwork:

(1) Weight of wet concrete: 20 kN/m^3 (127 PCF);
(2) Live load due to workmen and impact of ramming or vibrating: 1.5-4.0 kN/m^2 (light duty for carpenter and stone setters, medium duty for bricklayers and plasterers, heavy duty for stone masons);

9.4.1.1 **Formwork:** Formwork provided for concrete structures shall be designed and constructed for the anticipated loads. During the construction of the concrete element, the formwork shall be frequently inspected for defects. Enough walking platforms shall be provided in the reinforcement area to facilitate safe walking to the concreting area. Loose wires and unprotected reinforcement ends shall be avoided. Formwork supporting cast-in-place reinforced and pre stressed concrete floors and roofs shall be adequately tied or braced together to withstand all loads until the new construction has attained the required strengths.

9.4.1.2 All formworks and scaffolds shall be strong, substantial and stable. All centering and props shall be adequately braced to ensure lateral stability against all construction and incidental loads.

9.4.1.3 The space under the scaffold or formwork shall not be used as a working or living space. The space shall not be used as a shelter or refuge during inclement weather or at any other time.

9.5 General Requirements and Restrictions on Storage and Handling:

9.5.1 Materials required in construction operations shall be stored, and handled in a manner to prevent deterioration and damage to the materials, ensure safety of workmen in handling operations and non-interference with public life including safety of public, prevention of damage to public property and natural environment.

9.5.2 Materials shall be stored and placed so as not to endanger the public, the workers or the adjoining property. Materials shall be stacked on well-drained, flat and unyielding surface. Material stacks shall not impose any undue stresses on walls or other structures.

9.5.3 Materials shall be separated according to kind, size and length and placed in neat, orderly piles. High piles shall be staggered back at suitable intervals in height. Piles of materials shall be arranged so as to allow a minimum 800 mm wide passageway in between for inspection and removal. All passageways shall be kept clear of dry vegetation, greasy substance and debris.

9.5.4 For any site, there should be proper planning of the layout for stacking and storage of different materials, components and equipment with proper access and proper maneuverability of the vehicles carrying the material. While planning the layout, the requirements of various materials, components and equipment at different stages of construction shall be considered.

9.5.5 Stairways, passageways and gangways shall not become obstructed by storage of building materials, tools or accumulated rubbish.

9.5.6 Materials stored at site, depending upon the individual characteristics, shall be protected from atmospheric actions, such as rain, sun, winds and moisture, to avoid deterioration.

9.5.7 Special and specified care should be taken for inflammable and destructive chemicals and explosive during storage.

9.6 Fire Safety Construction practices: QCVN 06_2008/BXD Vietnam Fire Code, QCVN 18_2014/BXD National technical regulation on Safety on Construction and relevant standards shall be followed from the outset of the design and during all construction stages.

9.6.1 **Fire Protection during Inspections:** Inspections of construction activities in occupied facilities shall be performed by the Fire Safety Director or designee. These inspections shall insure compliance with this Chapter. The Fire Safety Director shall be given the contractual authority with the construction team to stop any construction or construction activity that creates an unsafe fire condition. Fire police department will arrange the inspections of construction activities.

9.6.2 **Escape Facilities:** In buildings under construction, adequate escape facilities shall be maintained at all

times for the use of construction workers. Escape facilities shall consist of doors, walkways, stairs, ramps, fire escapes, ladders, or other approved means or devices arranged in accordance with the general principles of Part 6 of this Standard.

9.6.3 **Waste:** Accumulations of combustible waste material, dust, and debris shall be removed from the structure and its immediate vicinity at the end of each work shift or more frequently as necessary for safe operations.

9.6.4 **Automatic sprinklers:** Where automatic sprinkler protection is to be provided, the building shall not be occupied until the sprinkler installation has been completed and tested.

9.6.5 **Standpipes:** Where standpipes are required, temporary or permanent standpipe connections shall be installed during construction.

9.6.5.1 The standpipes shall be securely supported.

9.6.5.2 At least one hose valve shall be provided to allow connection of fire department hoses.

9.6.5.3 The standpipes shall be extended up with each successive floor and securely capped at the top.

9.6.5.4 Top hose outlets shall not be more than one level below the highest forms, staging, and similar combustible materials at all times.

9.6.6 **Hot Work:** A hot-work permit system in accordance with NFPA 51B shall be provided for any construction in an occupied facility.

9.6.6.1 Fire watch personnel shall not be assigned other duties.

9.6.7 **Construction Materials**

9.6.7.1 Storage of construction materials shall not be placed in any means of egress from an occupied building.

9.6.7.2 Transportation of construction materials shall not use any required exits, including stairways, needed for safe egress of an occupied building.

9.6.7.3 **Inflammable and/or Fire-Sensitive Materials. NFPA 241 - *Standard for Safeguarding Construction, Alteration, and Demolition Operations*:** Materials under this classification shall be stored within fire-preventive confines, furnished with firefighting provisions. Buckets containing sand shall be kept ready for use. A 5 kg dry powder fire extinguisher conforming to accepted standards shall be kept at an easily accessible position. Besides the areas shall be close to fire hydrants.

9.6.7.4 **Protection against Fire. NFPA 241 - *Standard for Safeguarding Construction, Alteration, and Demolition Operations*:** Timber, Bamboo, coal, paints and similar combustible materials shall be kept separated from each other. A minimum of two dry chemical powder (DCP) type fire extinguishers shall be provided at both open and covered locations where combustible and flammable materials are stored. Flammable liquids like petrol, thinner etc., shall be stored in conformity with relevant regulations. Explosives like detonators, gun powder etc. shall be stored in conformity with the fire protection provisions set forth in this Code so as to ensure desire safety during storage. Stacks shall not be piled so high as to make them unstable under fire fighting conditions and in general they shall not be more than 4.5 m in height.

Further details on various material types are contained in section 2.2.3 of QCVN 18:2014.

Materials which are likely to be affected by subsidence of soil like precast beams, slabs and timber of sizes shall be stored by adopting suitable measures to ensure unyielding supports.

10 Part 10 Electrical Safety Requirements

10.1 Scope

10.1.1 The main aims of this section are to identify and aid the reduction of risk caused by;

(1) Shock currents,
(2) Excessive temperature likely to cause burns, fires and other injurious effects
(3) Ignition of a potentially explosive atmosphere
(4) Undervoltages, overvoltages and electromagnetic disturbances likely to cause or result in injury or damage
(5) Mechanical movement of electrically actuated equipment, in so far as such injury is intended to be prevented by electrical emergency switching or by electrical switching for mechanical maintenance of non-electrical parts of such equipment
(6) Power supply interruptions and/or interruptions of safety services
(7) Arcing or burning, likely to cause blinding effects, excessive pressure and/or toxic gases

10.1.2 The requirements of relevant national codes are adopted in their entirety except as specifically noted in the Sections below.

10.2 Applicability of National Building Code

10.2.1 This Standard utilizes the Vietnam National Construction Regulations as the applicable minimum standard for new factory construction and for all expansions or modifications to existing factories, unless modified by the Localised Standard in any particular country.

10.2.2 New factories shall comply with the more stringent requirements of this Standard and the relevant Vietnam National Construction Regulations, in particular (but not limited to): TCVN 7447 suite of documents together with associated code updates and jurisdictional circulars as they may be issued from time to time. New factories are those which are built after the adoption of this Standard.

10.2.3 Existing factory buildings are those that are in current use in the RMG and Footwear industry at the time of adoption of this Standard.

10.2.4 Any substantial retrofit or expansion of an existing factory building shall comply with Vietnam National Construction Regulations.

10.3 Electrical Safety of Existing Factory Buildings

10.3.1 Every existing factory building must demonstrate a minimum degree of electrical safety as confirmed by a Preliminary Electrical Safety Inspection performed by a LABS qualified Electrical Engineer.

10.4 Preliminary Electrical Safety Inspection to Confirm Electrical Safety of Existing Factory Buildings.

10.4.1 The Preliminary Electrical Inspection shall include the items detailed in the Preliminary Assessment Methodology document.

10.5 Terms and Definitions

10.5.1 Terms and Definitions shall be taken from TCVN 7447-1:2010

10.5.2 Protection Against Electric Shock

10.5.2.1 The requirement of TCVN 7447-4-41:2010 shall be followed.

10.5.3 Protection Against Thermal Effects

10.5.3.1 The requirement of TCVN 7447-4-42:2005 shall be followed.

10.5.4 Protection Against Overcurrent

10.5.4.1 The requirement of TCVN 7447-4-43:2010 shall be followed.

10.5.5 Selection and Erection of Wiring Systems

10.5.5.1 The requirement of TCVN 7447-5-52:2010 shall be followed.

10.5.6 Earthing Arrangements

10.5.6.1 The requirement of TCVN 7447-5-54:2015 shall be followed.

10.5.7 Generator Set Definitions

10.5.7.1 The terms used in ISO 8528 for definitions of generator set ratings shall be used.

10.5.8 Maximum Voltage Drop

10.5.8.1 The requirement of TCVN 7447-1:2010 shall be followed.

10.5.9 Building Electrical Load Estimate

10.5.10 In order to asses an installation, the actual maximum load demand likely to be imposed on the power-supply system must be determined. A load estimate calculation shall be carried for each building to determine the load. The load estimate shall be reviewed by a LABS engineer.

10.5.11 Load estimates shall be carried by summing all the power consuming appliances in the site and applying diversity factors.

10.5.12 Circuits in 3-phase installations shall be balanced as far as is reasonably practical.

10.6 Electrical Substation

10.6.1 Where practical direct access from the street for installation or removal of the equipment shall be provided.

10.6.2 Arrangements should be provided to prevent the entrance of storm or flood water into the substation area.

10.6.3 Areas in substation shall not be used as storage/dump areas or for other utility purposes other than those required for the functioning of the substation

10.7 Layout of Substation.

10.7.1 For new construction substations shall be sized to provide adequate clearance distances for the equipment contained within (transformer, MV and LV switchgear).

10.7.2 Sufficient access and working space to permit safe operation and maintenance of the equipment within the substation shall be no less than 1 m where access is required.

10.7.3 Where sufficient access isn't provided steps shall be taken to provide the required access. (for example, transformer room may need to increase in size to allow for this)

10.7.4 For new construction, the HV Panel shall be located near the exterior, just after or adjacent to the incoming supply and transformer.

10.7.5 For new construction, the location of the LV panel should such that the riser main cable can have their way upward or outward within very short distance.

10.7.6 The Substation shall be provided with adequate;

(1) partitions up to the ceiling (these may require to have a fire resistance which will defined by the
(2) Ventilation (ventilation shall be designed to comply with the recommendations of the equipment manufacturer)
(3) Lighting levels
(4) Earthing
(5) Warning Signage
(6) Lockable door with restricted access to those only competent to entry substations
(7) Emergency first aid signage and equipment

10.7.7 For transformers having large oil content (more than 600 liters), soak pits are to be provided. Soak pits shall be adequately sized to deal with the volume of oil.

10.8 Transformers

10.8.1 For new construction, in most cases oil type natural cooled transformer may be used for substations if adequate space is available to accommodate the transformer.

10.8.2 If total continuous load (determined from load estimate) exceed 95% serious consideration shall be given to upgrade the transformer.

10.8.3 The transformer shall have sufficient cooling air to maintain a room temperature below the transformers recommended operating temperature. Natural ventilation should be used where possible. If mechanical ventilation is used it shall be reviewed by a LABS engineer.

10.8.4 Sufficient access and working space to permit safe operation and maintenance of the transformers shall be no less than 1m.

10.9 Generator Room

10.9.1 The generator room should have significant ventilation. Appropriate type and number of firefighting equipment must be installed inside the generator room.

10.9.2 The generator engine exhaust shall be taken out of the building and should be routed above the height of the building.

10.9.3 In case of gas engine generator extra precaution must be taken regarding ventilation, leakage to prevent explosion. [Scope to be developed during localization, local gas regulations to be followed in full)

10.9.4 For existing construction, the room shall have sufficient access and working space to permit safe operation and maintenance of the equipment within generator room. Access shall be no less than 1 m on all sides of the generator that require access.

10.9.5 The generator shall have sufficient combustion and cooling air. Air shall always be taken from outside. Air shall always be exhausted to outside.

10.9.6 Air inlets should be located away from sources of heat.

10.10 Switchgear

10.10.1 All switchgear shall be either of metal clad enclosed patterns or of any insulated enclosed pattern.

10.10.2 For each building a main switch shall be installed at close proximity to the point of entry of the supply.

10.10.3 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, 4 pole breakers shall generally not be used.

10.10.4 The location of the main switch shall be such that it is easily accessible for the fire services and other personnel to quickly disconnect the supply in case of emergencies. The entire building(s) supply shall be isolated from a single point, safety service sources shall not be affected by this.

10.10.5 Open type switchboards are not allowed.

10.10.6 In damp situation or where inflammable or explosive dust, vapor 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.

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

10.10.8 In case of switchgear 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.

10.10.9 Adequate illumination shall be provided for all working spaces about the switchboards when installed indoors. Vietnamese standard TCVN 7114-1:2008 Ergonomics – Lighting of workplaces – Part 1: Indoor gives 200 lux for switchboard room; 500 lux for electrical panel.

10.10.10 All metal casings or metallic coverings containing or protecting any switchgear shall be connected to earth.

10.10.11 There shall be a distance of 1 m clear in front of all switchgear.

10.10.12 Metal Clad Switchgear

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

10.10.12.2 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 and shall be provided with locking arrangement and earthing stud. All wires passing though the metal board shall be protected by a suitable glad at the entry hole. The earth stud should be commensurate with the size of the earth lead(s).

10.10.12.3 All switchgear shall have a minimum rating of IP31.

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

10.11 Location of Distribution Boards

10.11.1.1 They shall be fixed on suitable stanchion or wall and shall be accessible - for replacement of protective devices and generally maintenance. The top of boards shall not be more than 2 m from floor level.

10.11.1.2 Boards should not be exposed to

(1) External weather conditions
(2) Explosive dust
(3) Vapors / steam
(4) Gas
(5) Corrosive atmospheres

10.11.1.3 If unavoidable, within corrosive atmospheres they shall be treated with anticorrosive preservative or covered with suitable plastic compounds.

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

(1) fixed not less than 2m apart, or
(2) 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.

10.11.1.5 All distribution boards shall be marked with the voltage and number of phases of the supply. Each shall be provided with a circuit list of each circuit which it controls and the current rating for the circuit and size of protective device.

10.12 Switchboards / Main Distribution Boards

10.12.1 Enclosures

10.12.1.1 Low-voltage switchgear and control gear shall comply with TCVN 6592-1:2009

10.12.1.2 Low voltage products shall comply with the following IEC 60949.

10.12.1.3 Enclosures for distribution boards located inside the building shall be vermin- proof using sheet steel fabrication of a minimum thickness of 2 mm^2. All live parts must be concealed by a non-combustible material.

10.12.1.4 Every circuit shall be legibly identified as to its clear, evident, and specific purpose or use. Spare positions that contain unused overcurrent devices or switches shall be described accordingly. The identification shall include a circuit directory that is located on the face or inside of the panel door. Circuits used for the same purpose must be identified by their location.

10.12.2 Wiring of Distribution Boards

(1) In wiring a distribution board, total load of the consuming devices shall be distributed as far as possible evenly between the phases.

(2) Outgoing 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. Terminals shall be wired to the correct circuit protective device.

10.12.3 'Form' of switchgear enclosure

(1) The international standard describes four basic Forms from 1 to 4, with Forms 2, 3 and 4 having

further subdivisions 'a' and 'b'. The choice of which form to specify must be based on how any future maintenance or installation work will be carried out after the switchgear has been put into service. For example, if it will be necessary to terminate new cables while the remainder of the panel is still energised then the form of separation must ensure that it is not possible to make contact with any live parts during this work. The method of maintenance shall be checked to ensure that personal are not subjected to undue risk (e.g. that switchgear is de-energized during modification or maintenance works)

10.13 Equipment and Accessories

10.13.1 High Voltage (HV) Switchgear

10.13.1.1 HV switchgear shall be located in the same space as the transformer it serves. Access to HV switchgear shall be limited to only those who are qualified to enter. Unless trained, factory electricians or engineers shall not enter the space.

10.13.1.2 For new construction, 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.

10.13.1.3 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.

10.13.2 Low Voltage (LV) Switchgear

10.13.2.1 LV switchgear must have adequate breaking capacity in relation to the capacity of the transformers.

10.13.2.2 Circuit protection shall comply with TCVN 7447-5-53.

10.14 Changeover Switch of a Standby Generator

10.14.1 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. A mechanical or /and electrical interlock shall be installed to ensure this.

10.14.2 The changeover switch may be manual type or automatic type.

10.15 Electrical Cabling

10.15.1 Conductor and Cables

10.15.1.1 Conductors shall be of copper or aluminum.

10.15.1.2 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.

10.15.1.3 Phase and neutral wires shall be of the same size.

10.15.1.4 For new and existing construction, conductors for power distribution shall be properly identified in order to easily distinguish the neutral, line, and earth conductors. Means of identification shall be through the use of colored insulation or colored plastic vinyl tape.

10.15.2 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.

10.15.3 Cable Ends

All stranded conductors having nominal cross-sectional area 6mm^2 and above shall be provided with cable sockets. For stranded conductors of cross-sectional area below 6mm^2 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.

10.15.4 Cable Joints

Cable joints are to be realized through porcelain/PVC connectors with PIB tape wound around before placing the cable in the box. Where joints exist on fire rated cabling they shall be made using porcelain connectors only and within a fire junction box.

10.15.5 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 wiring are not in any way put to strain or are not damaged due to expansion/ contraction of the building structure.

10.15.5.1 Socket and Plug

Each socket outlet for air-conditioner, water cooler, etc. shall be provided with its own individual protective device 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 adjacent thereto or combined therewith.

(1) The copper earth wire for 5A socket outlets shall not be smaller in size than 4 mm^2 and the phase wire to the socket outlet shall be through the switch.

10.15.6 twoElectrical Connections

10.15.6.1 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:

(1) the requirement of over current protection,
(2) the requirement for isolation and switching, and
(3) the selection of cables and conductors.

10.15.6.2 Separate branch circuits shall be provided from their own protective device for
(1) general lighting
(2) fixed appliances with a load of 500 watt or more
(3) and plug receptacles.

10.15.6.3 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 15 m.

10.15.6.4 When the distance from the over current protective device to the first socket outlet on a receptacle circuit is over 30 m the minimum size of cable used for a 15A branch circuit shall be 4mm^2.

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

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

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

10.16 Installation

10.16.1 Surface/exposed wiring shall be run-either horizontally or vertically, and never at an angle.

10.16.2 In case of concealed wiring, the cables 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.

10.16.3 Underground cables for electrical distribution in the premises/garden/compound of the building shall be encased in GI or PVC conduit and laid in earth trenches of a minimum depth of 600 mm. Armored cables need not be encased in conduit except for crossings under road, footpath, walkway or floors.

10.16.4 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.

10.17 Wiring for Lighting

10.17.1 Internal fittings cabling shall normally be restricted to the internal wiring of the lighting. When the fittings wire is used outside the fitting it shall terminate in a ceiling rose or box with connectors.

10.18 External Influences

10.18.1 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.

10.18.2 External heat sources: In order to avoid the effects of heat from external sources one of the following methods shall be used to protect wiring systems:

(1) shielding;
(2) placing 900 mm (36 in.) from the source of heat;
(3) selecting a system with due regard for the additional temperature rise which may occur;
(4) local reinforcement or substitution of insulating material.

10.18.3 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.

10.19 Selection and Erection to Minimize the Spread of Fire

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

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

10.19.3 Cables not complying, as a minimum, with the IEC 60332- (1flame propagation) and IEC 60332-1-3

(fire droplet) requirements shall be;

(1) limited to short lengths for connection of appliances to permanent wiring systems and

(2) shall in any event not cross fire compartments

10.19.4 Parts of wiring systems other than cables which do not comply, as a minimum, with the flame propagation and flaming droplets 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.

10.19.5 Conduits and Conduit Fitting

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.

10.20 Conductor and Cables

10.20.1 For new construction, the advice of the cable manufacturer with regard to installation, jointing and sealing shall be followed.

10.20.2 The HV 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.

10.20.3 Methods of installation of cables and conductors in common use as specified in relevant national or international codes shall be followed.

10.21 Lighting Fittings

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

10.21.2 No flammable material shall form part of lighting fittings.

10.21.3 Lighting systems shall not be installed in a manner where the light fixture is supported by the False / Lay-in Ceiling Grid system. Light Fixtures shall be independently supported from the structure and 'seismic bracing' shall be installed as required.

10.22 Layout and Installation Drawings

10.22.1 The following list of drawings shall be provided for each building. Where these drawings do not exist or require updating to reflect the current installed equipment this shall be carried out by the factory.

- Electrical legend – with the standard electrical symbols and abbreviations.
- Distribution / containment drawings with size and type (where appropriate)
- Lighting layouts
- Fire detection and alarm layouts
- Small power layouts
- Lightning Protection layouts
- Fire alarm cause and effect matrix
- Set of relevant electrical schematics (where appropriate):
  - Low voltage
  - Earthing
  - Distribution board schematic

10.22.2 For new construction, 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.

10.22.3 For new and existing buildings, a Single Line Diagram (SLD) shall be maintained and continuously updated to reflect as built conditions. The SLD shall show a correct power distribution path from the incoming power source to switchgear, switchboards, panelboards, MCCs, fuses, circuit breakers, automatic transfer switches, and continuous current ratings.

10.22.4 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.

10.23 Service Entry

10.23.1 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 goose neck bend at the top and installed on the outer wall.

10.23.2 Underground service cables shall be laid in conformity with the requirements of wiring 10.16 above.

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

10.24 Electrical Service Shaft

10.24.1 Service Shaft

10.24.1.1 For new construction, vertical services 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 services wall is preferable.

10.24.1.2 For new construction, 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.

10.24.2 Sealing of Shaft

10.24.2.1 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.

10.25 Rotating Machines

10.25.1 All equipment including cables of every circuit carrying the starting 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.

10.25.2 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.

10.25.2.1 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.

10.25.2.2 The frame of every motor shall be connected to earth.

10.26 Supplies to Life Safety Services

10.26.1 General

10.26.1.1 Life Safety services can be defined as;

- Emergency (escape) lighting
- Fire pumps
- Fire rescues services lift
- Evacuation systems
- Smoke extract systems
- Industrial safety systems
- Fire services communications systems
- CO detection and alarm
- Fire detection and alarm

This list is not exhaustive and consideration of other systems should be given and their impact on occupants' safety.

10.26.1.2 A safety source is defined as;

(1) storage batteries,
(2) primary cells,
(3) generator sets independent of the normal supply.

10.26.1.3 Where safety services are installed or required to be installed provision should be made for safety source in accordance with TCVN 7447-5-56:2011 Selection and Erection of Electrical Equipment – Safety Services.

10.26.1.4 A safety source may, in addition, be used for purposes other than safety services, provided the availability for safety services is not thereby impaired. A fault occurring in a circuit for purposes other than safety services shall not cause the interruption of any circuit for safety services

10.26.1.5 Where more than one source is available, the sources are permitted to supply other loads provided that, in the event of failure of one source:

(1) automatic changeover with a suitable alarm is available, and
(2) the energy from the remaining source will be sufficient for starting and operating all safety services.

This shall be proven by way of a load estimate.

10.26.2 Where buildings contain a passenger and/or goods lift(s) consideration should be given to providing back up power to enable evacuation in the event of primary power failure to the lift.

10.26.2.1 **Generator Selection:** When selecting a generator for Emergency Standby Power (ESP) the rated power shall be the maximum power which the generator is capable of delivering continuously while supplying a variable electrical load when operating for up to 200 hours per year with no overload power rating.

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

10.26.2.3 Response time and rated operating time of the safety shall comply with the following table (Table B.1 IEC 60364-5-56);

Table B.1 – Guidance for safety equipment

Examples for safety equipment	Requirements									
	1	2	3	4	5	6	7	8	9	10
	Rated operating time of the source, h	Response time of the source, s. max.	Central power supply system	Low power supply system	Self-contained battery unit	Motor-generator unit with no break (0 s)	Motor-generator unit with short break (< 0,5 s)	Motor-generator unit with medium break (< 15 s)	Dual supply system	Monitoring and changeover in the case of failure of the source
Installations for fire pumps	12	15				✓	✓	✓	✓	✓
Fire rescue service lifts	8	15				✓	✓	✓	✓	✓
Lifts with special requirements	3	15				✓	✓	✓	✓	✓
Devices of alarm and issue of instructions	3	15	✓	✓		✓	✓	✓	✓	✓[a]
Smoke and heat extraction equipment	3	15	✓	✓	✓	✓	✓	✓	✓	✓[a]
CO warning equipment	1	15	✓	✓	✓	✓	✓	✓	✓	✓[a]

[a] Only in case of no separate safety supply equipment.

✓ Denotes suitable systems.

Wiring to Safety Service: One or more of the following wiring systems shall be utilized for safety services required to operate in fire conditions:

(1) Mineral insulated cable systems complying with TCVN 10348-1:2014 and TCVN 6613-1-2:2010 and IEC 60332-1-2

(2) Fire-resistant cables complying with TCVN 9618-1:2013, TCVN 9618-2:2013 or TCVN 9618-3:2013 and with IEC 60332-1-2

(3) Fire-resistant cables complying with rest requirements of EN 50200, BS 8434 or BS 8491

10.26.3 Generator Earthing: The generator frame shall be earthed by two separate and distinct connections to earth.

10.27 Protection of Circuits

10.27.1 General

10.27.1.1 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.

10.27.1.2 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.

10.27.1.3 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.

10.28 Additional Protection: Residual Current Devices (RCDs)

10.28.1 RCDs with a rated residual operating current (IΔn) not exceeding 30mA and operating time not exceeding 40ms at a residual current of 5 times IΔn shall be provided for

- Socket-outlets with a rated current not exceeding 20A, and
- Mobile equipment with a current rating not exceeding 32A for use outdoors.

10.28.2 An exception is permitted for specific labelled or otherwise suitably identified socket-outlet provided for connection of a particular item of equipment.

10.29 Protection against Overload Current

10.29.1 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.

10.29.2 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, for example fire pump circuit.

10.29.3 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.

10.30 Protection against Undervoltage

10.30.1 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.

10.30.2 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.

10.31 Maximum Voltage Drop

10.31.1 Maximum allowable voltage-drop limits for LV installations are given below in table according to IEC 60364-1;

Type of installations	Lighting	Other uses (heating and power)
A low-voltage service connection from a LT public power distribution network	3%	5%
Consumers HT/LT substation supplied for a public distribution HT system	6%	8%

Calculation of voltage drop is recommended for new and existing circuits were problems with voltage drops were observed for normal services.

Calculation of voltage drop shall be obligatory for safety services supply circuits like sprinkler pumps, fire alarm central, etc.) and shall comply with the limits set out above.

10.32 Earthing

10.32.1 General: 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.

10.32.2 Circuit and System Earthing

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

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

10.32.2.3 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.

10.33 Methods of Earthing

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

10.33.2 Earth Conductors

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

10.33.2.2 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.

10.33.2.3 Aluminum or copper clad aluminum conductors shall not be used for final connections to earth electrodes.

10.33.2.4 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.

10.33.2.5 IEC 60364-5-54 gives the minimum sizes of copper earth conductors corresponding to the sizes of associated copper circuit conductors.

IEC 60364-5-54 Table A54.7
Minimum Cross-sectional Area of Copper Earth Conductors in Relation to the Area of Associated Phase Conductors

Cross-sectional area of line conductors **S**	**Minimum cross-sectional area of the corresponding protective conductor**	
	If the protective conductor is of the same material as the line conductor	**If the protective conductor is not of the same material as the line conductor**
(mm2)	(mm2)	(mm2)
S<=16	S	(k1/k2) x S

16<S<=35	16	(k1/k2) x 16
S>35	S/2	(k1/k2) x (S/2)

10.33.3 Earth Lead

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

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

10.33.3.3 Earthing leads shall be run in duplicate down to the earth electrode so as to increase the safety factor of the installation.

10.33.4 Earth Electrodes

10.33.4.1 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.

10.33.4.2 The following types earth electrodes are recognized: Copper rods, copper plates, galvanized iron pipes.

10.33.4.3 The following is a guideline for electrode size: Copper rods shall have a minimum diameter of 12.7 mm, GI pipes shall have a minimum diameter of 50 mm, copper plates shall not be less than 600 mm x 600 mm in size, with 6mmthickness.

10.34 Lightning Protection System (LPS)

10.34.1 General: Lighting Protection shall be provided for in accordance with the following:

10.34.1.1 Protection shall be provided against lightning depending on the probability of a strike 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 the general principles of TCVN 9888-1:2013. relevant local or international codes.

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

10.35 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 cover and protect the required area according to the LPL previously calculated.

10.36 Down Conductor

10.36.1 The down conductor is the conductor which runs from the air termination to the earth termination. The spacing of down conductors will be determined by the previously calculated class of the LPS.

Class of LPS	Typical distances (m)
I	10
II	10
III	15
IV	20

Natural components as building metallic column components might be used instead of separate down conductors depending on how the building is built and providing continuity to earth is guaranteed.

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

10.37 Earth Termination:

10.37.1 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.

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

10.37.3 Recommended dimensions for various components of lightning arrester shall be provided as each service and Lightning Protection Zone (LPZ) as defined by the designer and IEC 62305.

10.38 Electrical Inspection and Testing

10.38.1 General: Every electrical 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.

10.38.2 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 this Standard.

10.38.2.1 The periodic inspection and testing program shall generally comply with the requirements of NFPA 110 or IEC 60034.

10.38.2.2 For existing construction, thermographic inspection of electrical equipment shall be provided on a tri-annual basis. The survey shall be used to highlight potential over heating of components.

(1) Where temperature exceed 60^0C these shall be investigated further
(2) Where temperatures exceed 70^oC immediate action shall be taken to reduce the temperature.

10.39 Insulation Tests

Dielectric test shall be carried out to verify the dielectric properties of electrical equipment. The test requirements shall be in accordance with TCVN 7994-1:2009.

10.39.1 For new installations, 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:

(1)	Circuits below 230 volts	500 volts Meggar
(2)	Circuits between 230 volts to 400 volts	1000 volts Meggar

10.39.2 The minimum acceptable insulation resistance value is 5 Mega Ohms for LV cables. 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.

10.39.3 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.

10.39.4 For existing construction, insulation resistance test shall be made on all electrical equipment as prescribed above on a 5 year cycle. If the insulation resistance test was not completed at the time of installation, the testing shall be completed at this time.

10.40 Earth Resistance Test

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

10.40.2 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.

10.40.3 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.

10.40.4 Inspection of the Installation: On completion of wiring a general inspection shall be carried out by competent personnel in order to verify that the provisions of relevant national and international standards are incorporated.

11 Part 11 Alterations / Change of Use

11.1 Alterations

11.1.1 The provisions of this part are intended to maintain or increase the current degree of public safety as well as health and general welfare in existing buildings while permitting alteration, addition to or change of use. See NFPA 5000 (2015) Sections 15.3 (Repair), 15.4 (Renovation) and 15.5. (Modification) for fire and life safety issues related to the design of expansions and alterations of existing factories.

11.2 Change in Use

11.2.1 No change in use of any existing compliant factory should be undertaken without prior notification to the LABS Executive Director.

11.2.2 Where an existing building is changed to a new use group classification, the provisions for the new use group in QCVN 06 and NFPA 5000, as set in this Standard, shall be used to determine compliance.

11.3 Change in Occupancy Classification

11.3.1 No change in occupancy classification of any part of any existing compliant factory should be undertaken without prior notification to the LABS Executive Director.

11.4 Additions

11.4.1 No addition to any existing buildings shall be undertaken without permission from the permitting authority.

11.4.2 Additions to existing buildings shall comply with all the requirements of QCVN 06 and NFPA 5000 for new constructions as set in this Standard.

11.5 An existing building or portion thereof which does not comply with the requirements of QCVN 06 and NFPA 5000 for new construction, as set in this Standard, shall not be altered in such a manner that results in the building being less safe or sanitary than such building is at present.

11.6 Any construction within the site which does not have approval of the appropriate authority must be removed before any new addition, alteration or change of use is carried out.

11.7 **Investigation and Evaluation:** For the proposed works relating to alteration, addition to and change of use, the owner of the building shall cause the existing buildings to be investigated and evaluated by competent professionals in accordance with the provisions of this Standard. For structural changes in use, the competent professional shall be a LABS-qualified Structural Engineer.

11.8 Structural Analysis

11.8.1 The owner shall have a structural analysis of the existing building carried out by a LABS-qualified structural engineer to determine the adequacy of all structural systems for the proposed alteration, addition or change of use.

11.9 The owner shall make any proposed factory modifications available for visual or analytical assessment by a third party.

11.9.1 Additions or alterations to an existing building or structure are not to be made if such additions or alterations cause the building or structure to be unsafe or more hazardous based on fire safety, life and structural safety or environmental degradation.

12 Part 12 Operations and Maintenance

12.1 Fire Safety Director

12.1.1 Duties: The duties of the Fire Safety Director shall include the following:

(1) Establish internal and external rally points and communicate to all employees in the building.
(2) Fire department pre-planning.
(3) Conduct safety inspections as outlined in 12.8.
(4) Ensure all testing of fire protection equipment is conducted in accordance with 12.9.

12.2 Fire Drills

12.2.1 Fire drills shall be conducted on a regular basis as outlined in the local code. Fire drills shall be held with sufficient frequency to familiarize occupants with the drill procedure and to establish conduct of the drill as a matter of routine. Fire drills shall be conducted at least once a year. Drills shall include suitable procedures to ensure that all individuals subject to the drill participate.

12.2.2 Fire drills shall be conducted under the direction of a Fire Safety Director.

12.3 Evacuation Plan

12.3.1 The Fire Service Director shall develop a fire evacuation plan for each building.

12.3.2 Fire evacuation maps shall be posted at the entrance to each exit stair.

12.3.3 The evacuation plan shall include provisions to assist physically disabled persons. A list of all employees with physical disabilities shall be kept by the Fire Service Director.

12.4 Hot Work Permit

12.4.1 A hot work permit system program shall be enacted for all RMG facilities in accordance with NFPA 51B.

12.5 Smoking

12.5.1 Smoking shall be prohibited in any garment factory building or any associated separate storage building.

12.5.2 Signs shall be posted in the local language and English at all building entrances.

12.5.3 If an Owner creates a designated smoking area outside the buildings, information on the location of these designated areas shall be posted on the signs required in 12.4.2.

12.6 Housekeeping

12.6.1 Policy: Establish written corporate and plant policies on housekeeping to ensure scheduled cleaning for floor, wall, ceiling, supply and return air ventilation systems. Promptly reschedule skipped cleanings. Provide a documented line of authority for authorizing a cleaning delay and rescheduling. As a general rule the maximum tolerable deposit thickness for loose fluffy lint is 13 mm over a maximum of 46.5 m^2. Limit dense deposits to 6 mm and oil saturated deposits to 3.2 mm.

12.6.2 Maintain electrical systems in good working order and keep free of lint buildup to reduce the potential for ignition. This includes cleaning inside junction boxes, buses, trays, tunnels, etc.

12.7 Storage Practices

12.7.1 Management of Operating Loads: Factory Owners shall ensure that at least one trained professional individual is assigned to each factory facility as Factory Load Manager in accordance with 8.9 of this Standard.

12.7.2 Cutting tables: Storage underneath the cutting tables shall be kept clear of combustibles at all time, except as provided for miscellaneous storage or where automatic sprinkler protection is installed. Where an automatic sprinkler system is installed sprinklers are required to be installed beneath cutting tables greater than 4 ft in width that are used for storage of combustibles.

12.8 Egress: All means of egress shall be kept free and clear at all times.

12.9 Safety Inspections: A safety inspection program shall be initiated and conducted on a quarterly basis. This program shall be conducted under the direction of the Fire Safety Director. These inspections shall look for egress maintenance, condition of fire doors and opening mechanisms, storage in aisle ways, excess storage, smoking, hot work and other fire-safety related items. Records of these inspections shall be kept for LABS inspection review.

12.9.1 Construction inspections: An additional safety inspection program shall be initiated under the direction of the Fire Safety Director for any construction that occurs in an occupied facility (see Section 9.2).

12.9.2 Doors tested: Fire doors shall be tested on a quarterly basis to ensure that they are properly closing and latching. They shall also be checked for the proper label and verification that the door has not been damaged in any way.

12.10 Maintenance of Fire Protection Equipment

12.10.1 Automatic Suppression Systems: Inspection, testing and maintenance in accordance with TCVN 3890:2009 shall be conducted on all water-based fire protection systems.

12.10.2 Fire alarm and detections systems: Inspection, testing and maintenance in accordance with TCVN 3890:2009 shall be conducted on all fire alarm systems.

12.10.3 Fire extinguishers: Fire extinguishers shall be inspected, tested, and maintained in accordance with TCVN 7435-2:2004.

12.11 Equipment

12.11.1 Establish a maintenance, cleaning and lubrication schedule for all equipment. The maintenance and cleaning schedule will vary with type of fiber processed and the equipment used. Lubricate equipment in accordance with manufacturer's recommendations. Review plant fire loss records to determine whether cleaning or equipment maintenance was a factor, and increase frequency as needed.

12.12 Electrical Maintenance

12.12.1 Testing of emergency lighting: Emergency lighting provided by battery backup shall be tested on a monthly basis.

12.12.2 Generators: Generators used for emergency or standby requirements of this Standard shall be inspected, tested, and maintained in accordance with NFPA 110.

Appendix A: Scope of Works for Detailed Engineering Assessment (DEA)

In developing the DEA report the Qualified Structural Engineering Consultant (QSEC) will:

- Engage on a regular basis with the Factory and the LABS Initiative during the development of the DEA report
- Develop the DEA report such that it takes note of, builds on and provides continuity with the work done during the initial Preliminary Structural Safety Inspection phase of the RMG programme.

The DEA will comprise of work in four stages:

1. Acquiring accurate as-built information of the structure to use as input data for an analysis.
2. Analysis of the performance of the existing structure under the specified loading conditions.
3. Recommendations as to any retrofit works required to achieve adequate performance of the structure, with remedial work options if appropriate.
4. Description and design of the remedial works for the option agreed with factory and LABS Initiative. This includes the design of any propping or temporary works required.

The work required to carry out the four stages mentioned above should be documented following the format given under the 'DEA Report Contents' outlined in the 'Deliverables' section below (items 1 to 4).

The following is a non-exhaustive list of the tasks that may be necessary to complete each of the four stages mentioned above:

1. Accurate as-built information for input data for the analysis

- Architectural drawings
- Develop a full set of architectural as-built drawings (plans, elevations and sections) that accurately reflect the layout and uses of the building at each floor. These drawings must include all partitions and facades
- The structural documentation of the building
- Verification of any existing drawings that are made available. This includes site surveys to verify the data on the existing drawings or identify discrepancies
- Documentation of building surveys carried out to verify accuracy of existing drawings and/or to produce new as-built drawings
- Develop a full set of new structural as-built drawings (plans and sections) that accurately reflect the structural system and all structural elements for the building(s) under consideration. This includes all floor levels, including foundations, grade beams, ground floor, upper floor(s), roof and any partially completed floors above roof level or extensions to the existing building
- Documentation of the procedure followed for determining the real or assumed reinforcement details for all main structural elements.
- Existing load plans giving actual dead and live loading and minimum design live loading on the existing structure
- All floor uses and live load must be indicated on the architectural floor layouts
- The 'Load plan' layouts should include all dead loads (floor finishes, partitions, floor build-up in toilets or other areas, façades, machine loads, etc.), the magnitude and extent of dead loads
- Observed live loads must be indicated on layouts for all areas of the floors.
- Material properties for all structural materials
- Procedures adopted to determine the actual concrete strength. Where cores are taken then give details of number of cores, diameters and location on layouts referencing the core locations
- Details of the analysis of concrete cores to derive the concrete design strength to be used in the analysis of the actual structure
- Procedures for determining the steel type and strength of reinforcement bars and structural steel sections
- Document how existing reinforcement drawings were verified and/or ferroscaning was used in deriving

the amount of steel reinforcement assumed for the analysis of the structure
- Determination of strength for other structural materials.
- Foundation assessment
- Analysis, testing or design necessary for the foundations (further analytical work, further visual or intrusive investigations, or other)
- As-built drawings giving foundation details assumed or verified as required for the structural analysis stage.

2. Analysis of the Structure

- Loading on the structure
- Reference to load plans used to derive the loading on the structure. This should include layouts for actual dead loads and live loads, taking into consideration minimum live loads specified by the relevant guidance documents
- Details and magnitude of the wind loads and seismic loading to be adopted for the analysis.
- Analysis of the structure
- Identify all load cases to be analysed in determining the performance of the structure. Include combination for seismic load case
- Identify software to be used for the analysis of the structure
- Document assumptions made in determining the input data for the analysis; identify parameters for which standard default values are used and where actual data used.
- Analysis results
- Based on analysis results describe overall performance of the structure and indicate which elements, if any, fail to satisfy the requirements
- Consider if any load reductions can be applied to remove some of the dead or superimposed dead loads
- Indicate what type of strengthening measures could be applied to elements with insufficient capacity.
- Re-run analysis with previously under-capacity elements enhanced by strengthening measures to demonstrate overall performance of the structure
- Repeat process until satisfactory performance of all structural elements has been demonstrated.

3. Recommendations for Retrofit Works

- Elements that need strengthening
- Identify elements that need strengthening and group according to type of strengthening
- Where possible indicate different options for combinations of remedial measures that could be used to achieve satisfactory performance of the structure.
- Prepare cost estimates and outline construction sequence to demonstrate how the proposed works will impact the factory operations
- Agree remedial works option
- In consultation with the factory and LABS Initiative, evaluate the impact of the proposed remedial works on the operation of the factory
- Identify and agree a combination of measures that provides the best outcome in terms of structural performance, cost-effectiveness and factory operations

4. Design for Retrofit Works

- Elements that need strengthening
- Document structural remediation measures, using standard typical details wherever possible and include material quantities, construction time and costs.
- Any propping requirements also need to be fully identified, designed and documented by the Consultant.
- Safe Load Plans
- Interim Safe Load Plans must be produced for each floor indicating the maximum permissible live loading that the structure can safely support before remediation works are complete. These are only required where remediation works are to be carried out

- Safe Load Plans must be produced for each floor and roof level (if accessible) after the completion of the DEA and remediation process, to indicate the maximum permissible live loading that the structure can safely support once remediation works have been implemented.

The work required in carrying out the four stages mentioned above should be documented following the format given below

The Consultant shall also provide site supervision during the construction phase to ensure the construction works are implemented in accordance with the approved design and certify the works on completion.

Deliverables

The contents and layout of the DEA report should be as given below. Not all the DEA reports will need to cover all the topics mentioned in depth, but all topics should either be addressed or a brief statement provided as to why no further work required in that area.

DEA Report Contents List

Executive Summary

Summary of work carried out and key findings

1 Introduction
1.1 Brief Overview of Buildings
1.2 Requirement for DEA Report

2 Methodology for Initial Assessment Work
2.1 Existing Data Collection
2.2 Visual Inspection
2.3 As –Built Surveys
2.4 Assessment of In-Situ Material Properties

3 Detailed Description of Buildings Subject to DEA
3.1 Phases and years of construction
3.2 Structural Systems & Construction Methods
3.3 Existing Buildings Records

4 Ground Conditions
4.1 Existing Soils Data Verification
4.2 Foundation Assessment for DEA
4.3 Soil Characteristics Assumed for DEA Analysis

5 Foundations
5.1 Foundation Design Drawings
5.2 Verification of Existing Foundations

6 Structural and Architectural Drawings
6.1 Verification of Accuracy of Provided Drawings
6.2 Preparation of As-Built Architectural Drawings
6.3 Preparation of As-Built Structural Drawings
6.4 Determining Reinforcement Details

7 Material Properties
7.1 Determining Actual Concrete Strength
7.2 Determining Reinforcement Strength
7.3 Material Properties for Other Materials

8 Loading on Structure
8.1 Existing Loads on Structure
8.2 Loading Assumed for Structural Analysis

9 Analysis of Structural Performance
9.1 Analysis Tools
9.2 Input Data Used in the Analysis
9.3 Analysis Results and Conclusions of Initial Analysis
9.4 Seismic Analysis Results and Commentary
9.5 Updated Analysis Including Proposed Strengthening

10 Proposed Strengthening Measures
10.1 Strengthening Options and Recommendations
10.2 Design of Strengthening Measures

11 Preparation of Safe Load Plans
11.1 Interim Safe Load Plans
11.2 Final Safe Load Plans

12 Conclusions and Recommendations

Appendices

Appendix A
Preliminary Assessment Report (Structural Inspection Report)
Appendix B
Soils Report
Appendix C
As-Built Architectural Drawings
Appendix D
As-Built Structural Drawings
Appendix E
Ferroscan Report
Appendix F
Core Testing Results and Concrete Strength Calculation
Appendix G
Steel Reinforcement Testing
Appendix H
Other Materials Testing
Appendix I
Existing Loading Plans
Appendix J
Analysis Results
Appendix K
Strengthening Design and Drawings
Appendix L
Factory Safe Load Plans