Bellevue Fire Department
Smoke Control Guidelines

Revised October 2018

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1 Scope and purpose. The purpose of this standard is to clarify current Code and City of Bellevue Fire Department (BFD) requirements for the design, installation and acceptance testing of smoke control systems. This information is intended to supplement existing code requirements and does not cover all aspects. This section applies to active and/or passive smoke control systems, and includes shaft pressurization as well as zoned smoke control systems.

Design approaches may include the Pressurization Method, Airflow Design Method, Exhaust Method, Passive Smoke Control or other Performance Based Designs. All of these are defined in the International Building/Fire Codes. The objective of such designs is to accomplish the following:

1. Contribute to the protection of life and to the reduction of property loss.
2. Provide conditions outside the event zone that enable emergency response personnel to enter for rescue and fire-fighting operations.
3. Maintain a tenable environment in smoke refuge areas and exit enclosures, and within the event zone when utilizing the exhaust method, for the required duration.
4. Inhibit smoke from entering stairwells, smoke refuge areas, elevator shafts, or similar areas.
5. Inhibit the migration of smoke from the event zone.

2 Where required. The IBC requires the following smoke control systems:

1. High-rise Buildings (BCC 23.10.403.7 – IBC 403.7 amended)
2. When utilizing Washington Administrative Code 51-50-0504 (5 story Type V over 2 story Type 1 Construction)
3. Pressurized Shafts/Smoke proof Enclosures (1023.11)
4. Underground Buildings (405.5)
5. Building Atriums (404.5)
6. Windowless Buildings (408.9)
7. Stages and Platforms (410.3.7.2)
8. Assembly Seating (1029.6.2.1)

3 Compliance. Smoke control and smoke management systems shall comply with IBC/IFC Section 909 and generally accepted and well-established principles of engineering as required by IBC Section 909.2. This shall include NFPA 92, A Guide to Smoke Control in the 2006 IBC, Dr. John H. Klote, P.E., and Douglas H. Evans, P.E., 2007, International Code Council, Principles of Smoke Management, Dr. John H. Klote, P.E., and Dr. James A. Milke, P.E., 2002, Handbook of Smoke Control Engineering, John H. Klote, James A Milke, Paul G Turnbull, Ahmed Kakhef, Michael J Ferreira, (ASHRAE) 2012. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE) Commissioning Process for Smoke Control Systems, 2012.

4 Definitions. The following words and terms shall, for the purposes of this chapter and as used elsewhere, have the meanings shown herein.

ACTIVE ZONE. A smoke-control zone that utilizes mechanical ventilation for smoke-control during smoke control mode to achieve design objectives.

DEDICATED SMOKE-CONTROL SYSTEM. Smoke-control systems and components that are installed for the sole purpose of providing smoke control, and upon activation these systems operate specifically to perform the smoke-control function. They include components that do not function under normal building operating conditions, such as stair pressurization fans or smoke control dampers that operate specifically to perform the smoke control function upon smoke control system activation.

END-TO-END VERIFICATION. A self-testing method that provides positive confirmation that the desired result (e.g., airflow or damper position) has been achieved when a controlled device has been activated, such as during smoke control mode, testing, or manual override operations. The intent of end-to-end verification goes beyond determining whether a circuit fault exists, but instead ascertains whether the desired end result is achieved. True end-to-end verification therefore, requires a comparison of the desired operation to the actual end result.

EVENT ZONE. The smoke-control zone where the fire event is considered to originate.

NONDEDICATED SMOKE-CONTROL SYSTEMS. Smoke-control systems and components that share components with some other system(s), such as the building HVAC system, and upon activation cause the HVAC system to change its mode of operation in order to achieve the smoke-control objectives.

PASSIVE ZONE. A smoke-control zone with no mechanical ventilation for smoke control.

PASSIVE SUB-ZONE. A space within an active smoke zone that is not provided with mechanical ventilation for smoke control. The passive sub-zone is not required to be separated by smoke barrier construction.

RACEWAY. Where referenced in accordance with IBC 909.12.1, shall be limited to rigid metal, IMC, EMT, and MC Cable.

SANDWICH METHOD. A zoned smoke-control system that utilizes a combination of exhaust in the event zone and pressurization in contiguous smoke zones.

SHAFT PRESSURIZATION (PRESSURIZED STAIRWELLS/HOISTWAYS.) A type of smoke-control approach in which stair shafts and elevator hoistways are mechanically pressurized, to establish prescribed pressure differentials with respect to the event zone, with outdoor air to keep smoke from contaminating them for a duration of at least 2-hour.

SMOKE-CONTROL MODE. A predefined operational configuration of a system or device for the purpose of smoke control. _____

SMOKE-CONTROL SYSTEM. An engineered system that utilizes a combination of passive barriers, mechanical equipment and automatic detection and/or suppression to inhibit smoke movement from the event zone to other smoke zones.

SMOKE-CONTROL ZONE. A space within a building enclosed by smoke barriers, including the top and bottom.

ZONED SMOKE-CONTROL SYSTEM. A smoke-control system applying the Pressurization Method that includes a relative negative pressure for the event zone and a relative positive pressure for all contiguous smoke-control zones, in accordance with IBC 909.6.

5 Design team. Each design individual must be registered or licensed in their particular branch of engineering or architecture by the State of Washington in accordance with RCW 18.235, and will be responsible for the elements of the smoke control system in their area of responsibility. Appropriate certification must also be demonstrated by fire alarm and fire sprinkler system designers.

Point of Information

Experience shows that the most successful projects utilize a Fire Protection Engineer early in a project to develop the smoke control concept, detailed design and maintain an active and integral role throughout the project. This individual is ideally the "Design Professional in Responsible Charge".

In many cases this may be the responsible registered design professional, but only if the scope of employment would include this additional responsibility.

5.1 Design professional in responsible charge. In buildings or occupancies that are provided with smoke control, in accordance with IBC Section 107.3.4, BFD requires that the owner engage and designate a registered design professional in responsible charge with respect to the smoke control permit who is responsible for reviewing and coordinating submittal documents prepared by others throughout the project, from concept submittal through the issuance of the Certificate of Occupancy.

5.1.1 Experience and Qualifications. The Design professional in responsible charge must have these minimum qualifications and submit a letter that documents the following:

- Professional Engineer licensed in the State of Washington
- Not less than 5 years documented experience in the design and/or review of smoke control systems
- Documented experience coordinating the following system drawings and calculations with respect to smoke control systems: fire sprinkler, fire alarm, electrical, mechanical, and architectural (see also IBC 1704.2.1)

5.2 Coordination of effort. Coordinated effort among all parties involved in designing, installing and testing smoke control systems is essential to meet applicable code requirements. It cannot be overemphasized that the design professionals, including the architect, mechanical engineer, electrical engineer, fire protection engineer, City reviewers, as well as all applicable trades including the fire alarm/electrical contractor(s), automatic sprinkler contractor, mechanical contractor and those responsible for construction of smoke barriers, must work together to accomplish a fully functional smoke control system.

5.3 Coordination letters. A signed statement must be provided from each of the individual designers (Electrical, Mechanical, Fire Alarm, Fire Sprinkler and Building Architectural) stating that the designer has read the Detailed Design Report and has incorporated it into their design, unless the design professional is the author of the report.

5.4 Commissioning. The owner must identify a special inspection agency in accordance with IBC 909.18.8.2 and 1703.1 acceptable to the Bellevue Fire Department whose duties and qualifications are further outlined in Section 13.2.

6 Special design considerations.

6.1 Phased Occupancy. Projects using a phased occupancy approach must include a phased occupancy design as part of their detailed submittal. If phased occupancy is determined at a later date, then a revised submittal is required.

Point of information

The following is not intended to be a comprehensive list of potential issues related to phased occupancy issues based on our previous experiences:

- Rating of electrical wiring reliant on sprinkler protection
- Elevator lobbies
- Completeness of corridors
- Completeness of shafts
- Stair shafts completeness and or use
- Sprinkler and fire alarm coverage
- Firefighter smoke control panel
- Emergency power

6.2 Tenant improvements. When the project work adds, modifies, or replaces smoke control zones, barriers, or fan equipment, operational testing and performance testing of the affected zones is required. Performance tests shall minimally demonstrate satisfactory performance of the elements of the affected smoke-control zones. Operational tests of selected areas outside of the work zone will be required to help ensure that programming changes did not affect other zones. If variable frequency drive (VFD) settings are modified, tests must be performed as required in the modified area and in adjacent areas served by previous fan speed to confirm proper pressure differentials.

> **Exception:** Where the project work is limited to modifications within an existing smoke zone, operational testing is only required to demonstrate appropriate system responses based on alarm sequences initiated in affected zones, as well as system responses in the affected zones based on alarm sequences initiated in adjacent zones. Manual control of equipment in affected zones via the FSCP must also be verified.

Point of information

There are some smoke control systems in existence based on the codes and standards in place at the time of original construction that would not be required under codes and standards in place today. Owners of these buildings must either maintain these systems in accordance with their original design or they must evaluate the **entire** building under the codes and standards in place to determine if these systems could be decommissioned. This will normally require an evaluation under the direction of a licensed architect and fire protection engineer.

6.3 Fire Resistance rated protection. Shaft pressurization equipment (smokeproof enclosure ventilation equipment) is required to be protected in accordance with IBC Section 909.20.6.1. This 2-hour fire barrier separation includes all equipment, power and control wiring associated with Shaft Pressurization systems.

6.4 Stair enclosures. The stair enclosure must be pressurized to not less than 0.10 inch of water (25 Pa) and not more than 0.35 inches of water (87 Pa) in the shaft relative

to the building, measured with all doors which form the interior exit stairway and ramp enclosures closed and latched under maximum anticipated conditions of stack effect and wind effect.

Point of Information

These design pressures must be achieved throughout the entire stair enclosure and must also take into account the interaction effects of the operation of multiple smoke control systems such as elevator hoistway pressurization and elevators at the recall floor with doors open versus elevators running.

For unusually tall buildings, design professionals may need to consider multiple injection points, multiple fans, variable frequency _ drives, pressure switches, barometric dampers, splitting stairs or performance based designs in order to achieve the desired outcome.

The design professional must identify where pressure differentials are measured, minimum pressure differentials, and include all interactions with building systems. The design must ensure a positive pressure in the shaft relative to the building under maximum anticipated conditions of stack effect and wind effect.

Special design considerations may be subject to peer review.

6.5 Elevator hoistway pressurization. Where hoistway pressurization is chosen as an option for compliance with the hoistway opening protection requirements, the design should consider other systems that need to operate at the same time without a negative impact on those systems in accordance with IBC 909.4.7

Elevator hoistway pressurization system shall be designed and tested under at least three separate conditions to comply with IBC 909.21.1: Condition one is elevator is recalled with doors open. Condition two is with fire service access elevators with a 5-minute delay in accordance with IBC 23.10.3007.10. Condition three requires the elevators continue running.

6.6 Penthouses. Rooftop penthouses are considered part of the building.

6.7 Generator and transfer switch. The emergency generator set shall be in a separate room from the remainder of the building, the transfer switches, and from the normal power source. The rooms must feature 2-hour FRR construction in high-rise and underground buildings, 1-hour FRR in all other buildings. (Ref. IBC 2702.1.8, IBC 909.11, NFPA 110- 7.2.1.1).

Point of Information

The intent of these provisions is to ensure that these critical components are to be protected from fire in other portions of the building and from exposure of transfer switches, generators and normal power to each other. These components therefore may not be co-located in the same room.

6.8 Garage ventilation. Where provided, mechanical garage ventilation systems (supply and exhaust) shall operate at 100% rated capacity in the event of automatic fire alarm activation in the garage zone. These systems do not require emergency power unless required by other codes or standards.

6.8.1 Fan control. Fan control must be provided at the FSCP in accordance with Appendix C.

6.9 Loading docks. Truck loading docks and similar facilities located interior of a building that is provided with smoke control requires special consideration. In general, smoke removal for the loading dock area within a building shall have a minimum exhaust volume of 10 air changes per hour.

6.9.1 Emergency power. Fans for truck loading docks must be on emergency power.

6.9.2 Fan control. Fan control and indication must be provided at the FSCP in accordance with Appendix C.

6.10 Continuously operating fans. Continuously operating fans such as those located in trash chutes and sub-ducted ventilation shafts shall be considered in the design.

6.11 Smoke removal- IBC 403.4.7. Item 3 of this section provides for any other approved design that will produce equivalent results. The Bellevue Fire Department will consider designs that rely on manipulating pressurized stair enclosures along with the use of portable Fire Department fans.

7 Permit timing. Permit application and approval timing is as follows:

1. The Smoke Control Concept (see Appendix A) must be approved prior to submittal of the garage building permit (BB for the garage).
2. The Smoke Control Detailed Design (see Appendix B) must be submitted prior to issuance of the garage building permit (BB for garage).
3. The Smoke Control Permit (FH Detailed Design see Appendix B) must be approved before the above grade building permit (BB for podium/tower) will be issued.
4. Work associated with the smoke control permit, except for a slab-only pre-wire, cannot occur until the Smoke Control permit (FH) is issued. An electrical Pre-Construction meeting is required before garage slab-only permit is issued.

Point of Information

The Special Inspection Agency should be consulted throughout smoke control design development to ensure the system can be tested as intended. As such, the Special Inspection Agency shall be designated and listed as part of the permit.

8 Submittal requirements. Submittal requirements shall be as described in this section, and the appropriate City of Bellevue Appendices:

Appendix A – Conceptual Smoke Control Submittal
Appendix B – Detailed Smoke Control Submittal
Appendix C – Smoke Control System Revision Submittal
Appendix D – Shaft Pressurization Only Submittal

8.1 Conceptual smoke control submittal. The conceptual design is the initial submittal of the Smoke Control Permit (type FH). The Conceptual Smoke Control Design must be prepared by a Professional Engineer competent in the design of smoke control systems. The Concept Design submittal contains the Life Safety Report, Summary Event Matrix and Zone Drawings in accordance with Appendix A. Once the Concept has been approved, then the Detailed Smoke Control Submittal is required to be submitted.

8.1.1. Life safety report. The life safety report must include a general project description of the building, life safety systems, and emergency evacuation plan including elevator operations and recall scenario, the smoke control methods and objectives that will be applied. This report must include a description of the various life safety features of the project (for example: sprinklers, fire pumps, reservoirs, standpipe systems, fire detection/alarm/communication system, FCC requirements, firefighter smoke control panel features, emergency power systems, in-building radio system, etc.) and how they will interface with each other. The smoke control narrative must detail how the code requirements of IBC 909 will be addressed, and describe the planned activation and operation of the system. Calculations and computer modeling analysis are not required until the detailed design stage.

8.1.2 Summary event matrix. A summary event matrix (Sequence of Operations) for the smoke control system shall be provided with the Conceptual Smoke Control Plans (Appendix A).

8.1.3 Zone drawings. Smoke zone drawings, with an appropriate legend identifying positive/negative pressure and passive zones shall be provided with the Conceptual Smoke Control Submittal (Appendix A). Zone drawings shall clearly identify (through the use of color coding or cross hatching) all passive and active zones.

8.2 Detailed smoke control submittal. The detailed design shall be prepared as described in Appendix A, Part 2, after approval of the Conceptual Smoke Control Submittal has been granted. This report shall be based on the Conceptual Design and include the required rational analysis.

8.2.1 Supporting Documents. Supporting documents (calculations, manufacturer sheets, zone drawings, special inspector test sheets, etc.) shall be provided as a bound document, independent of design plans, addressing each requirement of IBC 902 .

8.2.2 Plan Submittal. Plans must be submitted in a layered, comprehensive submittal limited to those items that are relevant to Smoke Control. This layered format shall include electrical, mechanical, fire alarm, identified sprinkler zones, smoke control zones, and architectural drawings. Where individual plan sheets

contain information that is not relative to smoke control, they should be distinguished using grayed out images or other approved methods. Submittals that do not follow these guidelines will be rejected.

8.2.3 Rational analysis. A rational analysis of the smoke control system is required in accordance with Section 909.4 of the IBC. Such analysis must be prepared by a responsible registered design professional competent in the design of smoke control systems. This analysis must include support for the types of smoke control systems to be employed, their methods of operation, the systems supporting them and the methods of construction to be utilized.

8.2.4 Computer modeling. IBC 909.4.2 and 909.4.3 requires designs to incorporate the effect of temperature and wind. The detailed design report shall address the anticipated performance of the smoke control system under extreme climatic conditions and the presence of operable windows or doors. It is acceptable to utilize a computer model, such as the National Institute of Standards and Technology – Building and Fire Research Laboratory software program CONTAM for such analysis.

8.2.4.1 Required. Residential Towers or other structures with operable windows, accessible balconies, shaft pressurization and zone smoke control may be required to computer model the smoke control systems or provide an engineering justification as to why such modeling is not necessary.

8.2.5 Smoke control zones. The architect of record must prepare smoke zone plans, with an appropriate legend showing the locations of all required smoke barriers as outlined in the detailed design report and described in Appendices B, C & D. Zone drawings shall clearly identify (through the use of cross hatching or color coding) all passive and active zones.

8.2.5.1 Designations. Designation of smoke zones and smoke barriers is a coordinated effort between the architect and mechanical engineer. Smoke zones must also be coordinated with fire alarm initiating devices (including automatic sprinkler systems) which activate mechanical smoke-control systems and occupant notification systems.

8.2.5.2 Floors. Floors define passive smoke zones. When floors are open to each other, the interconnected levels may be viewed as a single smoke zone.

8.2.5.3 Vestibules. Pressurized stair entrance vestibules and all other adjacent portions of the building always constitute separate smoke zones.

8.2.5.4 Stair enclosures. Stair enclosures and exit passageways must always be designed as completely independent smoke zones

8.2.5.5 Rated corridors. Rated corridors constitute passive smoke zones. (Ref. IBC 1018.1/708)

8.2.5.6 Horizontal exits. Horizontal exits always constitute smoke barriers. (Ref. IBC 1002)

8.2.6 Special inspector test procedure. The responsible registered design professional, author of the detailed design report, or special inspector shall prepare a Special Inspector Test Procedure in accordance with IBC Section 909.3 and Appendix D that will be submitted to the City of Bellevue for review and approval with the smoke control (FH) permit. As a minimum, this document must provide a detailed method of testing and documenting the pass/fail criteria of each test demonstrating that each component of the smoke control system functions as intended by the design. The document shall be provided as a bound document, independent of the design plans. It can be included in a binder with the detailed design report.

8.2.7 Detailed event matrix. A detailed event matrix that includes every fire System Input (alarm and smoke control initiating device) down one column, and every fire alarm notification device (by zone), every smoke control device (i.e. fans, dampers, etc.), and every other event that must occur in order for proper operation of the smoke control system (i.e. HVAC shutdown, etc.) across the top. See 2013 NFPA 72- Figure A14.6.2.4 for sample. With prior approval, some devices may be combined.

8.2.8 Firefighter's Smoke Control Panel. A full size (1:1) colored layout of the proposed Firefighter's Smoke Control Panel (FSCP) must be included with the Detailed Smoke Control Submittal.

9 Firefighter's Smoke Control Panel (FSCP). The FSCP is a system that provides visual status indication and manual overriding capability over smoke-control systems and equipment. This is also referred to as the Fire Fighters' Smoke-Control Station (FSCS) in NFPA 92. The purpose of the FSCP is for fire department use during an emergency. This panel shall be in accordance with IBC Sections 909.12 and 909.16, and incorporate BFD standards listed in this section.

9.1 Priority and control. The FSCP shall have the highest priority control over all smoke-control systems and equipment, whether or not the Automatic Fire Alarm System has been activated. The panel shall be designed to enable Fire Department personnel who may be unfamiliar with the specific system the ability to reconfigure the status of each smoke zone as deemed necessary during an emergency.

9.2 Approval. The FSCP is not approved separately. Its features and functions are integral to the smoke control system and fire alarm system. Therefore, the panel layout must be included in both permit submittals, in accordance with Appendix B. A full-scale color representation of the FSCP must be submitted for final approval. Fire alarm submittals that add, alter or replace an existing FSCP must also include a full-size (1:1) color representation of the FSCP for review and approval.

9.3 Smoke detector for panel. When the FSCP is located in an area that is not continuously occupied a smoke detector shall be provided within 15 feet of the panel (measured horizontally). This also applies to all remotely located panels. (2013 NFPA 72-10.4.4).

9.4 Panel design. The FSCP shall incorporate all of the following design features.

9.4.1 Panel colors. The panel colors shall consist of a white background and generally depict significant smoke barriers (i.e. floors, shaft walls, exterior walls) by single black lines, appearing as a general section view of the building. The image shall sufficiently illustrate all smoke zones in the building without providing the level of detail common to architectural elevation or section views.

9.4.2 Building Image. The orientation of the building on the panel shall represent the view from the street of travel used to the access the FCC and/or FSCP unless otherwise approved by the Fire Chief.

9.4.3 Air flow. The indication and direction of air movement shall be shown with arrows of the following colors:

1. Stair/Elevator shaft pressurization supply air: **BLUE**
2. Building zoned smoke control exhaust shafts: **RED**
3. Building zoned smoke control supply air: **GREEN**

9.4.4 Garage and atria. Large smoke zones, such as atria or interconnected garage levels, shall be color shaded. In general, garage zones shall be solid shaded in **ORANGE**, atria in **PURPLE**.

9.4.5 Text. All text shall be on contrasting background with a minimum size and stroke equivalent to 12-point bold Sans Serif font (such as Helvetica)**.** Marking pens and self-adhesive labels are not acceptable for identification.

9.5 Panel indicators- equipment and status. The general location of each smoke control system component, including fans, ducts and dampers that is controlled or annunciated by the panel shall be depicted on the panel.

9.5.1 Fans, ducts, dampers, stairs, elevators. Fans, major ducts, dampers, stairwells, shafts and zoning within the building that are portions of the smoke control system shall be shown connected to their respective ducts or dedicated fans with clear indication of direction of airflow.

9.5.2 PRV's. Identification (Text "PRV") shall be provided to denote floors where standpipe hose connections are equipped with pressure-reducing valves (PRV's).

9.5.3 Door unlocking switch. A single switch shall be provided on the panel to unlock all locking stairway doors in accordance- with IBC 403.5.3, IFC 508.1.5, and IBC 1008.1.9.11 exception #3. The switch shall be provided in the lower right corner of the panel and labeled AUTO/UNLOCKED.

9.5.4 Equipment status indicators. Indicators as required by IBC Sections 909.16.1-2 through 909.16.1-3 shall be provided for each individually monitored piece of equipment.

Exception: Where specifically approved by the BFD, such indicators may be combined to represent the cumulative condition of monitored components within a zone. For example, all fans within a zone are expected

to be indicated with one set of lamps. All dampers and any monitored doors within a zone are expected to be on an alternate set of indicators.

9.5.5 Pump and generator. The location and status (NORMAL/RUNNING/FAULT) of each fire pump and emergency generator shall be depicted on the panel. Lamps shall be WHITE/RED/YELLOW.

9.5.6 Dampers. Positive indication of OPEN/CLOSED/FAULT status is required for smoke dampers and combination dampers that are part of a smoke control system and/or that are installed within smoke barriers separating smoke zones where either zone is served by the mechanical smoke control equipment.

> **Exception:** Fire dampers and barometric dampers generally cannot be remotely controlled nor are they required for the proper operation of the smoke control system; therefore, need not be monitored.

9.5.7 Fans. Positive indication of ON/OFF/FAULT status is required for all fans that are part of a smoke control system.

9.5.8 Doors. Automatic-closing doors in smoke barriers which separate active/active or active/passive smoke zones are required to be activated by system type detectors and close anytime mechanical smoke control is activated. The FSCP must indicate status of proper configuration for smoke control operation (i.e. open if need to be open; closed if need to be closed; both when applicable).

9.5.9 Smoke and waterflow alarms. Each zone shall be provided with a red smoke alarm indicator labeled AREA SMOKE, CORRIDOR SMOKE, LOBBY SMOKE, etc. (initiated by smoke detection) and red waterflow alarm indicator labeled WATERFLOW (initiated by automatic sprinkler protection waterflow). The appropriate indicator shall be illuminated upon initiation of the respective alarm in the zone. Where multiple zones exist on a floor, the zone of alarm shall be clearly depicted on the panel. If required for clarity, such alarm zones shall be shown in a plan view of the floor on the smoke control panel.

9.5.10 Duct detectors. When duct detectors for pressurization fans are provided, they shall have a single indication lamp near the fan/damper depiction. This shall be a yellow/amber lamp.

9.5.11 Additional alarms. The panel shall be provided with a list in the upper right corner of the panel of all possible and potential initiating device categories as appropriate, including: AREA SMOKE, CORRIDOR SMOKE, LOBBY SMOKE, DUCT DETECTOR, WATERFLOW, SPECIAL SYSTEM, HEAT DETECTOR, MANUAL STATION, POWER DISCONNECT. Each category shall be provided with a red indicator. The respective indicator is to be illuminated upon such an alarm event in the building.

9.5.12 System normal indicator. A single white indicator shall be provided and labeled “SYSTEM NORMAL”. This indicator shall be illuminated at all times when monitored equipment is in normal status and all switches are in the Auto position. Illumination of this lamp shall be in addition to the indication of the status of each component.

9.5.13 LED's. Where pilot type lamp indicators are required, Light Emitting Diodes (LED's) may be used.

9.6 Zone controls. Switches utilized for floor zone control shall be located on the left side of the building image.

9.6.1 Control functions. Control capability provided in accordance with IBC Section 909.16.2 for each smoke zone utilizing the pressurization method of IBC Section 909.6 shall be via a single 4-position switch. Settings for this switch shall be in the following sequence: CLOSED / EXHAUST / AUTO / PRESSURE. When approved, superfluous positions may be eliminated if the smoke control system is not provided with such control in a zone.

9.6.2 Closed. The CLOSED position shall automatically close/shut-down the components within a zone, isolating that zone from all adjacent smoke zones.

9.6.3 Exhaust. The EXHAUST position shall automatically posture the components within that zone, to create a negative pressure within the zone.

9.6.4 Auto. The AUTO position shall be configured in accordance with IBC 909.16.3 (2).

9.6.5 Pressure. The PRESSURE position shall automatically posture the components within that zone to create a positive pressure within the zone.

9.7 Garage control. A single 3 position switch shall be provided to operate the garage supply and exhaust fans. Settings for this switch shall be in the following sequence: GARAGE SUPPLY & EXHAUST FANS ON / AUTO /OFF. Monitoring of garage system status shall be provided only if components are provided with emergency power.

9.7.1 On. The GARAGE SUPPLY & EXHAUST FANS ON position shall serve to automatically posture the components of both the supply and exhaust system fans to on.

9.7.2 Auto. The AUTO position shall be the normal operating position of the components. If the fire alarm system in the garage zone is in alarm the system shall automatically posture the components of both the supply and exhaust system fans to on.

9.7.3 Off. The OFF position shall serve to automatically posture the components of both the supply and exhaust system fans to off.

9.8 Shaft pressurization fans. Shaft fan control switches shall be placed at the top of the associated shaft. Where fans are not located at the top of shafts, leaders shall be drawn from the switch to the fan(s) being controlled.

9.9 Multiple fans operating in a single zone. Where multiple fans intended to operate simultaneously in smoke control mode serve a single smoke zone, including stair/elevator shafts, a single switch shall be provided for simultaneous control of all associated fans. However, status indication of each individual fan unit is required.

9.10 Door unlocking switch. A single switch shall be provided on the panel to unlock all locking stairway doors in accordance with IBC 403.5.3, IFC 508.1.5, and IBC 1008.1.9.11, exception #3. The switch shall be provided in the lower right corner of the panel and labeled AUTO/UNLOCKED.

9.11 Hatched grade/street labels. Exterior grade shall be depicted in gray hatched brick pattern. Adjacent streets shall be identified above the hatched grade.

9.12 Concise description. A yellow text box shall be located in the upper left corner of the panel containing a concise description of the smoke control system operation together with special design features.

9.13 Blind shafts. Shafts without openings shall be depicted with blue crosshatching for pressurized hoistways and black crosshatching for non-pressurized hoistways.

9.14 Fire service elevator. Every elevator hoistway that has been designed as a fire service elevator shall be labeled "Fire Service Access Elevator" using vertical text.

9.15 Occupant evacuation elevator. Every elevator hoistway that has been designed as an occupant evacuation elevator shall be labeled "Occupant Evacuation Elevator" using vertical text.

9.16 Recall floors. Identify primary and secondary recall floors.

9.17 Site plan. When multiple buildings are located on a common podium, the panel shall include a site plan indicating where each building is located on the site relative to streets with stair and elevator shafts depicted. Each shaft shall be shaded blue when pressurized.

10 System activation. Smoke-control system activation shall be initiated immediately after receipt of an appropriate automatic or manual activation command.

10.1 Shaft pressurization. Shaft pressurization shall be initiated upon activation of any monitored fire alarm device, including but not limited to manual pull stations, smoke/heat detection, sprinkler waterflow, etc.

10.1.1 Smoke detectors. Smoke detectors used for activation of shaft pressurization in accordance with IBC Section 909.20.6 shall be located outside the smoke proof enclosure served. Where the conditions outside the smoke proof enclosure preclude the installation of a smoke detector, a smoke detector shall be located inside the smoke proof enclosure within 5 feet of each affected entrance.

10.2 Residential high-rise corridor systems. Typical tower floors should sequence as follows: a waterflow-first alarm on the event floor should initiate notification sequence and activate shaft pressurization. Subsequent corridor smoke detector activation should activate corridor exhaust. Should the corridor detection activate first w/o waterflow, then it must activate shaft pressurization and activate corridor exhaust on the design floors.

10.3 Waterflow and manual pull stations. Waterflow detection devices serving multiple smoke zones and manual pull stations may not be used to initiate smoke control systems (exception: shaft pressurization only) since the smoke zone of origin is unknown. Subsequent activation of an automatic fire alarm initiating device (i.e. addressable smoke

detector) within an active smoke control zone shall automatically configure the smoke control system appropriately.

11 Equipment. All equipment must comply with IBC 909.10, the NEC and associated NFPA documents.

11.1 Listed and labeled. All smoke control system equipment shall be listed and labeled by Underwriters' Laboratories. Interconnecting equipment that has not been listed for interconnection or the creation of components or system into a nonstandard unit that is not normally available from the manufacturer is not acceptable.

11.2 Installation. All smoke control system equipment shall be installed in accordance with its listing and manufacturer's recommendations.

11.3 Wiring. All wiring associated with the smoke control system shall be fully enclosed within continuous raceways (IBC 909.12.1). This includes all fire alarm component wiring utilized for activation and/or control. (Note: see raceway in definitions)

11.3.1 Shaft pressurization wiring. Stairwell and elevator hoistway pressurization equipment, control and power wiring, must comply with IBC Section 909. In particular, 2-hour rated separation must be provided in accordance with 909.20.6.1. Protection of wiring and control systems located inside the building must extend from the emergency source of power to the protected devices or equipment.

Bellevue Fire would deem the following designs to comply with the above noted integrity and survivability requirements.

1. **Concrete cover:** Wiring shall be located within concrete slabs and walls when covered with a minimum of 2" of concrete.
2. **Dedicated shaft/enclosure method:** Wiring shall be located in a dedicated 2-hour fire-resistance–rated (FRR) enclosure. Only wiring for emergency systems, fire service access and occupant evacuation elevator, fire alarm and pressurization systems may be located in this shaft. Panels, cabinets, etc. are not allowed to be placed in the shaft, only conductors installed in approved electrical raceway. All shaft penetrations must be protected by UL listed methods.

   Exception: Fire alarm panels and cabinets are allowed within the 2-hour enclosure as long as all other circuits are in continues approved electrical raceway without panels or splices.
3. **2-hour wiring systems:** The use of 2-hour FRR wiring systems protected by automatic sprinklers and against vandalism and other adverse effects including falling equipment or debris. This can typically be achieved by securing conduit tight to building structural elements.
4. **Interior exit stairway:** Wiring may be located within the 2-hour FRR stairwell it is servicing, when routed such that it is adequately protected against vandalism and other adverse effects including falling equipment or debris and in accordance with IBC Chapter 7. This can typically be achieved by securing raceway tight to building structural elements.

11.3.2 Panel separation. When shaft pressurization (smoke proof enclosure ventilation) power and control wiring, panels or equipment is located within a 2-hour FRR electrical room, such equipment must be separated by a 2-hour FRR fire barrier from all other systems within the room.

11.3.3 Common raceway. Wiring for stairwell and elevator hoistway pressurization systems may be included in the same raceway, cable, box, or cabinet with other emergency NEC 700 system feeders only up to the first distribution point after the emergency transfer switch, in accordance with Article 700 of the NEC as amended by the City of Bellevue. Where there is more than one emergency system feeder tapped from the emergency transfer switch, the separation of the stairwell and elevator hoistway pressurization system wiring from all other system wiring must begin at the emergency transfer switch. However, the 2-hour FRR separation must be provided for the conductors from the emergency source of power to the pressurization equipment.

11.3.4 Alternate methods and materials. Design proposals that do not conform to one, or a combination of the above methods will require submittal of an alternate materials, design and methods proposal, demonstrating compliance with the provisions of NEC 700.10 (c) and IBC 909.1.

11.3.5 Drawings. The chosen method of conductor protection shall be depicted and described on associated electrical, architectural and fire alarm drawings submitted as part of the smoke control permit.

11.4 Auxiliary equipment. The requirements for the primary power supply shall apply to all auxiliary panels and equipment. These shall include: A dedicated circuit, marked at the electric panels location and the smoke control panel or auxiliary panels locations. All primary power conductors shall be physically protected.

11.5 Data circuits. Signaling Line Circuits or other data control circuits shall be arranged so that a short, ground or open fault within a smoke zone will not cause the loss of initiating devices, monitoring devices, building control devices, fans, or dampers in any other smoke zone of the protected premises.

11.6 Marking and identification. All portions of the control system must be identified in the field in accordance with the National Electrical Code Article 700.9 as amended by the City of Bellevue. This includes all applicable junction boxes, control tubing, temperature control modules, relays, damper sensors, automatic door sensors and air movement sensors. All junction boxes and covers for the smoke control system (including all portions of the fire detection system which activate smoke control) shall be externally identifiable.

11.6.1 Emergency systems. All boxes and enclosures larger than 6x6 in. (including transfer switches, generators and power panels) for emergency circuits shall be permanently marked with an identification plate that is orange in color so they will be readily identified as a component of the emergency circuit or system. All other device and junction boxes for emergency systems and circuits shall be orange in color, both inside and outside.

11.6.2 Smoke control systems. All boxes and enclosures larger than 6x6 in. (including transfer switches, generators and power panels) for smoke control

power and circuits shall be permanently marked with an identification plate that is orange in color with a yellow diagonal stripe so they will be readily identified as a component of the smoke control circuit or system. All other device and junction boxes for smoke control systems and circuits shall be orange in color both inside and outside. Cover plates shall be orange in color with a yellow diagonal stripe. Raceways for stair and elevator pressurization system wiring shall be identified by labels or color coding and shall be visible at the time of inspection.

11.6.3 Smoke control equipment. All fans, dampers, and powered doors required to be tested as part of the Smoke Control system are required to be labeled with a with an identification tag that is orange in color with a yellow diagonal stripe, an inventoried label or as otherwise approved all of which would include the identification that this is a piece of Smoke Control system.

12 Testing, inspection and equipment. Smoke control systems shall be inspected and tested by special inspector in accordance with IBC 909.18, 909.20 and this standard (ref.: IFC 909.3).

Point of Information

Prior to issuance of the smoke control permit (FH), the following testing procedures in addition to the Special Inspector test procedures in accordance with IFC Section 909.20.1 must be submitted, reviewed and approved:

- Any known phased occupancy scenarios
- Ongoing confidence (maintenance) testing program

12.1 Equipment. Equipment used to test, measure pressure, air flow and/or pressure differential shall be in good working order and calibrated by a recognized agency in accordance with nationally recognized standards. Copies of the calibration records shall be submitted to the Special Inspector and are to be included with the final report.

13 Special Inspector. The role of the special inspector is to review the installation for conformance with the approved design approach and code.

13.1 Approval. Prior to issuance of the FH permit, the owner shall designate a Special Inspection Agency. The SIA must meet the criteria outlined in IBC Sections 909.18.8, 1704.2.1, 1705.18.2 and 13.6 herein.

13.2 Special Inspector qualifications. The City of Bellevue does not certify or list special inspection agencies (SIA) or special inspectors (SI). The qualifications for special inspector are described below.

13.2.1 Required expertise. Smoke control special inspection qualifications are outlined in IBC Section 909.18.8.2, 1704.2.1, and 1705.18.2. These sections indicate that agencies (rarely will a single entity have all of these qualifications as a single special inspector) shall have expertise in mechanical and fire protection engineering and certification as an air balancer. The combination of persons, agencies or firms can vary, but the qualifications must include all of the disciplines prescribed.

13.2.2 Agency requirements. Agencies serving as the SIA must have a Washington State Registered (P.E.) overseeing the special inspection process. The

combination of persons, agencies or firms can vary, but the qualifications of the team providing special inspections must include at a minimum all of the disciplines prescribed in IBC 909.18.8.2. Individuals witnessing the testing must be employees or subcontractors of the SIA.

13.2.3 Individual requirements. Individuals serving as the SI shall be a Washington State Registered (P.E.) Fire Protection, Mechanical, or Electrical Engineer with the qualifications outlined in IBC Section 909.18.8.2., 1704.2.1, and 1705.18.2. A P.E. with smoke management commissioning experience may serve as the SI to coordinate and verify all components of the smoke-control system within his or her area of expertise. The SI is required to provide a certificate of compliance in accordance with this document.

13.2.4 Allowed to be SI. The P.E. who prepared the rational analysis and Detailed Design Report may serve as the SI.

13.2.5 Conflict of Interest The vendor, technician, installing contractor or air balancer cannot serve as the SI nor be a subcontractor or affiliate to any of the aforementioned entities as a Special Inspector.

13.2.6 Air flow and pressure testing. All airflow and pressure testing must be done by an approved Associated Air Balance Council (AABC), National Environmental Balancing Bureau (NEBB), or Testing Adjusting, and Balancing Bureau (TABB) agency. The Special Inspection agency shall review all documentation prior to submission of final report. In accordance with IBC Section 909.10.5, fan curves shall be re-plotted by the air balancing agency after final balance to confirm stable performance.

13.3 Special Inspector Testing.

13.3.1 Coordination. The Special Inspection Agency must be provided with the approved smoke control Detailed Design Report, the Special Inspection Test Procedures, the control diagrams, and the approved smoke control permit plans.

13.3.2 Written test procedures. The testing shall follow the Special Inspector Test Procedure approved as part of the detailed submittal.

13.3.3 Deficiencies. The SI/SIA shall give written notice to the owner of any deficient or non-complying smoke control system feature that is discovered and is not corrected prior to the end of the day. All deficient or non-complying aspects shall be corrected.

13.3.4 Okay to test. Is an inspection request on the FH permit used by Building, Electrical, and Mechanical that ensures a level of completeness where the Special Inspector can begin testing pressure differentials for the final report. Upon approval of Building, Electrical and Mechanical Inspectors, The Bellevue Fire Department will authorize the approval to begin FH testing for the final report Inspection request codes for Okay to test: Building 265, Mechanical 339, and Electrical 457) System components should be pre-tested by the installing contractors prior to system testing witnessed by the special inspector.

13.3.5 Special inspection and acceptance test requirements. Each smoke control system shall be inspected and tested in accordance with IFC 909.3, 909.10

through 909.19, Chapter 8 of NFPA 92, ASHRAE Guideline 1.5, and as described in this section. The following is a list of example items that must be tested:

1. Each individual fire alarm initiating device which activates any portion of the smoke control system must be verified to provide all applicable output functions in accordance with IBC 909.18.7. Each detection device must also be tested in accordance with 909.18.1. Where testing would result in the repeated start and stop of large fans, such fans may be disabled or bypassed provided that verification that the proper system output to the fans is transmitted during testing while the FSCP is constantly attended. Proper operation of disabled equipment shall be restored and demonstrated upon receipt of an actual alarm event, or at the conclusion of the testing period, whichever occurs first. It is acceptable to conduct alarm confidence testing in conjunction with this test. Further, the output of the Fire Alarm Controller must be verified but it is not required that the equipment be put through complete functional tests.
2. Power systems shall automatically transfer to full standby power within 10 seconds of failure of the primary power per COB Ordinance.
3. Smoke Barrier construction shall be evaluated in accordance with IBC Section 909.5 requirements.
4. The pressure difference across door shall not exceed a 30-pound force to set the door in motion in accordance with IBC Section 1008.1.2.
5. Pressurized shafts shall have a positive pressure relative to the building, including where a shaft opening exists to a pressurized zone, measured with all stairway doors closed under maximum anticipated stack pressures.

13.4 Certificate of compliance by the special inspector. A certificate of compliance must be provided by the special inspector certifying that the referenced property is in substantial compliance. The certificate shall identify the company and special inspector that performed the testing, name, date and address of the property being tested. The following statement must also be included:

"I have reviewed the report and by personal knowledge and on-site observation certify that the smoke control system is in substantial compliance with the approved design documents, and to the best of my understanding complies with requirements of the applicable codes as identified in the smoke control report."

13.5 Special Provisions for the City of Newcastle. In addition to the special inspections provisions previously outlined, projects in the City of Newcastle will also require specialized inspectors for mechanical and electrical systems associated with smoke control. The special inspector(s) shall be approved by both the Building Official Marshal.

14 Commissioning by the Bellevue Fire Department.

14.1 When a building is deemed ready to initiate final Commissioning by the Responsible Person in Charge, the Commissioning shall be completed in accordance with Special Inspector Test Procedures, and this section. Operational and Performance testing will be witnessed by the Bellevue Fire Department.

14.1.1 Prior testing required. The special inspector testing procedure must be completed prior to system commissioning testing by the Bellevue Fire Department.

14.1.2 Procedures. The SI/SIA will arrange for system commissioning by the Bellevue Fire Department-Fire Prevention Division, to include witnessing contractor executed operational and performance testing of the system. The SI Test Procedures shall be referenced with regard to methodology for testing selected system components and features. All testing shall be conducted in accordance with approved permit documents.

14.1.3 Commissioning witnessed by the Bellevue FD. Commissioning witnessed by the Bellevue FD will consist of up to four components.

1. Operational Testing
2. Pressurization Testing (if applicable)
3. Exhaust or airflow method (if applicable)
4. Other designs (if applicable)

14.1.4 Operational Testing Witnessed by the Bellevue FD. Commissioning shall be conducted in accordance with applicable sections of the SI Test Procedures. Each control sequence of the smoke control systems must minimally include the following:

1. Manual control of smoke control system equipment serving select smoke-control zones shall be demonstrated.
2. Manual activation of equipment via FSCP while the system is in normal status; may result in transmission of trouble signal to FACP.
3. Trouble signal transmitted to FACP when FSCP manual control set to OFF or CLOSED position while system is in normal status.
4. Correct automatic system operation via a minimum of one of each type of initiating device (i.e. smoke detector, waterflow switch, manual station) and sequence of operation serving each smoke-control zone.
5. Manual control via FSCP when system is active to activate inactive system components and disable active system components. Manipulation of the system to achieve each possible combination of switch configurations need not be demonstrated. Manually override the operation of a sampling of fans and/or dampers during each test, taking care not to damage system components.
6. For each sequence of operations, visual confirmation that controlled components in associated active zones have assumed the correct operating condition for the type of alarm initiating device and the location of initiating device. Proper annunciation shall be confirmed also at the FSCP.
7. Self-test abort (when applicable). The system must demonstrate that upon initiation of an alarm, it will properly abort the self-test and initiate the programmed smoke control sequence of operation.
8. Return all override switches to their "Auto" position.

14.1.5 Pressurization testing witnessed by the Bellevue FD. Pressurization testing shall be conducted in accordance with applicable sections of the SI Test Procedures as follows:

1. For each building or tower, the testing must demonstrate proper system operation and performance tests, including observations and measurements of all aspects of the smoke control system, in no fewer than 3 smoke zones and a minimum of 10% of the building's smoke zones. Smoke zones will be selected at the Fire Prevention Officer's discretion and are generally intended to evaluate conditions at or near the bottom, middle and top of a tower; every pressurized shaft shall be evaluated. Proper system performance is demonstrated by achieving stated performance criteria.

2. Proper function of smoke control system in select smoke-control zones, including a minimum of one of each initiating device serving the zone (i.e. smoke detector, waterflow switch, manual station) and sequence of operation. Required pressure differentials across smoke barriers and maximum door opening forces must be demonstrated.

3. Proper function of any smoke control fan equipment via automatic initiation and manual control if not observed during evaluation of select smoke-control zones.

4. During at least one test, for buildings requiring elevator recall, confirm that the elevators return to the designated return floor and perform as required.

5. Return all override switches to their "Auto" position.

14.1.6 Exhaust or airflow method (IFC 909.7 or 909.8): Atria or other spaces utilizing the exhaust and/or airflow method. The testing must demonstrate proper system operation and performance of 100% of the smoke control equipment. Smoke control system features to be evaluated during system commissioning include:

1. Visual observation of elements described above.
2. Visual inspection of associated smoke barriers for absence of obvious deficiencies.
3. Proper function of smoke control system, including a minimum of 1 of each initiating device (i.e. smoke detector, waterflow switch, manual station) and sequence of operation. It shall be demonstrated that airflow toward the fire does not exceed 200 feet per minute, per IFC Sections 909.7.1 and 909.8.1.
4. Manual control of smoke control system equipment shall be demonstrated.

14.1.7 Other designs. For all other systems, conduct performance tests, observations and measurements of all aspects of the smoke control system at a minimum number of locations to demonstrate proper performance as approved by the BFD. Each test shall attempt to involve as many different fan systems as practical. Other smoke control systems or features shall be evaluated as requested by the Fire Prevention Officer based on the approved design and installed condition to demonstrate proper operation of the smoke control system and features.

14.1.8 Disabling fans. Where Operational or Performance Testing would result in the repeated start and stop of large fans, such fans may be disabled or bypassed provided that verification that the proper system output to the fans is transmitted during testing while the FSCP is constantly attended. Proper operation of disabled equipment shall be restored and demonstrated upon receipt of an actual alarm event, or at the conclusion of the testing period, whichever occurs first.

14.1.9 Chemical smoke. Testing involving chemical smoke or a tracer gas can be used for tracer test during acceptance testing to visually verify air movement.

14.1.10 System failures. If any smoke control system deficiency is discovered during system commissioning, system commissioning may be ceased at the Fire Prevention Officer's discretion until such time as testing in accordance with Section 13.6 above can be repeated as necessary to resolve the deficiency and a revised report is submitted in accordance with this Section.

14.1.11 Certificate of compliance by the designer. Upon completion of the commissioning report, IBC Section 909.18.8.3 requires the responsible registered design professional to review the report. When satisfied that the smoke management system has been properly inspected and tested and meets the acceptance criteria, the design professional must affix his or her seal and sign and date the report. They must also include the following statement:

"I have reviewed the report and by personal knowledge and on-site observation certify that the smoke-control system is in substantial compliance with the design intent and to the best of my understanding complies with the requirements of the code."

15 Smoke control record documents. The following items must be maintained current in the fire control room or other approved location for the life of the building: Items one and two must be submitted to and approved by BFD prior to the start of special inspections.

1. Approved control diagrams must be kept accessible in the Fire Control Room for the life of the building and must be updated when changes are made to the building.
2. Plans showing the devices and equipment which make up the smoke control system. This will include control diagrams in accordance with IBC 909.15, all smoke barriers, applicable initiating devices, controllers, fire alarm control panel, fire-fighter's smoke control panel, facility temperature controls, control wiring or tubing, isolation valves, relays, doors, dampers, fans, all supervision devices.
3. Every device must have a distinct identifying address. For purposes of this requirement, BFD will accept the detailed design drawings, provided all of the devices listed above are shown, and no extraneous equipment other than fire alarm devices.
4. A detailed event matrix (each device must be identified by individual address exactly as it is shown on the control diagram plans above);
5. Documents describing the proper operation and maintenance requirements of each component of the smoke control system, including fan curves for the smoke control fans in the building.
6. Maintenance logs and quarterly testing logs.
7. The approved smoke control Detailed Design Report.
8. UUKL panel self-test printouts (when applicable).

9. The final special inspection report.

15.1 Record modifications. Changes as a result of final installation, testing, or a change to the system design must be documented in the special inspection report, prepared in accordance with IBC Section 909.18.8.3. Record drawings shall include an accurate depiction of risers, raceway, conduit, all wire runs, cable identification, conduit size, location of junction boxes, terminal boxes, sources of power, devices, sensors, equipment, controlled equipment (motor starters, fans, pumps, valves, dampers, etc.).

16 Routine maintenance and testing. The system must be maintained in accordance with the manufacturer's instructions and IFC sections 909.12, and 909.20.1 - 909.20.5. See Appendix E for additional information.