in the event of a failure). Cryogen vent pipes and the emergency exhaust shall be airtight to ensure that escaping cryogens are vented to a safe discharge point outside of the building;

d) external quench discharge pipes shall be designed and fitted to prevent the ingress of rain, snow, etc., and shall include a protective grid and rain cover to minimize the risk of blockage;
e) discharge shall be directed to a restricted or unoccupied area (e.g., an unoccupied rooftop) so that discharged materials do not jeopardize people or property. Access to rooftops or other cryogen discharge areas shall be restricted to those with appropriate training;
f) weather-resistant signage/markings shall be provided that clearly identify a minimum 8 m radius from discharge points;
g) the point of exhaust air discharge shall be located such that discharged contaminants are not re-entrained into outside air intakes or building openings. Potential points of intake (e.g., supply, operable windows) shall not be located within 25 m of cryogen discharge areas if the discharge is below the intake, nor within 8 m of the discharge if the discharge is located above the intake (see Table 2); and
h) the venting system shall be adequately maintained to ensure it does not become blocked. The system should be checked regularly for blockages or breaks in the line as well as obstructed exits (e.g., bird nests).

6.11.5.6

Rooms for procedures using endoscopes shall be designed for positive pressure. Rooms for bronchoscopy shall be designed for negative pressure, even if they will also be used for other purposes – this includes rooms used for both bronchoscopy and endoscopy procedures, which shall be designed to the 'bronchoscopy' design parameters in Table 1.

Note: *The pressure relationship between endoscopy rooms and surrounding areas has changed since the 2015 edition to reflect the fact that processing of endoscopes no longer takes place in the same room as the procedure. This change does not apply to rooms where bronchoscopy takes place, as airborne containment of the procedure area is still essential. HCFs that perform both endoscopy and bronchoscopy should have two separate procedure rooms; one that is kept at positive pressure for endoscopy and invasive imaging procedures, and the other that is kept at negative pressure for bronchoscopy.*

6.11.6 Mental health facilities

Heating and cooling units, ventilation outlets, and associated equipment installed in patient-occupied areas of mental health units shall be in accordance with the following:

a) Accessible components of HVAC equipment shall be securely fastened.
b) Removable portions of HVAC equipment shall be securely attached with tamper-proof fasteners.
c) Air diffusers, grilles, and registers shall be of a type that prohibits the insertion of foreign objects.
d) Exposed HVAC components within rooms shall be constructed with rounded corners and fastened with tamper-resistant screws.
e) HVAC equipment shall be of a type that minimizes the need for maintenance within rooms.

Note: *The level of security of HVAC systems for mental health facilities should be determined by the HCF administration (see CSA Z8000).*

6.11.7 Hemodialysis

Special consideration shall be given to the appropriate number of outdoor and total air exchanges per hour in areas providing hemodialysis or hemodialysis training. Hemodialysis areas with increased activity levels, a large number of machines, or special disinfection processes could need a higher air exchange rate to manage air quality.

6.11.8 Normally unoccupied service areas

Normally unoccupied service areas shall be mechanically ventilated in accordance with Table 1.

Notes:

1) *Normally unoccupied service areas include areas such as crawl spaces, unoccupied basements, shell spaces for future development, or inaccessible spaces that may only be accessed to service equipment upon failure.*
2) *See local codes for guidance on air movement requirements in these spaces.*

6.12 HVAC heating/cooling terminals and local heating/cooling units

6.12.1 Access

Heating terminals and (where permitted) cooling terminals connected to the HVAC system shall be accessible for inspection and cleaning.

Note: *Consideration should be given to inspection and cleaning of fire dampers, smoke dampers, reheat coils, and VAV terminal boxes.*

6.12.2 Finned elements

Heating or cooling terminals constructed with fin-like projections shall not be located or installed in Type I and II areas in Class A HCFs.

Notes:

1) *When Type I and II areas are renovated, non-complying units (e.g., fin-like radiation and cabinet heaters) should be replaced with an appropriate alternative.*
2) *This does not apply for terminal reheat coils when 100% of the air is filtered by the source air handling unit.*

6.12.3 Local heating or cooling units

6.12.3.1

Local heating or cooling units (e.g., window or through-wall air conditioners, split systems, fan coils, induction units, heat pumps, cabinet unit heaters, and perimeter finned baseboard heaters) shall not be used in

a) Type I areas in any HCF; and
b) Type II areas in Class A and C-1 HCFs.

Notes:

1) *When Type I and II areas are renovated, non-complying units should be replaced with an appropriate alternative.*
2) *See CSA Z8000 for the placement of equipment within the healthcare space and the risks related to electrical equipment and wet systems.*
3) *Where a local heating or cooling unit is required to serve a specific equipment space within a Type I or Type II area, a unit located entirely in the equipment space would be deemed to comply with this Clause.*

6.12.3.2

Placement of any local heating or cooling unit shall minimize the impact on infection prevention and control (see CAN/CSA-Z317.13 for the ICRA).

6.12.3.3

Local heating and cooling units may be used in Class B and C-2 HCFs provided that

a) units that utilize forced air are equipped with filters having a minimum of MERV 7 which are located in front of the coils;
b) units are of a design that permits internal cleaning of the coils and grilles;

c) there is a cleaning protocol in place such that units are internally and externally cleaned at least annually; and
d) an evaluation has been done to identify infection control risks and develop appropriate mitigation strategies.

6.12.3.4

In addition to the annual cleaning, a local heating or cooling unit in a patient bedroom of a Class B HCF shall be cleaned whenever there is a change of occupant.

6.12.4 Noncentral air handling units

6.12.4.1

Local recirculating units (e.g., fan coil units, heat pump units) may be used in Type III areas provided that units are equipped with filters having a minimum of MERV 7 which are located in front of the coils. Outdoor air requirements, as specified in Table 1, shall be met by a separate central air handling system with filtration as specified in Table 3.

Notes:

1) *See CSA Z8000 for the placement of equipment within the HCF and the risks related to electrical equipment and wet systems.*
2) *Where a noncentral air handling unit is required to serve a specific equipment space within a Type I or Type II area, a unit located entirely in the equipment space would be deemed to comply with this Clause.*

6.12.4.2

Placement of any noncentral air handling unit shall consider placement of the unit in the space to minimize the impact on infection prevention and control (see CAN/CSA-Z317.13 for ICRA).

6.12.4.3

Noncentral air handling systems may be used in Type II areas with high equipment heat gains provided that

a) the required air change rate is maintained by the central air handling system;
b) filtration levels meet the requirements of Table 3;
c) the equipment is located outside the Type II area;
d) the equipment is designed for sensible cooling only; and
e) the air handling unit meets the requirements of Clause 6.6.

6.12.5 Water removal for local cooling and non-central air handling units

6.12.5.1

Drain pans of local heating/cooling units and non-central air handling units shall be configured and piped to freely drain water in accordance with the requirements in Clause 6.6 for all condensation (e.g., from cooling coils, humidifiers, etc.) and any washing water.

Note: *Drain pans cannot assume that vapourization of condensate will be sufficient.*

6.12.5.2

Units shall not be located within the ceiling space of patient care areas (see Clauses 6.12.3 and 6.12.4). Drainage piping from allowable units shall be piped as per manufacturer's recommendations and

applicable code requirements. External open drain pans shall not be placed in the ceiling space of patient care areas.

Notes:

1) *Drainage piping should not use open flow drains or be combined into any other area drains.*
2) *In Canada, the applicable code is the* National Building Code of Canada.

6.13 Exhaust systems

6.13.1 General

The following shall be constructed of stainless steel with sealed seams:

a) exhaust ducts conveying corrosive fumes and vapours or other hazardous substances (including fume hoods and biological safety cabinet exhaust systems); and
b) exhaust ducts where condensation is likely to occur.

Ducts shall be sloped to provide drainage where condensation is expected. The exhaust duct and the sheet metal transition to the connection of the fan and to the connection of the hood or cabinets shall be pressure tested to meet SMACNA Class A leakage criteria.

Note: *Special requirements might be necessary for duct drain lines.*

6.13.2 Alarms

Fume hoods, biological safety cabinets, radioisotope exhaust systems, and exhaust systems conveying other hazardous substances shall have audible and visible alarms for low-flow conditions. Alarm annunciation shall be located both locally and centrally.

Note: *See the* Canadian Biosafety Standards and Guidelines.

6.13.3 Dedicated exhaust

6.13.3.1

Dedicated nonrecirculating exhaust systems shall be provided for the following equipment and areas:

a) anaesthetic gas scavenging system conforming to CSA Z7396.1;
b) animal facilities;
c) autopsy suites and morgue;
d) biohazard laminar flow hoods, fume hoods, fume cabinets, chemical storage cabinets, and biosafety hoods;
e) cart and can washers;
f) chemical storage;
g) cooking facilities (see NFPA 96);
h) ethylene oxide (see CAN/CSA-Z314.9);
i) radioisotope hoods;
j) perchloric hoods;
k) areas using hazardous gases; and
l) AIRs and other special precaution rooms, including bronchoscopy procedure rooms.

A low-flow sensor and audible and visible alarm shall be provided for each system specified in Items d), i), and j) of Clause 6.13.3.1.

Notes:

1) *These exhaust systems are generally installed on the basis of an independent fan system for each type of equipment, function, room, or area served.*

2) *These exhaust systems may be combined as long as it does not negatively impact system reliability (e.g. system degradation) or mix contaminated air, which could risk exhaust system operation or safety.*
3) *See ANSI/ASHRAE 62.1.*

6.13.3.2
Areas of same air type and with similar function may be combined on a common exhaust system; radioisotope and perchloric hoods shall have separate exhaust systems.

6.13.4 Discharge locations
The point of exhaust air discharge shall be located such that discharged contaminants are not re-entrained into outside air intakes or building openings. The exhaust types specified in Table 2 are considered contaminated exhausts; exhausts not listed in Table 2 but that are expected to contain toxic or odorous contaminants shall be considered as "other contaminated sources" in the Table. A detailed dispersion study shall be performed for exhausts in Table 2 that can be significantly influenced by building wake zones or discharge below an intake (see Clause 6.5.7.1).

6.13.5 Filtration and treatment

6.13.5.1
Exhaust air containing hazardous substances shall be filtered and/or treated to prevent discharge to the atmosphere, in accordance with applicable requirements.

Note: *Federal, provincial, and local regulations can apply.*

6.13.5.2
HEPA filters that are located downstream of a possible contaminant source (e.g., AIR or OR) shall be housed in a "bag-in, bag-out" filter housing.

6.13.6 Nitrous oxide cylinder storage
Ventilation of nitrous oxide cylinder storage closets shall meet the requirements of CSA Z7396.1.

6.13.7 Ethylene oxide exhaust
Ethylene oxide exhaust systems shall meet the requirements of CAN/CSA-Z314.9.

Note: *See Environment Canada's* Guidelines for the Reduction of Ethylene Oxide Releases from Sterilization Applications.

6.13.8 Fans
Fans serving exhaust systems shall be located at the discharge end of the system. Where energy recovery devices are present, fans shall be located after such devices.

6.14 Controls

6.14.1 Individual temperature controls
Type I and II areas shall have individual temperature controls as appropriate to the functions and divisions of each area.

Note: *This Clause is meant to ensure that occupants can control the temperature in the space where they live or work. This is not meant to imply a strict one-to-one correlation between rooms and temperature controls. A room that is not normally occupied (e.g., a utility cupboard) would not require a control, nor would there be controls in each room in a single occupancy suite such as a patient room with washroom and storage closet. Alternatively, in*

some cases a single large room might be logically divided into zones, in which case there could be more than one control.

6.14.2 Area humidity controls

Area humidity controls shall be provided for ORs, burn unit areas, and intensive care units. Sterile storage areas shall either have an area humidity control, or there shall be alternate means to promptly address situations where humidity in sterile storage goes outside of design limits.

6.14.3 Essential electrical system

Control systems for HVAC systems shall be connected to the same branch of the delayed vital or conditional essential electrical system as the equipment it is controlling (see CSA Z32).

Notes:

1) *CSA Z32 outlines when ventilation systems must be connected to an essential power system and to which branch - vital, delayed vital or conditional (see Clause 6).*
2) *Where the branch of the essential electrical system is not identified in CSA Z32 for a specific piece of equipment, the choice of the branch should be based on the duration of time that the equipment or system can remain inoperable without jeopardizing the safety of patients or staff. In general, mechanical equipment should be connected to the delayed vital or conditional branch. Typically, the vital branch should be used only when specifically required by CSA Z32. Adding mechanical equipment loads to the vital branch can jeopardize the operation of the emergency electrical power supply system. The electrical designer for the facility should be consulted when selecting which branch of the essential electrical system to use.*
3) *Consideration should be given to control system restart time and sequences and the use of uninterruptible power supplies.*

6.14.4 Indicators

The location of monitors for temperature, relative humidity, and relative pressurization shall be selected based on the monitoring requirements in Table 4.

6.15 Smoke management

6.15.1 General

Smoke management systems shall be designed, commissioned, and tested in accordance with the applicable requirements.

Note: *Smoke management requirements are contained in the* National Building Code of Canada*, the* National Fire Code of Canada*, NFPA 92, ASHRAE Gdl 5, and ANSI/ASHRAE 149.*

6.15.2 Special considerations

Operating rooms, delivery rooms, intensive care units, and other areas where moving a patient during an emergency could endanger his or her life shall be provided with a mechanical air supply that will continue to operate during a fire to assist in keeping the areas smoke free. Ductwork passing through other zones that is required to keep such areas smoke free shall be protected with a fire rating equivalent to the length of time that the area is required to be kept smoke free.

6.15.3 Sleeping rooms

Sleeping room fire compartments shall be designed, installed, commissioned, and regularly tested to prevent smoke from spreading to other compartments or areas of the HCF, to allow for horizontal relocation of patients to a smoke-free area.

Note: *CSA standards generally refer to patient bedrooms, but in this Clause and in Clause 6.15.4 the term "sleeping room" is used because of its significance in fire codes.*

6.15.4 Smoke dampers

Smoke dampers shall be provided to prevent the passage of smoke from one sleeping room fire compartment to another, except when the duct system continues to operate during a fire.

Note: *Maintaining airflow in the duct has been found to prevent the migration of smoke between compartments.*

6.15.5 Coordination

Fire protection and smoke management systems shall be coordinated with regulatory authorities.

6.15.6 Smoke management zoning

Smoke management zoning shall correspond to fire alarm and sprinkler zoning.

Note: *Special consideration should be given to interconnected floor space (e.g., an atrium) and coordination with adjacent areas.*

6.15.7 Functionality

Smoke management systems shall be functional at all times.

Note: *Special consideration should be given to heating design days and stack effects.*

6.15.8 Testing

Testing of smoke management systems shall be conducted in the presence of owners and regulatory authorities.

6.15.9 Priority

Smoke management sequences shall override all other control sequences.

6.15.10 Sequence

Smoke management systems shall be activated in a sequence that ensures maximum benefit and minimizes any damage or undesirable effects on ducts or equipment.

6.15.11 Response time

The response time from the activation of a device or component to its achieving the desired state shall be 60 seconds.

Note: *Smoke exhaust (dedicated or otherwise) might require provisions to control space pressure.*

6.15.12 Sealing

Consideration shall be given to sealing around partitions, ductwork, and piping from room to room as well as around door frames to stairwells and elevators to inhibit smoke from spreading from the affected zone.

Note: *For additional information, see NFPA 92, the* National Building Code of Canada, *ASHRAE Gdl 5, and ANSI/ASHRAE 149.*

6.16 Catastrophic event management

6.16.1 General

6.16.1.1

The HCF shall develop and maintain contingency plans for the HVAC system in relation to a catastrophic event, or combination of events, that could reasonably be expected for its location. Contingency plans for addressing catastrophic events shall be reviewed at least annually.

A catastrophic event risk assessment shall be conducted prior to finalizing the contingency planning to provide information for HVAC system planning, design, and configuration.

The catastrophic event risk assessment shall take into account the role of the HCF (in typical and in regional emergency models), the services provided, and the availability of those services at alternate locations. Based on the context in which the HCF serves its catchment community, contingency planning for catastrophic events shall include an assessment of the utility needs of the HCF and the contingency plan, including backups in the case of temporary or extended periods of loss thereof. It shall also include provisions for surge capacity, i.e., management of situations where there is a significant increase in the number of patients due to a disaster or other cause.

Notes:

1) *Requirements for catastrophic event management are addressed in national, provincial, and local codes and regulations, and by Accreditation Canada.*
2) *See CSA Z8000 for additional guidance on catastrophic event management and risk assessment.*
3) *Review of the HVAC contingency plan for catastrophic events should be coordinated with the HCF emergency response team and/or local officials responsible for emergency measures and coordination.*
4) *Decisions on the level of redundancy and other design aspects needed for the HVAC system to accommodate potential catastrophic events should be made in consultation with the sponsoring agencies for the HCF.*
5) *See Clause 8.7.2 for provisions on continued operation during emergency conditions.*
6) *See CSA Z1600 for additional guidance for developing the emergency and continuity management program of the HCF. The contingency plan for the HVAC system should form part of HCF's emergency and continuity response plans to allow for O&M coordination during events.*

6.16.1.2

HCF contingency plans shall reflect the need for business continuity in the event of a catastrophic event, as identified.

Note: *This includes a determination of whether a HCF will be utilized for a surge in the context of multi-casualty incidents, CBRNE exposure, and other high volume incidents like a pandemic. This assessment would consider the geographic hazards in the area, the population, and the nature of the HCF (e.g., trauma centre/ specialty centre, etc.). Other factors for consideration include the proximity of alternate facilities for alternate care centres such as a municipality-owned recreation centre or community hall.*

6.16.1.3

HCF contingency plans shall assume the minimum timeframe for continued operation for each component during a catastrophic event, including the services that will need to be maintained during that period. The following minimums shall apply:

a) HCF Class A-1: 72 h (see CSA Z32);
b) HCF Class A-2: plan to operate for 72 h;
c) HCF Class B: plan to operate for 72 h if patients are continuously housed (i.e., 24 h/day); and

   Note: *If patients are not continuously housed, then operations should continue for as long as necessary to allow for the orderly winding down of services.*

d) HCF Classes C-1 and C-2: plan to operate as long as necessary to allow for the orderly winding
e) down of services.

6.16.1.4

HCF contingency plans should consider the potential scenarios under which the HVAC system could need to operate beyond the minimum (based on the catastrophic event risk assessment), and anticipate the potential need to vary ventilation air intake and recirculation volumes or increase filtration to react to specific types of catastrophic events. Depending on the circumstances, this could include

a) operation using an increased proportion of outdoor air (up to 100%) during an internal catastrophic event;
b) operation using 100% recirculated air during an external catastrophic event;
c) operation with HVAC systems stopped (to prevent spread of localized contamination) during an internal or external catastrophic event; or
d) operation with HVAC systems drawing outside air from an alternate source located with some physical separation from the primary outside air intake.

Note: *Physical separation as indicated in 6.16.1.4 d) can be accomplished by providing an emergency air intake louvre on a separate wall from the main outside air intake.*

6.16.1.5

The HVAC system shall be designed to protect inhabitants in Type I and Type II areas from potentially contaminated air in the event of an internal or external catastrophic event as identified in the HCF's contingency plans.

6.16.1.6

The contingency planning process should consider factors such as location (i.e., rural, suburban, or urban), proximity to other hospitals, the patient population, staffing levels and capability, and the expected level of service should a catastrophic event occur.

Notes:

1) *This part of the process is meant to determine what additional capabilities might be needed for the system to manage catastrophic events. It does not in any way alter the requirements for redundancy and backup systems specified elsewhere in this Standard.*
2) *Contingency plans should consider the implications of access to additional skilled staff (and their safe passage to the site, if necessary).*

6.16.1.7

HCFs whose contingency plans anticipate maintaining full or partial operations during a catastrophic event should conduct a documented risk management exercise to identify potential catastrophic situations and establish the system design aspects that would be necessary to mitigate risk to the interior environment including indoor air quality if these situations occur.

Notes:

1) *A risk management exercise supports contingency planning by identifying the actual risks the HCF could encounter from a catastrophic event, the likelihood of their occurring, their possible duration, and appropriate mitigation strategies. It may encompass all or part of the HCF. Systems can then be designed and built such that they can respond to the challenges the HCF could have to face, allowing it to meet its defined expectations in a catastrophic event.*
2) *The risk management exercise may be used to highlight potential vulnerabilities such as plant space or equipment location (e.g., Does the plant equipment being located below grade create an unacceptable risk for flooding based on the HCF's contingency plans?).*
3) *In some jurisdictions the risk management exercise may be performed by a provincial/territorial authority on behalf of, or in consultation with the HCF.*

6.16.1.8

HVAC systems shall be designed and constructed to comply with the requirements for air exchange and design conditions for catastrophic event planning, as specified in Clauses 6.16.2 and 6.16.3, unless it has been determined through the documented risk management exercise that alternative approaches or design values will address the potential risks and service needs for that HCF during a catastrophic event.

Note: *In addition to the operational states specified in Clause 6.16.1.3, the documented risk management exercise could support different strategies to preserve indoor air quality in response to potential catastrophic events, for example*

a) *increasing the percentage of outdoor air at levels lower than 100%;*
b) *using 100% outdoor air, partially conditioned;*
c) *switching to 100% exhaust in designated areas while increasing outdoor air;*
d) *allowing for the isolation and independent control of specific system elements that are necessary to respond to catastrophic events;*
e) *protecting specific areas through system zoning, or by engaging emergency HEPA filtration systems or carbon filters; or*
f) *opening windows or vents.*

6.16.1.9

Systems for controlling HVAC functions during a catastrophic event shall be based on manual initiation, except as noted in Clause 6.16.1.10, so that the proper function can be selected based on the nature of the catastrophic event and the overall situation in the HCF.

Note: *The nature of catastrophic events can vary greatly and as such, automated responses are not appropriate.*

6.16.1.10

In the case of catastrophic HVAC equipment failure or gradual system change causing excess humidification or insufficient dehumidification an alarm serving Type I and Type II areas where sterile supplies are prepared, stored, or used shall be immediately sent to the appropriate HCF personnel in accordance with the facility's catastrophic event management plan. The HCF should have automated mechanisms or catastrophic event management plans in place to prevent condensation on sterile surfaces in Type I and Type II areas, including sterile devices introduced into the space served.

Note: *Sudden increases in humidity above the dew point temperature of the space can cause condensation on sterile equipment, sterile devices, materials, and surfaces within the space served.*

6.16.2 Air exchange rates

6.16.2.1

HVAC systems shall be designed to maintain minimum air exchange rates as appropriate to the HCF class during a catastrophic event. The design values for minimum air exchange rates during a catastrophic event shall be as specified in Figure 2 unless it has been determined through a documented risk management exercise that alternative values or configurations are appropriate (see Clause 6.16.1.6).

Note: *In general, the minimum air exchange rate for a catastrophic event is 70% of the total air changes outlined in Table 1. In other words, the air flow parameters of Table 1 may be reduced by as much as 30% provided that critical pressure relationships are maintained as required by Clause 6.10.2.*