

MULTI-LEVEL STORAGE RACKING SYSTEMS

PURPOSE

The purpose of this variance is to allow for an alternative solution for multi-level storage racking systems to be considered as special and unusual structures under the National Building Code – 2019 Alberta Edition (NBC(AE)). The NBC(AE) contains no specific requirements for multi-level storage racking systems. Manufacturers of these types of structures have requested that they be considered as special and unusual structures according to Article 3.2.2.2. and be designed according to good fire protection engineering practice.

DISCUSSION

Multi-level storage racking systems have distinctive features that distinguish these systems from high rack storage systems. In traditional high rack storage systems, access to the commodities is provided by means of ladders or robotic material handling systems. Multi-level storage racking systems, however, have intermediate work platforms designed to enable access to the stored commodities without the use of ladders.

Various safety codes officers have interpreted the design of the multi-level storage racking systems as equivalent to individual storeys, mezzanines or interconnected floor spaces. While this interpretation can be supported by the NBC(AE), the low occupant loads and the restriction on access for the general public to areas housing these systems allows for an alternative assessment as special and unusual structures. Specific conditions related to fire safety plans, fire prevention, protection and suppression, egress, signage and lighting and emergency power systems are necessary to be in place to support an assessment of these systems as special and unusual structures.

Parts 3 and 4 of the National Fire Code–2019 Alberta Edition (NFC(AE)) contain provisions for the storage of products that may affect the design of the storage racking system, therefore it is highly recommended to solicit the input of local fire prevention and/or fire department personnel prior to applying for a building permit to construct a multi-level storage racking system.

Please refer to the following publications for additional information on good fire protection engineering principles related to time-based egress analysis, occupant behaviour during fire conditions and emergency movement of building occupants:

- “The SFPE Handbook of Fire Protection Engineering, Fifth Edition”, published by Springer (ISBN 978-1-4939-2565-0)

Unless stated otherwise, all Code references in this STANDATA are to Division B of the National Building Code-2019 Alberta Edition

Issue of this STANDATA is authorized by
the Provincial Building Administrator

[Original Signed]
Paul Chang

The logo for the province of Alberta, featuring the word "Alberta" in a stylized, cursive font with a small blue square at the end of the word.

DEFINED TERMS

The words and terms in italics in this STANDATA have the following meanings that are specific to this STANDATA only and are not intended to be used in other contexts:

Access level means an intermediate walkway within a *multi-level storage racking system* for personnel access.

Multi-level storage racking system means a self-supporting structural facility within a building having one or more intermediate *access levels*.

CODE REFERENCES

Sentence 3.2.2.2.(1) states:

3.2.2.2. Special and Unusual Structures

1) A structure that cannot be identified with the characteristics of a *building* in Articles 3.2.2.20. to 3.2.2.90. shall be protected against fire spread and collapse in conformance with good fire protection engineering practice. (See Note A-3.2.2.2.(1).) (See also Notes A-3 and A-3.2.5.12.(1))

Note A-3.2.2.2.(1) states:

A-3.2.2.2.(1) Special and Unusual Structures. Examples of structures which cannot be identified with the descriptions of buildings in Articles 3.2.2.20. to 3.2.2.90. include grain elevators, refineries and towers. Publications that may be consulted to establish good engineering practice for the purposes of Article 3.2.2.2. include the NFPA Fire Protection Handbook, Factory Mutual Data Sheets, and publications of the Society for Fire Protection Engineering.

VARIANCE

This variance provides approximately equivalent or greater safety performance with respect to persons and property as that provided for by the Safety Codes Act and the NBC(AE).

Multi-level storage racking systems are permitted to be classified as special and unusual structures according to Sentence 3.2.2.2.(1), provided the following features are included in the design.

1. GENERAL

- 1.1. A *multi-level storage racking system* shall be designed for the storage, accessing, retrieval, packaging and distribution of products in conformance with the NFC(AE)
- 1.2. A fire safety plan shall be prepared and submitted along with the application for building permit in accordance with Section 2.8. and Article 3.2.2.5. of Division B of the NFC(AE)
- 1.3. A *multi-level storage racking system* shall be designed and arranged to prevent access to persons other than employees.
- 1.4. A *multi-level storage racking system* is permitted in buildings of
 - 1.4.1. medium- and low-hazard industrial occupancies, or
 - 1.4.2. mercantile occupancies.
- 1.5. A *multi-level storage racking system* is not required to conform to the requirements of Subsection 3.2.6. or Section 3.8.

2. CONSTRUCTION

- 2.1. All structural and supporting elements of a *multi-level storage racking system*, including posts, beams, decks, *access levels*, connections, concrete slabs and foundation elements, shall
 - 2.1.1. be designed in accordance with Part 4,
 - 2.1.2. have a flame-spread rating not more than 25, and
 - 2.1.3. have a smoke developed classification not more than 50.
- 2.2. Except as required by Item 2.3., *access levels* shall be of open construction consisting of steel grating or open steel floor planking, with not less than 70% open face area.
- 2.3. *Access levels* shall be of solid construction consisting of steel plate or steel roof decking with a top substrate that forms a serviceable floor area where the *multi-level storage racking system* is designed to store
 - 2.3.1. Group A, B or C plastics, as defined in NFPA 13, "Installation of Sprinkler Systems,"
 - 2.3.2. rubber tires, or
 - 2.3.3. combustible fibres.
- 2.4. Guards in conformance with Article 3.3.1.18. shall be provided
 - 2.4.1. at all edges of *access levels*, and
 - 2.4.2. around all openings between *access levels*.
- 2.5. Toe-boards extending from the surface of the *access level* to a height not less than 125 mm above the surface of the *access level* shall be provided
 - 2.5.1. at all edges of *access levels*, and
 - 2.5.2. around all openings between *access levels*.
- 2.6. Except where the *access levels* are of open construction as required by Item 2.2., noncombustible draft stops extending to not less than 450 mm below the surface of the *access level* above shall be provided
 - 2.6.1. at all edges of *access levels*, and
 - 2.6.2. around all openings between *access levels*.
- 2.7. All *access levels*, including the ground floor level, of a *multi-level storage racking system* shall have a headroom clearance not less than 2100 mm, including any projections by sprinkler heads, piping or building services.

3. SIGNAGE

- 3.1. A sign shall be posted in a conspicuous location on each *access level* to indicate the maximum permissible design loads for each *access level* in a *multi-level storage racking system*.
- 3.2. Signs prohibiting smoking shall be posted in conspicuous locations on each *access level* in conformance with Article 2.4.2.2. of Division B of the NFC(AE).

4. LIGHTING AND EMERGENCY POWER SYSTEMS

- 4.1. Every *access level* shall be equipped to provide illumination at floor or tread level and at angles and intersections at changes of level where there are stairs or ramps to an average level not less than
 - 4.1.1. 50 lx for regular lighting, and
 - 4.1.2. 10 lx for emergency lighting.

- 4.2. An emergency power supply shall be provided in accordance with Subsection 3.2.7.

5. FIRE PREVENTION

5.1. Portable Extinguishers

- 5.1.1. Every *access level* shall be provided with portable extinguishers in conformance with the NFPA 10 as referenced in the NFC(AE).

5.2. Fire Alarm and Detection Systems

- 5.2.1. A fire alarm system complying with Subsection 3.2.4. shall be installed.
- 5.2.2. In addition to the requirements of Subsection 3.2.4., every egress stair shall be provided with manual stations
- 5.2.2.1. at the entrance to each egress stair on every *access level*, and
- 5.2.2.2. at the bottom of each egress stair at the ground floor level.

5.3. Provisions for Firefighting

- 5.3.1. A floor area containing a *multi-level storage racking system* shall be protected by an automatic sprinkler system that shall be designed, constructed, installed and tested in conformance with
- 5.3.1.1. NFPA 13, "Installation of Sprinkler Systems", or
- 5.3.1.2. the appropriate NFPA standard for the most severe hazard to which the *multi-level storage racking system* is exposed.
- 5.3.2. Notwithstanding any of the provisions of the standards in Item 5.3.1., sprinkler protection shall be provided under all platforms and *access levels*.
- 5.3.3. Combustible sprinkler piping is not permitted in a *multi-level storage racking system*.
- 5.3.4. Equipment forming part of a fire protection system shall be protected from freezing if
- 5.3.4.1. it could be adversely affected by freezing temperatures, or
- 5.3.4.2. it is located in an unheated area.

6. EXITS AND AISLES

- 6.1. Aisles within a *multi-level storage racking system* shall conform to the NFC(AE).
- 6.2. Except as permitted by Item 6.3., each *access level* of a *multi-level storage racking system* shall be provided with not less than two egress stairs located remotely from each other and located so that the travel distance from anywhere on the *multi-level storage racking system* to the nearest egress stair shall be not more than 15 m.
- 6.3. Any single *access level* in a *multi-level storage racking system* may be served by a single egress stair leading to the *access level* immediately below provided,
- 6.3.1. the *access level* is not more than 200 m² in area, including the area occupied by the storage racks,
- 6.3.2. the travel distance from any point on the *access level* to the bottom of the egress stair on the *access level* below, including the travel distance along the egress stair, is not more than 25 m, and
- 6.3.3. the *access level* below is provided with two separate egress stairs or exits.
- 6.4. Egress stairs required by Items 6.2. or 6.3. may be provided by means of open, unenclosed stairs serving,
- 6.4.1. not more than four *access levels*, where the *multi-level storage racking system* is intended for the storage of commodities, and

- 6.4.2. not more than two *access levels*, where the *multi-level storage racking system* is intended for the storage of plastics, rubber tires or combustible fibres.
- 6.5. Except as permitted by Item 6.6., the maximum travel distance from the bottom of an egress stair to an exit along a main aisle at the ground floor level shall be not more than 30 m.
- 6.6. The maximum travel distance required by Item 6.5. is permitted to be more than 30 m, provided a time-based egress analysis has been performed using the following formula:

$$T_{ET} = \left[\left(\frac{H_{td}}{H_s} \right) + \left(\frac{V_{td}}{V_s} \right) + \left(\frac{M_{td}}{M_s} \right) + (T_{lg} \cdot N_{lg}) + (T_{co} \cdot N_{co}) \right] * SF$$

where:

- T_{ET} = the total egress time from the bottom of an egress stair to an exit, not more than 4 min.,
- H_{td} = horizontal travel distance within the *multi-level storage racking system*, in metres,
- H_s = occupant egress speed not more than 1.0 m/sec for horizontal egress routes,
- V_{td} = vertical travel distance within the *multi-level storage racking system*, in metres, measured on the diagonal along the nosing of the stairs,
- V_s = occupant egress speed not more than 0.6 m/sec for vertical egress routes,
- M_{td} = horizontal travel distance on the main floor, in metres,
- M_s = occupant egress speed not more than 1.0 m/sec for horizontal egress routes on the main floor,
- T_{lg} = time assigned to each lift gate within an egress route, not less than 10 sec,
- N_{lg} = number of lift gates in the egress route,
- T_{co} = time assigned to each at-level conveyor cross-over, not less than 5 sec,
- N_{co} = number of at-level conveyor cross-overs in the egress route,
- SF = safety factor, not less than 1.5.

- 6.7. The occupant load on each level of the *multi-level storage racking system* shall not exceed 10 persons per egress stair.
- 6.8. A dead end aisle shall not exceed 6 m where the platform or walkway is provided with two or more egress stairs or exits.
- 6.9. Conveyors, trolleys, tracks or any other similar mode of product transportation within the aisle or walkway shall not reduce the clear widths required by the NFC(AE).
- 6.10. A single egress route shall contain
 - 6.10.1. not more than two lift-gates,
 - 6.10.2. not more than two at-level conveyor cross-overs, or
 - 6.10.3. not more than one lift-gate and not more than one at-level conveyor cross-over.
- 6.11. Where a lift-gate is incorporated along an egress route, each lift-gate shall be
 - 6.11.1. equipped with a positive lock when open, and

- 6.11.2. designed to automatically stop the conveyor belt that it serves when the lift-gate is open.
- 6.12. Where an at-level conveyor cross-over is incorporated along an egress route,
 - 6.12.1. handrails spaced not more than 1 m apart and parallel to the direction of travel shall be provided on both sides of the at-level conveyor cross-over,
 - 6.12.2. a clearly identified and easily accessible switch that will stop the conveyor shall be located at each at-level conveyor cross-over, and
 - 6.12.3. stairs approaching at-level conveyor cross-overs shall be marked to indicate that they are readily identifiable as part of the egress route.

This VARIANCE is applicable throughout the Province of Alberta.