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## Proposed Change 1777

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<b>Code Reference(s):</b>	<b>NBC20 Div.B 2.2. (first printing)</b>
Subject:	Large Farm Buildings (General)
Title:	Spatial Separation and Exposure Protection
Description:	This proposed change introduces requirements for the spatial separation and exposure protection of large farm buildings.
Related Code Change Request(s):	CCR 1570
Related Proposed Change(s):	PCF 1918, PCF 1919, PCF 1935, PCF 1936

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 checked="" type="checkbox"/> Design and Construction |
| <input type="checkbox"/> Building operations                       | <input type="checkbox"/> Housing                            |
| <input type="checkbox"/> Small Buildings                           | <input checked="" type="checkbox"/> Large Buildings         |
| <input checked="" 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  |

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## Problem

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Farm buildings are unique occupancies having unique uses, hazards and expected performance. The NBC 2020 introduced Part 2 to acknowledge this fact by providing suitable minimum requirements for large farm buildings and agricultural occupancies.

NBC Part 2 provisions comprise a model set of minimum requirements for large farm buildings, with the objective being to limit the probability that, as a result of the design, construction or demolition of the building, a person in or adjacent to the building will be exposed to an unacceptable risk of injury; and, more specifically, to limit the probability that a person will be exposed to an unacceptable risk of injury due to fire, structural failure or other hazards.

As originally directed by the Executive Committee of the Canadian Commission on Building and Fire Codes (EC), the overriding objective of the Part 2 requirements is the safety of persons in large farm buildings. Property protection objectives for farm buildings were not considered in the development of the technical requirements.

The requirements for farm buildings in Part 2 tend to include some relaxations of similar requirements for other occupancies. The rationale for this approach is based on the remote location of typical farm buildings and the specific characteristics of their occupants, namely:

- low human occupant load,
- typically familiar with the layout of the building,
- tend to be only in the building for short duration at limited times throughout a day, depending on specific farm building use,
- not typically members of the public, and
- not typically vulnerable.

Many farm buildings are constructed adjacent to property lines, public thoroughfares and non-farm buildings on the same property. The adjacent non-farm buildings have property protection objectives that must be satisfied. However, the lack of spatial separation requirements for Part 2 farm buildings does not provide the guidance necessary for designers to appropriately protect these adjacent properties and non-farm buildings from fires originating in farm buildings.

During the development of the technical requirements in the 2020 Code cycle, it was determined that spatial separation requirements should be developed for the large farm buildings covered by Part 2. These proposed requirements were not included in the NBC 2020. However, it was recommended that this issue be revisited during the 2025 Code cycle as the EC has confirmed through the property protection objective (i.e., OP3.1) that spatial separation requirements for large farm buildings may be considered.

Part 2 has few requirements for fire separations within large farm buildings. However, the occupant safety objectives (i.e., OS1.2 and OS1.5) relating to exposure protection between fire compartments and the protection of exits, which are typically grouped with spatial separation requirements, are important to capture in Part 2. These occupant safety requirements directly relate to the intent of Part 2.

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## Justification

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While the intent of Part 2 is related to occupant safety, property protection objectives are required to be considered for adjacent buildings of other occupancy classifications and adjacent properties.

The spatial separation and exposure protection requirements are well developed in Subsection 3.2.3. For familiarity and clarity, this proposed change refers to these requirements.

Proposed Article 2.2.9.1. states the application of proposed Subsection 2.2.9. Sentence (1) establishes the spatial separation requirements for farm buildings to property lines, streets, lanes, public thoroughfares, farm buildings or non-farm buildings on the same property, and how this separation should be calculated. Sentence (2) requires that farm buildings be subjected to the applicable requirements for exposure protection in Subsection 3.2.3. Sentence (3) provides an exemption to the application of Sentence 3.2.3.1.(8) regarding fire department response time, as response time in rural areas will generally be more than 10 minutes. Existing rural firefighting services are well prepared to carry out their

operations in rural areas for agricultural or other occupancies located in the countryside. Given the low density of development in rural areas, it would be unreasonable to impose the requirements of Sentence 3.2.3.1.(8).

Proposed Article 2.2.9.2. provides requirements related to limiting distance and area of unprotected openings for specific major occupancies by referring to Tables 3.2.3.1.-B and -C. Sentence 3) provides a relaxation of the spatial separation requirements between two exposing building faces of farm buildings with a G1 occupancy containing livestock and having below-floor storage areas for liquid manure, G2, G3 and G4 occupancies because these occupancies present a lower risk of fire spread and to the safety of persons in a fire. No relaxation is permitted for a Group G, Division 1 major occupancy, other than one containing livestock and having below-floor storage areas for liquid manure, because this specific occupancy, and the activities within the building, presents a higher fire or explosion risk that may lead to more severe damage to adjacent buildings. This approach is consistent with the intent of Part 2.

Proposed Article 2.2.9.3. provides requirements for the construction of the exposing building face for specific major occupancies by referring to Table 3.2.3.7.

When establishing the requirements in proposed Articles 2.2.9.2. and 2.2.9.3., differentiation was made between Group G, Division 1 major occupancy, other than one housing livestock having below-floor storage areas for liquid manure, and the other Group G major occupancies because the former presents a higher fire or explosion risk due to the anticipated activities within the building. As such, this occupancy needs to comply with relatively more stringent requirements.

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## **PROPOSED CHANGE**

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### **[2.2.] 2.2. Fire Protection and Occupant Safety**

#### **[2.2.1.] 2.2.1. General**

##### **[2.2.1.1.] 2.2.1.1. Classification**

##### **[2.2.1.2.] 2.2.1.2. Prohibition of Occupancy Combinations**

##### **[2.2.1.3.] 2.2.1.3. Exceptions for Major Occupancies**

##### **[2.2.1.4.] 2.2.1.4. Separation of Occupancies**

##### **[2.2.1.5.] 2.2.1.5. Fire Separations and Closures**

##### **[2.2.1.6.] 2.2.1.6. Penetrations in Fire Separations and Fire-Rated Assemblies**

##### **[2.2.1.7.] 2.2.1.7. Firewalls**

##### **[2.2.1.8.] 2.2.1.8. Fire Blocks**

##### **[2.2.1.9.] 2.2.1.9. Additional Fire Separations**

##### **[2.2.1.10.] 2.2.1.10. Determination of Fire-Resistance Ratings**

##### **[2.2.1.11.] 2.2.1.11. Determination of Flame-Spread Ratings**

##### **[2.2.1.12.] 2.2.1.12. Flame-Spread Rating**

##### **[2.2.1.13.] 2.2.1.13. Foamed Plastics**

##### **[2.2.1.14.] 2.2.1.14. Fabrics and Films**

##### **[2.2.1.15.] 2.2.1.15. Electrical Wiring and Equipment**

##### **[2.2.1.16.] 2.2.1.16. Wires and Cables**

##### **[2.2.1.17.] 2.2.1.17. Occupant Load**

#### **[2.2.2.] 2.2.2. Building Size and Construction Relative to Major Occupancy**

##### **[2.2.2.1.] 2.2.2.1. Farm Buildings with Multiple Agricultural Major Occupancies**

##### **[2.2.2.2.] 2.2.2.2. Exceptions in Determining Building Height**

##### **[2.2.2.3.] 2.2.2.3. Group G, Division 1, up to 3 Storeys, Limited Area, Sprinklered**

**[\[2.2.2.4.\]](#) 2.2.2.4. Group G, Division 1, One Storey**

**[\[2.2.2.5.\]](#) 2.2.2.5. Group G, Division 2, Any Height, Any Area, Sprinklered**

**[\[2.2.2.6.\]](#) 2.2.2.6. Group G, Division 2, up to 3 Storeys, Any Area**

**[\[2.2.2.7.\]](#) 2.2.2.7. Group G, Division 3, One Storey, Any Area**

**[\[2.2.2.8.\]](#) 2.2.2.8. Group G, Division 4, Any Height, Any Area**

## **[\[2.2.3.\]](#) 2.2.3. Fire Alarm and Detection Systems**

**[\[2.2.3.1.\]](#) 2.2.3.1. Determination of Requirement for a Fire Alarm System**

**[\[2.2.3.2.\]](#) 2.2.3.2. Types of Fire Alarm Systems**

**[\[2.2.3.3.\]](#) 2.2.3.3. Design of Fire Alarm Systems**

**[\[2.2.3.4.\]](#) 2.2.3.4. Fire Alarm Signals**

**[\[2.2.3.5.\]](#) 2.2.3.5. Silencing of Alarm Signals**

**[\[2.2.3.6.\]](#) 2.2.3.6. Electrical Supervision**

**[\[2.2.3.7.\]](#) 2.2.3.7. Fire Detectors**

## **[\[2.2.4.\]](#) 2.2.4. Provisions for Firefighting**

**[\[2.2.4.1.\]](#) 2.2.4.1. Fire Department Access to Buildings**

**[\[2.2.4.2.\]](#) 2.2.4.2. Automatic Sprinkler Systems**

**[\[2.2.4.3.\]](#) 2.2.4.3. Portable Fire Extinguishers**

## **[\[2.2.5.\]](#) 2.2.5. Emergency Lighting**

**[\[2.2.5.1.\]](#) 2.2.5.1. Minimum Lighting Requirements**

## **[\[2.2.6.\]](#) 2.2.6. Safety within Farm Buildings**

**[\[2.2.6.1.\]](#) 2.2.6.1. Means of Egress**

**[\[2.2.6.2.\]](#) 2.2.6.2. Egress Doorways**

**[\[2.2.6.3.\]](#) 2.2.6.3. Travel Distance**

**[\[2.2.6.4.\]](#) 2.2.6.4. Headroom Clearance**

**[\[2.2.6.5.\]](#) 2.2.6.5. Access to Exits**

[\[2.2.6.6.\]](#) 2.2.6.6. Door Swing

[\[2.2.6.7.\]](#) 2.2.6.7. Doors and Door Hardware

[\[2.2.6.8.\]](#) 2.2.6.8. Ramps and Stairways

[\[2.2.6.9.\]](#) 2.2.6.9. Floor Openings

[\[2.2.6.10.\]](#) 2.2.6.10. Guards

[\[2.2.6.11.\]](#) 2.2.6.11. Signage

[\[2.2.6.12.\]](#) 2.2.6.12. Transparent Doors and Panels

[\[2.2.7.\]](#) 2.2.7. Exits

[\[2.2.7.1.\]](#) 2.2.7.1. Exit Facilities

[\[2.2.7.2.\]](#) 2.2.7.2. Types of Exits

[\[2.2.7.3.\]](#) 2.2.7.3. Minimum Number of Exits

[\[2.2.7.4.\]](#) 2.2.7.4. Distance between Exits

[\[2.2.7.5.\]](#) 2.2.7.5. Location of Exits

[\[2.2.7.6.\]](#) 2.2.7.6. Width and Height of Exits

[\[2.2.7.7.\]](#) 2.2.7.7. Direction of Exit Door Swing

[\[2.2.7.8.\]](#) 2.2.7.8. Exit Door Hardware

[\[2.2.7.9.\]](#) 2.2.7.9. Exit Stairs and Fire Escapes

[\[2.2.7.10.\]](#) 2.2.7.10. Exit Signs

[\[2.2.8.\]](#) 2.2.8. Hazardous Substances, Processes and Equipment

[\[2.2.8.1.\]](#) 2.2.8.1. General

[\[2.2.8.2.\]](#) 2.2.8.2. Exhaust Ventilation and Explosion Venting

[\[2.2.8.3.\]](#) 2.2.8.3. Below-Floor Storage Areas for Liquid Manure

[\[2.2.8.4.\]](#) 2.2.8.4. Welding and Cutting

[\[2.2.8.5.\]](#) 2.2.8.5. Liquid Manure Storage Tanks and Piping Systems

[\[2.2.8.6.\]](#) 2.2.8.6. Gas Traps or Valves

**[2.2.8.7.] 2.2.8.7. Dangerous Goods Storage****[2.2.8.8.] 2.2.8.8. Pesticide Storage Areas****[2.2.9.] -- Spatial Separation and Exposure Protection****[2.2.9.1.] --- Application**

- [1] --)** Except where stated otherwise, this Subsection applies to *farm buildings* located adjacent to
- [a] --) a property line,
  - [b] --) the centre line of a *street, lane or public thoroughfare, or*
  - [c] --) a *building* or part of a *building* on the same property.
- [2] --)** Except as provided in Sentence (3), the *farm buildings* referred to in Sentence (1) shall comply with Articles 2.2.9.2. and 2.2.9.3.
- [3] --)** Sentence 3.2.3.1.(8) does not apply to the *farm buildings* referred to in Sentence (1).

**[2.2.9.2.] --- Limiting Distance and Area of Unprotected Openings**

- [1] --)** A *building* or part of a *building* containing a Group G, Division 1 *major occupancy*, other than one housing livestock with a below-floor storage area for liquid manure, shall comply with Tables 3.2.3.1.-C and 3.2.3.1.-E.
- [2] --)** Except as provided in Sentence (3), a *building* or part of a *building* containing a Group G, Division 1 *major occupancy* housing livestock with a below-floor storage area for liquid manure or a Group G, Division 2, 3 or 4 *major occupancy* shall comply with Tables 3.2.3.1.-B and 3.2.3.1.-D.
- [3] --)** Where more than one *building* or part of a *building* containing a Group G, Division 1 *major occupancy* housing livestock with below-floor storage area for liquid manure or a Group G, Division 2, 3 or 4 *major occupancy* is located on the same property,
- [a] --) the *limiting distance* between their *exposing building faces* is permitted to be zero, and
  - [b] --) the *area of unprotected openings* of their *exposing building faces* is permitted to be 100%.

**[2.2.9.3.] --- Construction of Exposing Building Face**

- [1] --)** The *fire-resistance rating*, construction and cladding for *exposing building faces* of *farm buildings*, or *fire compartments* within a *farm building*, containing a Group G, Division 1 *major occupancy*, other than one housing livestock with a below-floor storage area for liquid manure, shall comply with the requirements for a Group E or Group F, Division 1 or 2 *occupancy* in Table 3.2.3.7.
- [2] --)** The *fire-resistance rating*, construction and cladding for *exposing building faces* of *farm buildings*, or *fire compartments* within a *farm building*, containing a Group G, Division 1 *major occupancy* housing livestock with a below-floor storage area for liquid manure or a Group G, Division 2, 3 or 4 *major occupancy* shall comply with the requirements for a Group A, B, C or D or Group F, Division 3 *occupancy* in Table 3.2.3.7.

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## Impact analysis

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Positive impacts of the provisions include the following:

- Clear, consistent methodology for designers to satisfy the property protection objectives of adjacent non-farm buildings and adjacent properties.
- Harmonization with Part 3 regarding occupant safety and logical protection of exit facilities and separate fire compartments within farm buildings to achieve the same level of protection.
- Clear, consistent methodology for authorities having jurisdiction to appropriately enforce spatial separation requirements.
- In many cases, there should be no discernable impact on farm building construction as similar requirements have existed since the 1995 edition of the National Farm Building Code of Canada (NFBC).

Potential negative impacts of the provisions may include the following:

- Large exposing building faces may cause increased construction costs for fire-rated exterior wall assemblies or increased land to meet the requirements for limiting distances. The actual incremental cost varies by building type and size of farm land.

The following are a few simple examples of common farm buildings used to illustrate the financial impact of this proposed change, assuming that the size of farm land is not large enough to provide the required limiting distance.

- According to a feasibility study conducted in Western Canada, a swine barn with concrete walls and manure tanks (Group G, Division 1 occupancy housing livestock with below-floor liquid manure storage tanks) promises the best longevity and reduced costs [1]. A cast-in-place concrete wall of at least 90 mm thick is able to meet the proposed requirement and provide a 1h fire-resistance rating without additional cost as a result of the proposed change. A cast-in-place concrete wall of at least 130 mm thick can provide a 2h fire-resistance rating as required for other Group G, Division 1 major occupancies according to Table D-2.1.1. of the NBC.
- Buildings containing Group G, Division 2 or 4 occupancies may also be constructed with concrete walls that already provide the required 1h fire-resistance rating if they are not less than 90 mm thick. Generally speaking, masonry walls are able to provide a similar level of fire performance to that required by Table D-2.1.1. of the NBC.
- Uninsulated wood-frame structures are commonly used for farm buildings. Table 1 shows a simple example that compares a non-compliant exterior wall assembly with one that has a 1h fire-resistance rating. There are various ways of achieving a 1h fire-resistance rating; the building owner may choose to use the same insulation and interior finish as wall assembly EW1a of Table 9.10.3.1.-A of the NBC. There could be a cost increase of 59.79% for the construction of the wood framing exterior wall (not the entire farm building) as a result of this proposed change.



**Table 1. Comparison of Non-Compliant Exterior Wall Assembly with Assembly Having 1-Hour Fire-Resistance Rating<sup>(1)</sup>**

<b>Cost Analysis Example</b>	<b>38 mm × 140 mm stud wall (single bottom plate, double top plates), 2.438 m high, 60.96 m long on top of concrete wall expending 1.219 m above grade. Steel siding finish on the exterior.</b>					
<b>Baseline Wall Assembly</b>	<b>Material</b>	<b>Labour</b>	<b>Base Total</b>	<b>Total O&amp;P</b>	<b>Total w. 20% Contingency</b>	<b>Total Cost</b>
Steel siding, galvanized, corrugated or ribbed, on steel frame, 26 gauge, incl. fasteners	\$ 4 112.00	\$ 2 528.00	\$ 6 640.00	\$ 8,672.00	\$ 10 406.40	\$ 17 788.80 for 119.67 \$/m <sup>2</sup>
Furring, wood, on walls, on wood, 19 mm × 64 mm, pneumatic nailed	\$ 450.00	\$ 430.00	\$ 880.00	\$ 1,170.00	\$ 1 404.00	
Sheathing, oriented strand board, 12.7 mm thick, on walls	\$ 1 104.00	\$ 816.00	\$ 1 920.00	\$ 2,544.00	\$ 3 052.80	
Wall framing, studs, 38 mm × 140 mm, 2.438 m high wall	\$ 332.00	\$ 120.00	\$ 452.00	\$ 560.00	\$ 672.00	
Wall framing, plates, untreated, 38 mm × 140 mm	\$ 996.00	\$ 480.00	\$ 1 476.00	\$ 1 878.00	\$ 2 253.60	
<b>1h Fire-Resistance Rating</b>	<b>Material</b>	<b>Labour</b>	<b>Base Total</b>	<b>Total O&amp;P</b>	<b>Total w. 20% Contingency</b>	

**Table 1. Comparison of Non-Compliant Exterior Wall Assembly with Assembly Having 1-Hour Fire-Resistance Rating<sup>(1)</sup> (Continued)**

<b>Cost Analysis Example</b>	<b>38 mm × 140 mm stud wall (single bottom plate, double top plates), 2.438 m high, 60.96 m long on top of concrete wall expending 1.219 m above grade. Steel siding finish on the exterior.</b>					
Steel siding, galvanized, corrugated or ribbed, on steel frame, 26 gauge, incl. fasteners	\$ 4 112.00	\$ 2 528.00	\$ 6 640.00	\$ 8,672.00	\$ 10 406.40	\$ 28 425.60 for 191.23 \$/m <sup>2</sup>
Furring, wood, on walls, on wood, 19 mm × 64 mm, pneumatic nailed	\$ 450.00	\$ 430.00	\$ 880.00	\$ 1 170.00	\$ 1 404.00	
Sheathing, oriented strand board, 12.7 mm thick, on walls	\$ 1 104.00	\$ 816.00	\$ 1 920.00	\$ 2 544.00	\$ 3 052.80	
Blanket insulation, for walls or ceilings, mineral wool batts, 140 mm thick, R23	\$ 6 240.00	\$ 352.00	\$ 6 592.00	\$ 7 440.00	\$ 8 928.00	
Wall framing, studs, 38 mm × 140 mm, 2.438 m high wall	\$ 332.00	\$ 120.00	\$ 452.00	\$ 560.00	\$ 672.00	
Wall framing, plates, untreated, 38 mm × 140 mm	\$ 996.00	\$ 480.00	\$ 1 476.00	\$ 1 878.00	\$ 2 253.60	

**Table 1. Comparison of Non-Compliant Exterior Wall Assembly with Assembly Having 1-Hour Fire-Resistance Rating<sup>(1)</sup> (Continued)**

<b>Cost Analysis Example</b>	<b>38 mm × 140 mm stud wall (single bottom plate, double top plates), 2.438 m high, 60.96 m long on top of concrete wall expending 1.219 m above grade. Steel siding finish on the exterior.</b>					
Gypsum wallboard, on walls, standard, 15.9 mm thick, finish excluded	\$ 608.00	\$ 480.00	\$ 1 088.00	\$ 1 424.00	\$ 1 708.80	

Note to Table 1:

(1) This cost estimate was conducted using RSMeans 2023 data online from Gordian.

- New greenhouses (Group G, Division 3 occupancy) will likely experience increased land costs to ensure sufficient spatial separation with 100% unprotected openings as fire rating a greenhouse wall would be impractical. Note that the requirements in Subsection 3.1.2. of the NFBC 1995 are not applicable to greenhouses. Table 2 shows the value of farm land and buildings per 4 047 m<sup>2</sup> [2].

<b>Geography</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>
<b>Canada</b>	\$ 3 415	\$ 3 739	\$ 4 285
<b>British Columbia</b>	\$ 6 540	\$ 7 491	\$ 8 485
<b>Alberta</b>	\$ 3 009	\$ 3 170	\$ 3 380
<b>Saskatchewan</b>	\$ 1 601	\$ 1 656	\$ 1 888
<b>Manitoba</b>	\$ 2 281	\$ 2 423	\$ 2 739
<b>Ontario</b>	\$ 11 889	\$ 13 781	\$ 17 143
<b>Quebec</b>	\$ 6 897	\$ 7 834	\$ 8 824
<b>New Brunswick</b>	\$ 2 880	\$ 2 838	\$ 3 100
<b>Nova Scotia</b>	\$ 2 354	\$ 2 542	\$ 2 816
<b>Prince Edward Island</b>	\$ 4 185	\$ 4 356	\$ 5 520
<b>Newfoundland and Labrador</b>	\$ 5 421	\$ 5 812	\$ 6 298

- Requirements for exposure protection of exit facilities and separate fire compartments within a farm building may increase construction costs, as these requirements were not considered for large farm buildings in the past. However, these requirements would likely apply to a small number of new farm buildings or small parts of new farm buildings as Part 2 allows unlimited building area in most cases.

## References

(1) Lemay, S., Laguë, C. and Chénard, L. (2002). Feasibility Study for Concrete Swine Buildings and Manure Storage Facilities in Western Canada. Available: <https://www.prairieswine.com/wp-content/uploads/2020/10/Feasibility-Study-for-Concrete-Swine-Buildings-and-Manure-Storage-Facilities-in-Western-Canada.pdf>

(2) Statistics Canada (2023). Value per acre of farm land and buildings at July 1. <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210004701>

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## Enforcement implications

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As the spatial separation and exposure protection provisions are familiar to authorities having jurisdiction for all other occupancy classifications, it is anticipated that enforcement of this proposed change could be achieved using the established regulatory framework and resources.

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## Who is affected

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People concerned with the design, construction and operation of farm buildings, such as engineers, architects, building owners and regulators, would be affected by this proposed change.

## Supporting Document(s)

[Cost Analysis for PCF 1777 \(cost\\_analysis\\_for\\_pcf\\_1777.pdf\)](#)

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## OBJECTIVE-BASED ANALYSIS OF NEW OR CHANGED PROVISIONS

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[\[2.2.1.1.\]](#) 2.2.1.1. ([1] 1) no attributions

[\[2.2.1.1.\]](#) 2.2.1.1. ([2] 2) no attributions

[\[2.2.1.2.\]](#) 2.2.1.2. ([1] 1) [F02-OS1.2]

[\[2.2.1.2.\]](#) 2.2.1.2. ([2] 2) [F02-OS1.2]

[\[2.2.1.3.\]](#) 2.2.1.3. ([1] 1) no attributions

[\[2.2.1.4.\]](#) 2.2.1.4. ([1] 1) [F03-OS1.2]

[\[2.2.1.4.\]](#) 2.2.1.4. ([2] 2) no attributions

[\[2.2.1.4.\]](#) 2.2.1.4. ([3] 3) [F03-OS1.2]

[\[2.2.1.5.\]](#) 2.2.1.5. ([1] 1) [F03-OS1.2]

[\[2.2.1.5.\]](#) 2.2.1.5. ([2] 2) no attributions

[\[2.2.1.6.\]](#) 2.2.1.6. ([1] 1) no attributions

[2.2.1.7.] 2.2.1.7. ([1] 1) [F03-OS1.2] [F12-OS1.5]  
[2.2.1.7.] 2.2.1.7. ([2] 2) [F03-OS1.2] [F12-OS1.5]  
[2.2.1.7.] 2.2.1.7. ([3] 3) no attributions  
[2.2.1.8.] 2.2.1.8. ([1] 1) [F03-OS1.2]  
[2.2.1.8.] 2.2.1.8. ([2] 2) [F03-OS1.2]  
[2.2.1.8.] 2.2.1.8. ([3] 3) [F03-OS1.2]  
[2.2.1.8.] 2.2.1.8. ([4] 4) [F03-OS1.2]  
[2.2.1.8.] 2.2.1.8. ([5] 5) no attributions  
[2.2.1.9.] 2.2.1.9. ([1] 1) [F03-OS1.2]  
[2.2.1.9.] 2.2.1.9. ([2] 2) no attributions  
[2.2.1.9.] 2.2.1.9. ([3] 3) ([a] a) [F02-OS1.2]  
[2.2.1.9.] 2.2.1.9. ([3] 3) ([b] b) [F02,F03-OS1.2]  
[2.2.1.9.] 2.2.1.9. ([4] 4) [F02,F03-OS1.2]  
[2.2.1.9.] 2.2.1.9. ([5] 5) [F02,F03-OS1.2]  
[2.2.1.9.] 2.2.1.9. ([6] 6) no attributions  
[2.2.1.10.] 2.2.1.10. ([1] 1) [F03-OS1.2]  
[2.2.1.10.] 2.2.1.10. ([1] 1) [F04-OS1.3]  
[2.2.1.10.] 2.2.1.10. ([2] 2) [F03-OS1.2]  
[2.2.1.10.] 2.2.1.10. ([2] 2) [F04-OS1.3]  
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[2.2.1.11.] 2.2.1.11. ([1] 1) no attributions  
[2.2.1.12.] 2.2.1.12. ([1] 1) [F02,F03-OS1.2]  
[2.2.1.12.] 2.2.1.12. ([2] 2) no attributions  
[2.2.1.12.] 2.2.1.12. ([3] 3) [F02,F03-OS1.2]  
[2.2.1.13.] 2.2.1.13. ([1] 1) [F01-OS1.1] [F02-OS1.2]  
[2.2.1.14.] 2.2.1.14. ([1] 1) [F02-OS1.2]  
[2.2.1.15.] 2.2.1.15. ([1] 1) [F01-OS1.1] [F81-OS1.1]  
[2.2.1.15.] 2.2.1.15. ([1] 1) [F81-OS1.4]  
[2.2.1.15.] 2.2.1.15. ([1] 1) [F32-OS3.3]  
[2.2.1.15.] 2.2.1.15. ([2] 2) [F01-OS1.1]  
[2.2.1.15.] 2.2.1.15. ([2] 2) [F81-OS1.4]  
[2.2.1.16.] 2.2.1.16. ([1] 1) no attributions

- [2.2.1.17.] 2.2.1.17. ([1] 1) no attributions**
- [2.2.1.17.] 2.2.1.17. ([1] 1) [F10-OS1.5]**
- [2.2.2.1.] 2.2.2.1. ([1] 1) no attributions**
- [2.2.2.2.] 2.2.2.2. ([1] 1) no attributions**
- [2.2.2.2.] 2.2.2.2. ([2] 2) no attributions**
- [2.2.2.3.] 2.2.2.3. ([1] 1) no attributions**
- [2.2.2.4.] 2.2.2.4. ([1] 1) no attributions**
- [2.2.2.4.] 2.2.2.4. ([2] 2) no attributions**
- [2.2.2.5.] 2.2.2.5. ([1] 1) no attributions**
- [2.2.2.6.] 2.2.2.6. ([1] 1) no attributions**
- [2.2.2.7.] 2.2.2.7. ([1] 1) no attributions**
- [2.2.2.8.] 2.2.2.8. ([1] 1) no attributions**
- [2.2.3.1.] 2.2.3.1. ([1] 1) [F11-OS1.5] [F13-OS1.5,OS1.2]**
- [2.2.3.1.] 2.2.3.1. ([2] 2) no attributions**
- [2.2.3.2.] 2.2.3.2. ([1] 1) [F11-OS1.5]**
- [2.2.3.3.] 2.2.3.3. ([1] 1) ([a] a) [F03-OS1.2]**
- [2.2.3.3.] 2.2.3.3. ([1] 1) ([b] b) [F11-OS1.2]**
- [2.2.3.4.] 2.2.3.4. ([1] 1) ([a] a)**
- [2.2.3.4.] 2.2.3.4. ([1] 1) ([b] b),([c] c) [F11-OS1.5]**
- [2.2.3.4.] 2.2.3.4. ([2] 2) [F11-OS1.5]**
- [2.2.3.4.] 2.2.3.4. ([3] 3) [F11-OS1.5]**
- [2.2.3.5.] 2.2.3.5. ([1] 1) [F11-OS1.5] [F34,F81-OS1.5]**
- [2.2.3.6.] 2.2.3.6. ([1] 1) [F82-OS1.2,OS1.5]**
- [2.2.3.7.] 2.2.3.7. ([1] 1) ([a] a) [F11-OS1.5]**
- [2.2.3.7.] 2.2.3.7. ([1] 1) ([b] b) [F11-OS1.5]**
- [2.2.3.7.] 2.2.3.7. ([2] 2) [F02-OS1.2] [F11-OS1.5]**
- [2.2.4.1.] 2.2.4.1. ([1] 1) [F12-OS1.2,OS1.5]**
- [2.2.4.1.] 2.2.4.1. ([2] 2) [F12-OS1.2,OS1.5]**
- [2.2.4.2.] 2.2.4.2. ([1] 1) no attributions**
- [2.2.4.2.] 2.2.4.2. ([2] 2) no attributions**
- [2.2.4.2.] 2.2.4.2. ([3] 3) [F11-OS1.5] [F12-OS1.2,OS1.5]**
- [2.2.4.3.] 2.2.4.3. ([1] 1) [F02,F12,F81-OS1.2]**

- [\[2.2.5.1.\]](#) 2.2.5.1. ([\[1\]](#) 1) [F30-OS3.1] [F10-OS3.7]
- [\[2.2.5.1.\]](#) 2.2.5.1. ([\[1\]](#) 1) [F10-OS1.5]
- [\[2.2.5.1.\]](#) 2.2.5.1. ([\[2\]](#) 2) [F30-OS3.1] [F10-OS3.7]
- [\[2.2.5.1.\]](#) 2.2.5.1. ([\[2\]](#) 2) [F10-OS1.5]
- [\[2.2.5.1.\]](#) 2.2.5.1. ([\[3\]](#) 3) [F30-OS3.1] [F10-OS3.7]
- [\[2.2.5.1.\]](#) 2.2.5.1. ([\[3\]](#) 3) [F10-OS1.5]
- [\[2.2.6.1.\]](#) 2.2.6.1. ([\[1\]](#) 1) no attributions
- [\[2.2.6.1.\]](#) 2.2.6.1. ([\[2\]](#) 2) no attributions
- [\[2.2.6.1.\]](#) 2.2.6.1. ([\[3\]](#) 3) no attributions
- [\[2.2.6.1.\]](#) 2.2.6.1. ([\[4\]](#) 4) no attributions
- [\[2.2.6.2.\]](#) 2.2.6.2. ([\[1\]](#) 1) [F10-OS1.5]
- [\[2.2.6.2.\]](#) 2.2.6.2. ([\[2\]](#) 2) [F10-OS1.5]
- [\[2.2.6.2.\]](#) 2.2.6.2. ([\[3\]](#) 3) [F10-OS1.5]
- [\[2.2.6.3.\]](#) 2.2.6.3. ([\[1\]](#) 1) no attributions
- [\[2.2.6.3.\]](#) 2.2.6.3. ([\[1\]](#) 1) [F10-OS1.5]
- [\[2.2.6.4.\]](#) 2.2.6.4. ([\[1\]](#) 1) no attributions
- [\[2.2.6.5.\]](#) 2.2.6.5. ([\[1\]](#) 1) no attributions
- [\[2.2.6.5.\]](#) 2.2.6.5. ([\[1\]](#) 1) [F30-OS3.1] [F10-OS3.7]
- [\[2.2.6.5.\]](#) 2.2.6.5. ([\[1\]](#) 1) [F10-OS1.5]
- [\[2.2.6.5.\]](#) 2.2.6.5. ([\[2\]](#) 2) [F43-OS3.7]
- [\[2.2.6.6.\]](#) 2.2.6.6. ([\[1\]](#) 1) [F10-OS3.7]
- [\[2.2.6.6.\]](#) 2.2.6.6. ([\[1\]](#) 1) [F10-OS1.5]
- [\[2.2.6.6.\]](#) 2.2.6.6. ([\[2\]](#) 2) no attributions
- [\[2.2.6.6.\]](#) 2.2.6.6. ([\[2\]](#) 2) [F10-OS3.7]
- [\[2.2.6.7.\]](#) 2.2.6.7. ([\[1\]](#) 1) ([\[a\]](#) a),([\[b\]](#) b),([\[c\]](#) c) [F10,F12-OS3.7]
- [\[2.2.6.7.\]](#) 2.2.6.7. ([\[1\]](#) 1) ([\[d\]](#) d) [F30-OS3.1]
- [\[2.2.6.7.\]](#) 2.2.6.7. ([\[2\]](#) 2) no attributions
- [\[2.2.6.7.\]](#) 2.2.6.7. ([\[2\]](#) 2) ([\[a\]](#) a) [F03-OS1.2]
- [\[2.2.6.7.\]](#) 2.2.6.7. ([\[2\]](#) 2) ([\[b\]](#) b) [F44-OS3.4]
- [\[2.2.6.7.\]](#) 2.2.6.7. ([\[3\]](#) 3) no attributions
- [\[2.2.6.8.\]](#) 2.2.6.8. ([\[1\]](#) 1) ([\[a\]](#) a)
- [\[2.2.6.8.\]](#) 2.2.6.8. ([\[1\]](#) 1) ([\[a\]](#) a) [F30-OS3.1]

- [\[2.2.6.8.\]](#) 2.2.6.8. ([\[1\]](#) 1) ([\[b\]](#) b)
- [\[2.2.6.8.\]](#) 2.2.6.8. ([\[2\]](#) 2) [F30-OS3.1]
- [\[2.2.6.8.\]](#) 2.2.6.8. ([\[3\]](#) 3) no attributions
- [\[2.2.6.9.\]](#) 2.2.6.9. ([\[1\]](#) 1) [F20-OS3.1]
- [\[2.2.6.9.\]](#) 2.2.6.9. ([\[2\]](#) 2) [F30-OS3.1]
- [\[2.2.6.9.\]](#) 2.2.6.9. ([\[2\]](#) 2) no attributions
- [\[2.2.6.10.\]](#) 2.2.6.10. ([\[1\]](#) 1) [F30-OS3.1]
- [\[2.2.6.10.\]](#) 2.2.6.10. ([\[2\]](#) 2) [F30-OS3.1]
- [\[2.2.6.10.\]](#) 2.2.6.10. ([\[2\]](#) 2) no attributions
- [\[2.2.6.10.\]](#) 2.2.6.10. ([\[3\]](#) 3) no attributions
- [\[2.2.6.11.\]](#) 2.2.6.11. ([\[1\]](#) 1) no attributions
- [\[2.2.6.12.\]](#) 2.2.6.12. ([\[1\]](#) 1) [F30-OS3.1] [F10-OS3.7]
- [\[2.2.6.12.\]](#) 2.2.6.12. ([\[2\]](#) 2) no attributions
- [\[2.2.6.12.\]](#) 2.2.6.12. ([\[3\]](#) 3) [F30-OS3.1] [F10-OS3.7]
- [\[2.2.7.1.\]](#) 2.2.7.1. ([\[1\]](#) 1) no attributions
- [\[2.2.7.2.\]](#) 2.2.7.2. ([\[1\]](#) 1) no attributions
- [\[2.2.7.3.\]](#) 2.2.7.3. ([\[1\]](#) 1) no attributions
- [\[2.2.7.3.\]](#) 2.2.7.3. ([\[1\]](#) 1) [F10,F12-OS3.7]
- [\[2.2.7.3.\]](#) 2.2.7.3. ([\[1\]](#) 1) [F10,F12-OS1.5]
- [\[2.2.7.3.\]](#) 2.2.7.3. ([\[2\]](#) 2) no attributions
- [\[2.2.7.3.\]](#) 2.2.7.3. ([\[3\]](#) 3) no attributions
- [\[2.2.7.4.\]](#) 2.2.7.4. ([\[1\]](#) 1) no attributions
- [\[2.2.7.4.\]](#) 2.2.7.4. ([\[1\]](#) 1) [F10-OS1.5]
- [\[2.2.7.5.\]](#) 2.2.7.5. ([\[1\]](#) 1) no attributions
- [\[2.2.7.5.\]](#) 2.2.7.5. ([\[1\]](#) 1) [F10-OS3.7]
- [\[2.2.7.5.\]](#) 2.2.7.5. ([\[1\]](#) 1) [F10-OS1.5]
- [\[2.2.7.5.\]](#) 2.2.7.5. ([\[2\]](#) 2) no attributions
- [\[2.2.7.5.\]](#) 2.2.7.5. ([\[3\]](#) 3) no attributions
- [\[2.2.7.6.\]](#) 2.2.7.6. ([\[1\]](#) 1) no attributions
- [\[2.2.7.6.\]](#) 2.2.7.6. ([\[1\]](#) 1) [F10-OS3.7]
- [\[2.2.7.6.\]](#) 2.2.7.6. ([\[2\]](#) 2) no attributions
- [\[2.2.7.6.\]](#) 2.2.7.6. ([\[3\]](#) 3) no attributions



- [\[2.2.7.6.\]](#) 2.2.7.6. ([\[3\]](#) 3) [F10,F30-OS3.7]
- [\[2.2.7.6.\]](#) 2.2.7.6. ([\[3\]](#) 3) [F10-OS1.5]
- [\[2.2.7.7.\]](#) 2.2.7.7. ([\[1\]](#) 1) [F10-OS3.7]
- [\[2.2.7.7.\]](#) 2.2.7.7. ([\[1\]](#) 1) [F10-OS1.5]
- [\[2.2.7.7.\]](#) 2.2.7.7. ([\[2\]](#) 2) no attributions
- [\[2.2.7.8.\]](#) 2.2.7.8. ([\[1\]](#) 1) [F10-OS3.7]
- [\[2.2.7.8.\]](#) 2.2.7.8. ([\[1\]](#) 1) [F10-OS1.5]
- [\[2.2.7.9.\]](#) 2.2.7.9. ([\[1\]](#) 1) no attributions
- [\[2.2.7.9.\]](#) 2.2.7.9. ([\[1\]](#) 1) [F10-OS3.7] [F30-OS3.1]
- [\[2.2.7.9.\]](#) 2.2.7.9. ([\[2\]](#) 2) [F10-OS3.7]
- [\[2.2.7.9.\]](#) 2.2.7.9. ([\[2\]](#) 2) [F10-OS1.5]
- [\[2.2.7.9.\]](#) 2.2.7.9. ([\[3\]](#) 3) no attributions
- [\[2.2.7.9.\]](#) 2.2.7.9. ([\[4\]](#) 4) no attributions
- [\[2.2.7.9.\]](#) 2.2.7.9. ([\[5\]](#) 5) no attributions
- [\[2.2.7.9.\]](#) 2.2.7.9. ([\[5\]](#) 5) [F10,F12-OS3.7] [F30-OS3.1]
- [\[2.2.7.9.\]](#) 2.2.7.9. ([\[5\]](#) 5) [F10,F12-OS1.5]
- [\[2.2.7.10.\]](#) 2.2.7.10. ([\[1\]](#) 1) no attributions
- [\[2.2.8.1.\]](#) 2.2.8.1. ([\[1\]](#) 1) [F01,F02,F03-OS1.1,OS1.2]
- [\[2.2.8.1.\]](#) 2.2.8.1. ([\[1\]](#) 1) [F43-OS3.4]
- [\[2.2.8.1.\]](#) 2.2.8.1. ([\[1\]](#) 1) no attributions
- [\[2.2.8.1.\]](#) 2.2.8.1. ([\[2\]](#) 2) no attributions
- [\[2.2.8.1.\]](#) 2.2.8.1. ([\[3\]](#) 3) [F43-OS1.1]
- [\[2.2.8.1.\]](#) 2.2.8.1. ([\[3\]](#) 3) [F43-OS3.4]
- [\[2.2.8.1.\]](#) 2.2.8.1. ([\[4\]](#) 4) no attributions
- [\[2.2.8.1.\]](#) 2.2.8.1. ([\[5\]](#) 5) no attributions
- [\[2.2.8.2.\]](#) 2.2.8.2. ([\[1\]](#) 1) [F01-OS1.1]
- [\[2.2.8.2.\]](#) 2.2.8.2. ([\[2\]](#) 2) no attributions
- [\[2.2.8.2.\]](#) 2.2.8.2. ([\[3\]](#) 3) no attributions
- [\[2.2.8.3.\]](#) 2.2.8.3. ([\[1\]](#) 1) no attributions
- [\[2.2.8.3.\]](#) 2.2.8.3. ([\[2\]](#) 2) [F01-OS1.1]
- [\[2.2.8.3.\]](#) 2.2.8.3. ([\[3\]](#) 3) ([\[a\]](#) a) [F11-OS1.1,OS1.4]
- [\[2.2.8.3.\]](#) 2.2.8.3. ([\[3\]](#) 3) ([\[b\]](#) b),([\[c\]](#) c) [F11-OS1.1,OS1.4]

- [2.2.8.3.] 2.2.8.3. ([3] 3) no attributions
- [2.2.8.3.] 2.2.8.3. ([3] 3) ([d] d) [F01,F02-OS1.1]
- [2.2.8.3.] 2.2.8.3. ([3] 3) ([e] e) [F01,F02-OS1.4]
- [2.2.8.3.] 2.2.8.3. ([4] 4) [F01,F02-OS1.2] [F12-OS1.1]
- [2.2.8.3.] 2.2.8.3. ([5] 5) [F03-OS1.2]
- [2.2.8.4.] 2.2.8.4. ([1] 1) no attributions
- [2.2.8.4.] 2.2.8.4. ([2] 2) no attributions
- [2.2.8.5.] 2.2.8.5. ([1] 1) no attributions
- [2.2.8.5.] 2.2.8.5. ([2] 2) no attributions
- [2.2.8.5.] 2.2.8.5. ([3] 3) [F30,F34-OS3.1]
- [2.2.8.5.] 2.2.8.5. ([4] 4) [F34-OS3.4]
- [2.2.8.5.] 2.2.8.5. ([5] 5) [F34,F43-OS3.4]
- [2.2.8.5.] 2.2.8.5. ([6] 6) [F34,F43-OS3.4]
- [2.2.8.6.] 2.2.8.6. ([1] 1) [F01-OS1.1]
- [2.2.8.6.] 2.2.8.6. ([1] 1) [F43-OS3.4]
- [2.2.8.6.] 2.2.8.6. ([2] 2) [F01-OS1.1]
- [2.2.8.6.] 2.2.8.6. ([2] 2) [F43-OS3.4]
- [2.2.8.6.] 2.2.8.6. ([2] 2) no attributions
- [2.2.8.7.] 2.2.8.7. ([1] 1) no attributions
- [2.2.8.8.] 2.2.8.8. ([1] 1) no attributions
- [2.2.8.8.] 2.2.8.8. ([2] 2) ([a] a)
- [2.2.8.8.] 2.2.8.8. ([2] 2) ([a] a) [F01-OS1.1]
- [2.2.8.8.] 2.2.8.8. ([2] 2) ([a] a) [F43-OS3.4]
- [2.2.8.8.] 2.2.8.8. ([2] 2) ([b] b),([c] c) [F34-OS3.4]
- [2.2.8.8.] 2.2.8.8. ([3] 3) [F43,F44-OS3.4]
- [2.2.8.8.] 2.2.8.8. ([4] 4) [F43,F44,F46-OS3.4]
- [2.2.8.8.] 2.2.8.8. ([4] 4) [F01,F02,F03-OS1.2]
- [2.2.9.1.] -- ([1] --) no attributions
- [2.2.9.1.] -- ([2] --) no attributions
- [2.2.9.1.] -- ([3] --) no attributions
- [2.2.9.2.] -- ([1] --) no attributions
- [2.2.9.2.] -- ([1] --) [F03-OS1.2]

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