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Proposed Change 1914

Code Reference(s):	NFC20 Div.B 5.5.5.1. (first printing)
Subject:	Dangerous Goods — Laboratories
Title:	Maximum Quantities of Dangerous Goods Kept in Laboratories
Description:	This proposed change revises Article 5.5.5.1. to require that quantities of all classes of dangerous goods, including compressed gases, be minimized and to provide the maximum quantities permitted for use in laboratories.

This change could potentially affect the following topic areas:

- | | |
|--|--|
| <input type="checkbox"/> Division A | <input checked="" type="checkbox"/> Division B |
| <input type="checkbox"/> Division C | <input type="checkbox"/> Design and Construction |
| <input checked="" type="checkbox"/> Building operations | <input type="checkbox"/> Housing |
| <input checked="" type="checkbox"/> Small Buildings | <input checked="" type="checkbox"/> Large Buildings |
| <input type="checkbox"/> Fire Protection | <input type="checkbox"/> Occupant safety in use |
| <input type="checkbox"/> Accessibility | <input type="checkbox"/> Structural Requirements |
| <input type="checkbox"/> Building Envelope | <input type="checkbox"/> Energy Efficiency |
| <input type="checkbox"/> Heating, Ventilating and Air Conditioning | <input type="checkbox"/> Plumbing |
| | <input type="checkbox"/> Construction and Demolition Sites |

Problem

The storage of dangerous goods classified as flammable liquids, combustible liquids and compressed gases is permitted within a fire compartment in accordance with Subsections 3.2.8. and 3.2.9. of the National Fire Code of Canada (NFC) 2020. Article 5.5.5.1. provides the maximum quantities of dangerous goods classified as flammable liquids and combustible liquids for use and storage in laboratories; however, Article 5.5.5.1. does not cover compressed gases by specifying the maximum quantities.

Small quantities of compressed gases that fall below the maximum quantities stated in Table 3.2.7.1. are exempted from the requirements of Subsection 3.2.7. Subsection 3.2.8. applies to the indoor storage of dangerous goods classified as flammable, toxic and oxidizing gases. However, the requirements in Articles 3.2.8.2. and 3.2.8.3. may be overly onerous or impractical for a laboratory in terms of the limitations on the quantities of compressed gases, construction of the storage room,

and storage of other materials. These requirements could lead to unnecessary construction costs and operation difficulties for laboratories. As such, there is a need to permit the storage of small quantities of compressed gases in laboratories.

There is a distinction between the permitted quantities of "in use" dangerous goods and "for use" dangerous goods, and both are distinct from stored dangerous goods. The quantity of compressed gases considered to be "in use" is not currently regulated since compressed gases in cylinders that are connected to equipment are not included in the calculation of the in-storage volume since they are classified as "in use". But the hazards associated with the presence of cylinders of dangerous goods classified as compressed gases in laboratories that are used for experiments, measurement, etc. are equivalent to the hazards associated with them in storage. Moreover, in a laboratory setting, the presence of "in use" compressed gases in cylinders may be increased in various research fields, e.g., microbiology, which requires an increased number of cylinders for use in labs with microbiological incubators.

Sentence 5.5.5.1.(1), supported by its explanatory Note, currently sets the limit on the quantities of dangerous goods, excluding compressed gases, that are actually "in use" during normal operations. Regardless, the quantities of dangerous goods in a laboratory should be limited in accordance with Table 3.2.7.1. whether or not the dangerous goods are "in use" during normal operations.

In addition, the existing NFC requirements may unintentionally permit increased quantities of "for use" (i.e., quantities "in use" and quantities kept outside of storage areas) dangerous goods in a laboratory by not limiting the quantities of these goods that are stored and kept in the laboratory on a non-permanent basis and that are not connected to equipment. Limiting these quantities is one of the main reasons why this proposed change introduces requirements on "for use" dangerous goods.

Therefore, this proposed change limits the maximum quantities of dangerous goods, including compressed gases, used in laboratories and refers Code users to Parts 3 and 4 for the storage requirements for dangerous goods.

Justification

The quantities of dangerous goods classified as compressed gases in a laboratory within a fire compartment that are either "for use" (inclusive of the quantity of "in use" dangerous goods) or stored for future use present the same hazard to people and the building in a fire emergency, upon accidental release of the gases into the atmosphere. When a cylinder of compressed gases is exposed to flame, the hazard associated with the expansion of the gas inside the cylinder is identical whether the cylinder is for use, in use or stored. Therefore, in laboratories, it is necessary to limit the quantities of compressed gases that are not in storage to reduce the fire and explosion risk to the building and occupants.

In 2009, there was a fire in the zoology building at the University of Manitoba which resulted in millions of dollars in damages. The fire occurred in a building that stored about 250 different types of chemicals. Toxic fumes from the fire resulted in the

evacuation of other parts of the campus not directly affected by the fire and deterred firefighters and hazardous materials personnel from approaching the site for an extended period time, which allowed the fire to spread beyond the laboratories.

It is understood that some quantities of dangerous goods are required to ensure the normal operation of the various experiments in laboratories; however, the vast majority of cylinders of dangerous goods classified as compressed gases found in laboratories pose a serious threat to the safety of people, first responders and to the building.

In addition to the exemptions for small quantities of dangerous goods previously mentioned in Part 3, Part 4 also permits small quantities of these goods classified as flammable liquids and combustible liquids to be located outside of a cabinet or storage room in certain situations. These exemptions are provided on the basis that they do not pose a significant hazard to persons, buildings or facilities and should also apply to the quantities of dangerous goods used in laboratories.

In other words, the quantities of dangerous goods that are in use must not exceed the small quantities exempted from the storage requirements in Parts 3 and 4 to help avoid situations where a large quantity of these dangerous goods still presents a high risk.

To address these concerns, Sentence 5.5.5.1.(1)-2025 provides restrictions on the permitted quantities of "for use" dangerous goods in a laboratory. The concept of "for use" dangerous goods is introduced to refer to the limited quantities of dangerous goods that exist in a laboratory, whether they are connected (i.e., "in use") or intended to be connected to equipment (i.e., kept outside of storage areas) during normal operations. Explanatory Note A-5.5.5.1.-2025 further clarifies the meaning of "for use" and "in use".

Since small quantities of dangerous goods that are frequently needed are permitted to be kept in the laboratory, the quantities of "for use" dangerous goods are typically greater than those of "in use" dangerous goods. The quantities of "for use" dangerous goods in a laboratory should be minimized. They should not exceed the quantities allowed in a single fire compartment that are exempted from the requirements for designated storage areas and cabinets as stated in Parts 3 and 4, on the basis that they present at least the same level of risk whether they are stored or connected to equipment, i.e., "in use" during normal operations. The intent of Clause 5.5.5.1.(1)(b) is to remind Code users that the storage of large quantities of dangerous goods needs to comply with the storage requirements in Parts 3 and 4 outside of the laboratory.

Sentence 5.5.5.1.(2)-2025 provides the maximum quantities of dangerous goods classified as flammable liquids and combustible liquids permitted for use in laboratories. The importance of locating the limited quantities of dangerous goods specifically in the basement of a laboratory, i.e., one or more storeys below the first storey of the laboratory's building, is based on the fact that vapours from dangerous goods classified as flammable liquids and combustible liquids are typically heavier than air and dedicated ventilation on the floor level, or natural ventilation to open air, may be expected to be less effective in a basement.

For the purpose of this Section, a "laboratory" is defined as a room or facility where dangerous goods are used, stored for use or handled for experimental purposes; however, the definition does not distinguish between laboratories in educational, hospital or industrial settings.

Clause 5.5.5.1.(1)(b)-2025 is only applicable to Group A, Division 2 educational occupancies or Group D major occupancies, but not Group B occupancies. The fire hazard associated with laboratories is relatively the same in all occupancies; however, the personal safety hazard is greater in Group B major occupancies. Group B occupancies include Division 1 detention occupancies, Division 2 treatment occupancies, and Division 3 care occupancies.

Therefore, the quantities of dangerous goods in a Group B major occupancy are determined in accordance with Sentence 4.2.6.3.(1), which allows lesser quantities than the revised Clause 5.5.5.1.(2)(b) applying to Group A, Division 2 or a Group D occupancies.

Sentence 5.5.5.1.(1)-2025 is intended to clarify that the specific requirements of Section 5.5. override those of Parts 3 and 4 in case of conflict and to direct Code users to Parts 3 and 4 for requirements for the storage of dangerous goods outside laboratories. This new Sentence would mean that dangerous goods used in areas other than laboratories are required to comply with other NFC requirements and that, where the Section is silent, other NFC requirements are applicable to laboratories. For example, Class 1 flammable liquids are limited to 10 L in a basement in accordance with Sentence 4.1.5.8.(1).

Sentence 5.5.5.1.(3)-2025 provides the maximum quantities of dangerous goods classified as compressed gases permitted for use in laboratories, similar to the requirements for dangerous goods classified as flammable liquids and combustible liquids. To establish the maximum quantities, the limits listed in Table 6.3.1.1. of the NFPA 55-2020, "Compressed Gases and Cryogenic Fluids Code," were considered and converted into metric units (m³) from imperial units (ft.³).

The maximum allowable quantity of hazardous materials per control area is specified in Table 6.3.1.1 of NFPA 55. See Table 1 for a comparison of maximum quantities proposed for the NFC and in NFPA 55.

Table 1. Maximum Quantities of Hazardous Materials

Type of Hazardous Material	NFC		NFPA 55
	Sentence 5.5.5.1.(4)-2025		Table 6.3.1.1
	Sprinklered m ³ (ft. ³)	Unsprinklered m ³ (ft. ³)	m ³ (ft. ³) ⁽¹⁾
Flammable gas	56 (1 978)	28 (938)	approximately 28 m ³ (1 000)
Oxidizing gas	85 (3 000)	43 (1 519)	approximately 43 m ³ (1 500)
Toxic gas	46 (1 623)	23 (812)	approximately 23 m ³ (810)

Note to Table 1:

(1) Values in lb. were converted to ft.³ using the following equation: Volume of total gas in ft.³ = (lb. gas) × [379.3(ideal gas law conversion factor) ft.³/lb.-mole] ÷ (molecular weight of gas in lb./lb.-mole). The quantity limit in Table 6.3.1.1 of NFPA 55 is at 50% reduced capacity. The limit is permitted to be 100% when automatic sprinklers are installed in accordance with NFPA 13, "Standard for the Installation of Sprinkler Systems," which is consistent with the conditions stated in the NFC.

This proposed change restricts the quantities permitted in buildings depending on whether a sprinkler system is provided. The quantities permitted for the Group A, Division 2 educational occupancy and Group B major occupancies are reduced by 50%. This practice is generally consistent with the NFPA 55 limits for low hazard laboratories.

Sentence 5.5.5.1.(4)-2025 clarifies that the quantities in the piping system do not need to be counted towards the maximum quantities specified in Sentences (2) and (3)-2025. The piping system that supplies dangerous goods from an external source (such as a storage tank) to the laboratory is typically equipped with a remote device to control the shut-off valve. Articles 4.5.7.2. and 4.5.9.4. provide shut-off requirements for dangerous goods classified as flammable liquids and combustible liquids.

Clause 5.5.5.3.(3)(b) requires that each point of supply and use of cylinders or piping systems for dangerous goods classified as compressed gases be provided with a manual shut-off valve. As such, the amount contained in the piping systems is exempted when maximum allowable quantities are calculated.

This proposed change would help avoid situations where large quantities of dangerous goods exist (either stored or used) in laboratories. It would permit a maximum quantity of dangerous goods for use inside laboratories based on the types of materials, location, occupancy and existence of a sprinkler system.

EXISTING PROVISION

5.5.5.1. Maximum Quantities

- 1) The quantity of *dangerous goods* kept in a laboratory shall be minimized and shall not exceed the lesser of
 - a) the supply necessary for normal operation, or
 - b) when located in
 - i) a Group A, Division 2 educational or a Group D *major occupancy*, 300 L of *flammable liquids* and *combustible liquids*, of which not more than 50 L shall be Class I liquids, or
 - ii) a Group B *major occupancy*, the quantities of *flammable liquids* and *combustible liquids* permitted in Sentence 4.2.6.3.(1).

(See Note A-5.5.5.1.(1).)

- 2) Quantities of *flammable liquids* and *combustible liquids* in excess of those permitted in Sentence (1) shall be stored in
 - a) cabinets conforming to Subsection 4.2.10. except that, in laboratories described in Clause (1)(b), the total quantity of *flammable liquids* and *combustible liquids* stored in such cabinets shall not exceed the quantity permitted for one cabinet, or
 - b) a room conforming to Subsection 4.2.9.
- 3) Quantities of *dangerous goods* other than *flammable liquids* and *combustible liquids* in excess of those permitted in Sentence (1) shall be stored outside of the laboratory in conformance with Part 3.

Note A-5.5.5.1.(1)

The intent of Sentence 5.5.5.1.(1) is to limit the quantities of dangerous goods that are

- a. stored outside of storage areas and cabinets referred to in Sentences 5.5.5.1.(2) and (3),
- b. kept in the laboratory on a permanent or semi-permanent basis, e.g. dangerous goods that are normally kept out overnight because they are frequently needed, and
- c. connected to equipment and/or devices required to conduct an experiment in the laboratory.

The intent is also to limit the quantities of dangerous goods that are actually "in use" during normal operations and those used for special experiments or processes, which may require that greater quantities be brought into the laboratory for the duration of these operations.

However, the quantities of dangerous goods in a laboratory should be limited to the quantities allowed in a single fire compartment as stated in Part 3, on the basis that they present at least the same level of risk whether they are stored or connected to equipment, i.e. "in use" during normal operations.

PROPOSED CHANGE

[5.5.5.1.] 5.5.5.1. Maximum Quantities

(See Note A-5.5.5.1.)

[1] --) Except as provided in Sentences (2) and (3)-2025, the quantities of dangerous goods available for use in a laboratory shall be kept to a minimum and shall

[a] --) not exceed the quantities necessary for normal operations, and

[b] --) be stored outside the laboratory in conformance with Part 3 or 4.

[2] 1) The quantities ~~ies~~ of dangerous goods classified as flammable liquids or combustible liquids ~~kept~~ available for use in a laboratory shall be ~~minimized~~ kept to a minimum and shall not exceed ~~the lesser of~~

[a] a) when located in a basement, the supply necessary for normal operation ~~quantities permitted in Part 4, or~~

[b] b) when located in a Group A, Division 2 educational or Group D major occupancy not in a basement, 300 L of which not more than 50 L shall be Class I liquids.

[i] i) ~~a Group A, Division 2 educational or a Group D major occupancy, 300 L of flammable liquids and combustible liquids, of which not more than 50 L shall be Class I liquids, or~~

[ii] ii) ~~a Group B major occupancy, the quantities of flammable liquids and combustible liquids permitted in Sentence 4.2.6.3.(1).~~

~~(See Note A-5.5.5.1.(1).)~~

[3] --) The quantities of dangerous goods classified as compressed gases that

are kept in the open area of a laboratory in a building containing any major occupancy other than an industrial occupancy shall not exceed

- [a] --) in a sprinklered building,
- [i] --) 56 m³ of dangerous goods classified as flammable gases,
 - [ii] --) 85 m³ of dangerous goods classified as oxidizing gases, or
 - [iii] --) 46 m³ of dangerous goods classified as toxic gases,
- [b] --) in a building that is not sprinklered,
- [i] --) 28 m³ of dangerous goods classified as flammable gases,
 - [ii] --) 43 m³ of dangerous goods classified as oxidizing gases, or
 - [iii] --) 23 m³ of dangerous goods classified as toxic gases, or
- [c] --) in a building containing a Group A, Division 2 educational or Group B major occupancy, 50% of the quantities stated in Clauses (a) and (b).

(See Note A-3.2.8.2.(2).)

[4] --) The quantities of dangerous goods permitted by Sentences (1) to (3)-2025 do not include the quantities of dangerous goods contained in piping systems conveying the dangerous goods from an external source to the laboratory.

~~**[5] 2)** Quantities of flammable liquids and combustible liquids in excess of those permitted in Sentence (1) shall be stored in~~

~~[a] a) cabinets conforming to Subsection 4.2.10. except that, in laboratories described in Clause (1)(b), the total quantity of flammable liquids and combustible liquids stored in such cabinets shall not exceed the quantity permitted for one cabinet, or~~

~~[b] b) a room conforming to Subsection 4.2.9.~~

~~**[6] 3)** Quantities of dangerous goods other than flammable liquids and combustible liquids in excess of those permitted in Sentence (1) shall be stored outside of the laboratory in conformance with Part 3.~~

Note A-5.5.5.1.(1)

~~The intent of Sentence 5.5.5.1.(1) Article 5.5.5.1. is to~~ limits the quantities of dangerous goods classified as flammable liquids, combustible liquids or compressed gases that are available for use in a laboratory, including quantities that are

- stored outside of storage areas and cabinets ~~referred to in Sentences 5.5.5.1.(2) and (3),~~
- kept in the laboratory on a permanent or semi-permanent basis, (e.g. dangerous goods that are normally kept out overnight because they are frequently needed), and
- connected, or intended to be connected, to equipment ~~and/or~~ devices required to conduct an experiment in the laboratory.

The ~~intent is also to~~ limits stated in Article 5.5.5.1. include the quantities of dangerous goods that are actually "in use" during normal operations and ~~those~~ the quantities used ~~during~~ for special experiments or processes, which may require that greater quantities be brought into the laboratory for the duration of these operations.

Small quantities of dangerous goods may be stored in a laboratory because they are frequently needed. As such, the quantities of dangerous goods available for use in a laboratory are typically greater than the quantities actually in use. However, the quantities of dangerous goods ~~available for use in a laboratory~~ should be minimized. limited to They should not exceed the quantities ~~allowed~~ in a single fire compartment that are exempted from the requirements for storage in designated areas or cabinets as stated in Parts 3 and 4, on the basis that they present at least the same level of risk whether they are stored or connected to equipment₇ (i.e. “in use” during normal operations).

Impact analysis

There are many different types of indoor and outdoor storage cabinets that are commercially available and compliant with the Code requirements. Some additional cost is expected if installation of additional storage cabinets is necessary, whether the cabinets are located indoors or outdoors, in order to limit the quantities of dangerous goods in laboratories. The overall cost of the installation of storage cabinets differs greatly according to their specifications (hazardous material class, indoor or outdoor, capacity, presence of fume hood, etc.) and ranges between \$300 and over \$40,000.

It is also expected that such costs can be minimized by implementing better storage practices of the quantities of dangerous goods in laboratories and allocating a dedicated storage room. The storage of dangerous goods should already comply with the current Code requirements in Parts 3 and 4, so no additional cost is anticipated. Instead of storing excess amounts of dangerous goods, more frequent scheduled delivery of goods would minimize the risks associated with storing such goods without having a negative impact on the scheduled experimental work.

Providing maximum allowable quantities for occupancies including educational and Group B major occupancies would minimize the serious threat to the safety of people and first responders, and to the building.

Enforcement implications

This proposed change regarding dangerous goods classified as compressed gases is consistent with the requirements of NFPA 55, which facilitates the enforcement the Code requirements by the industry and authorities having jurisdiction.

This proposed change is intended to provide descriptive information on maximum quantities of dangerous goods allowed in a laboratory, which should aid in the understanding and enforcement of the Code.

Who is affected

Designers, building officials, fire services, building operations personnel and contractors.

OBJECTIVE-BASED ANALYSIS OF NEW OR CHANGED PROVISIONS

[5.5.5.1.] -- ([1] --) (a) [F02-OS1.2]

[5.5.5.1.] -- ([1] --) (a) [F02-OP1.2]

[5.5.5.1.] -- ([1] --) (b)

[5.5.5.1.] 5.5.5.1. ([2] 1) ([a] a)

[5.5.5.1.] 5.5.5.1. ([2] 1) ([b] b) [F02-OS1.2]

[5.5.5.1.] 5.5.5.1. ([2] 1) ([b] b) [F02-OP1.2]

[5.5.5.1.] -- ([3] --) [F02-OS1.2]

[5.5.5.1.] -- ([3] --) [F02-OP1.2]

[5.5.5.1.] -- ([4] --) no attributions

~~[5.5.5.1.] 5.5.5.1. ([5] 2) ([a] a), ([b] b)~~

~~[5.5.5.1.] 5.5.5.1. ([5] 2) ([a] a)~~

~~[5.5.5.1.] 5.5.5.1. ([6] 3) [F02-OS1.2]~~

~~[5.5.5.1.] 5.5.5.1. ([6] 3) [F02-OP1.2]~~

~~[5.5.5.1.] 5.5.5.1. ([6] 3) no attributions~~