



## Fire Department Smoke Control Systems Plan Submittal, Design, Installation, and Inspection Requirements

Effective Date: 1/1/2020

### 1.0 Purpose

- 1.1 This policy outlines the minimum requirements for Smoke Control Systems, including design criteria, required submittals and documentation. This policy applies to both new and existing Smoke Control Systems.
- 1.2 2019 California Fire Code (CFC), 2019 California Building Code (CBC), and 2015 NFPA 92 provide criteria for Smoke Control Systems, but the provisions are limited to providing a tenable environment for the evacuation or relocation of the occupants. The CFC/CBC specifically state that the design criteria are not intended for the preservation of contents, the timely restoration of operations, or for assistance in fire suppression of overhaul activities. The design engineer should keep these constraints in mind because the owner's fire safety objectives may include property protection and continuity of operations. Hence, a Basis of Design (BoD) report with a description of the system's purpose and design objectives will be required. San Jose Fire Department (SJFD) makes compulsory the minimum requirements for an acceptable level of safety as required by the code/standard unless modified for cause such as Alternate Means or Methods of Constructions (AMMC) or Variance.
- 1.3 Equivalent or alternate methods must be pre-approved by the Building and Fire Departments. Examples of alternate methods include but are not limited to: natural ventilation (Those not applicable to CBC 909.20.3 - natural ventilation alternative within smokeproof enclosures), utilizing garage CO exhaust, entirely passive systems, and other methods not specifically prescribed under CBC/CFC Section 909. Additional justification and analyses are required to show the method provides an equivalent level of life-safety to prescribed methods, typically consisting of providing documentation and supporting calculations.
- 1.4 Smoke control is a comprehensive approach to fire safety in a building, established by the integration of various building characteristics, features, or systems. Effective smoke control starts with providing automatic sprinkler protection. Properly designed, installed, and maintained automatic sprinkler systems will assist in accomplishing any smoke control by limiting fire growth and therefore the quantity of smoke produced. *Note: Typically, buildings requiring smoke control will also require a fire sprinkler system complying with Section 903.3.1.1 of the CFC. However, per CFC 909.6.1, in buildings permitted to be other than fully sprinklered, the Smoke Control System shall be designed to achieve pressure differences not less than two times the maximum calculated pressure difference produced by the design fire.*
- 1.5 The building codes also address smoke control by varying degrees of compartmentation ranging from corridor walls to smoke barriers and fire barriers. Control features required in air handling systems also address smoke control by reducing the likelihood that smoke will spread through the air handling systems to other parts of the building.
- 1.6 Smoke control is typically accomplished by either containing smoke to the zone of origin or managing the smoke with a defined space, typically a large volume. As defined in section 4.1.2 of NFPA 92: Standard for Smoke Control Systems, the specific design objectives for a Smoke Control System will include one or more of the following:
- 1.6.1 Containing the smoke to the zone of fire origin
  - 1.6.2 Maintaining a tenable environment within exit stairwells for the time necessary to allow occupants to exit the building
  - 1.6.3 Maintaining a tenable environment within all exit access and smoke refuge areas access paths for the

time necessary to allow occupants to reach an exit of smoke refuge area

1.6.4 Maintaining the smoke layer interface to a predetermined elevation in large volume spaces.

1.7 Smoke Control Systems require unique testing strategies and involve coordination between construction disciplines including the Architect, Mechanical Engineer, Electrical Engineer, Fire/Life Safety Consulting Engineer, General Contractor, Mechanical Contractor, Electrical Contractor, Controls Contractor, and the Fire Alarm Contractor. Further, each piece of the system from each discipline requires individual testing prior to the integrated test of the system. This policy is a brief description of the total process involved in proving to the Authority Having Jurisdiction (AHJ) that the Smoke Control System meets the design goals and is operational for the purpose of occupying the building.

## 2.0 **Permit**

2.1 Prior to submittal of application for Building Permit, a preliminary smoke control meeting shall be scheduled with SJFD. At such time the BoD report will be presented. Although generally conceptual in nature, the BoD shall include all aspects required in the final Smoke Control Report other than calculations, supporting data, and diagrams. The acceptance of the BoD report does not constitute final approval by SJFD.

2.2 We no longer accept paper plans. Plans are to be submitted using the SJ ePlans system. Uploaded files must be correctly named. See “Fire SJ ePlans File Naming Convention”. To acquire an installation permit for the automatic sprinkler system, submit the following to the San Jose Fire Department’s Bureau of Fire Prevention (BFP):

2.2.1 To apply for fire and hazardous materials systems permits, please schedule an appointment and complete your application submittal using SJePlans.

2.2.2 A completed Fire Protection and Special Systems Installation Permit form (permit application) – for project/facility business name, if the project is speculative, type-in “SPEC.” followed by the anticipated occupancy (e.g., SPEC OFFICE, SPEC. WAREHOUSE, ETC).

2.2.3 The San Jose Fire Department Plan Check Comments (Plan Check Directives) – this may be obtained from the General Contractor or Architect.

2.2.4 All approved variances or AMMCs that are relevant to the project – these may be obtained from the General Contractor or Architect.

2.2.5 Shop quality plans, system equipment list, component cut sheets/ data sheets, California State Fire Marshal (CSFM) listing documentation, and supporting documents for the proposed Smoke Control System. Construction documents shall include sufficient information and detail to adequately describe the design and properly facilitate installation.

*Note: It is the responsibility of the Architect and/ or applicant to coordinate documentation with all trades.*

2.2.6 Include the set of Electrical, Mechanical, and Architectural plans relevant to the Smoke Control System package.

2.3 See current Fee Schedule.

2.3.1 Initial permit fees will be collected when plans are submitted. Permit fees are non-refundable.

2.4 Installation, alteration, or demolition of a system shall not commence prior to the approval of plans and the issuance of a permit.

2.5 Four types of reports are required: (1) Basis of Design, (2) the Smoke Control Report, (3) Special Inspection Program, and (4) Special Inspection and Testing Final Report. Acceptance of the BoD is required prior to submittal of a Building Permit application. Approval of the Smoke Control Report and Special Inspection Program are required before the Smoke control Permit is issued. Provide the (3) Final Testing Report (CBC 909.18.8.3) and Identification and Documentation (909.18.9) to SJFD and Owner at project completion.

*Note: The Smoke Control Report and Special Inspection Program may be combined into a single report.*

- 2.6 The approved permit and a SJFD approved set of plans shall be kept at the project site until final approval of the permit, after which they shall remain in the possession of the owner.

### **3.0 Qualifications**

#### 3.1 Smoke Control System Designer's Qualifications

- 3.1.1 The building owner shall engage an Architect, Mechanical Engineer, and Electrical Engineer as the Architect and Engineers of Record to prepare Smoke Control System design documents. All design professionals shall be licensed in the State of California. The Architect and Engineers of Record shall be responsible for reviewing and coordinating all submittal documents, including reports and deferred submittals, for compatibility with the building design. The smoke control professional shall be experienced in Smoke Control Systems and provide credentials demonstrating such.

#### 3.2 Special Inspector

- 3.2.1 The special inspector shall be employed by the owner, owner's agent, Architect, or Engineers of Record, but not the contractor or any other person responsible for the work.
- 3.2.2 The special inspector shall be a qualified person who shall demonstrate compliance with International Accreditation Service, Inc (of ICC) AC291, Table 1 item 16, to the satisfaction of SJFD, for the inspection and testing of Smoke Control Systems. An interview with the SJFD may be required to prove competence; submittal of documented qualifications and experience accompanied by a letter of request shall be submitted for review. The interviewee(s) shall pay meeting fees at the current rate to the SJFD. (CBC 909.18.8.2, 1704.4.2)
- 3.2.3 The special inspector may be the Smoke Control System Designer, if qualified per 3.2.2 herein.
- 3.2.4 Special inspection may be performed by a qualified individual or a team comprised of a California Licensed Professionals, each having smoke management testing and inspection experience and each coordinating and verifying all elements of the Smoke Control System within their area of expertise.

### **4.0 Basis of Design**

- 4.1 The Basis of Design (BoD) report shall describe the system's purpose and design objectives. Effective smoke control in buildings requires coordination between passive and active fire protection features and fire protection systems. The requirement to provide smoke control in a building is dictated either by the CBC/ CFC, or by the fire safety objectives for a specific project. Even when the system is provided based upon a code requirement; the Design Engineer shall consider other design objectives the owner might desire. Some prescriptive code criteria are based on the need to maintain a tenable environment and do not consider property protection or continuity of operations. The Design Engineer should prepare a BOD report that not only identifies the design objectives, code requirements, and system calculations, but should also explicitly state the design assumptions, system operation logic, and commissioning procedures. The Engineer shall indicate if the objectives will be accomplished with smoke containment systems (e.g., stair pressurization) or smoke management systems (e.g., smoke exhaust). While often overlooked, natural smoke filling and gravity smoke venting may be used as smoke management systems.
- 4.2 The BoD then needs to address the design assumptions and design criteria. Design assumptions include items such as ambient conditions (wind effect, climate, and temperature), leakage rates, and the impact and reliability of other fire protection systems (impact of automatic sprinkler protection on the heat release rate). With respect to the effect of wind, the CBC/ CFC requires that the design considerations are consistent with the wind loading provisions in the CBC/ CFC.
- 4.3 In some cases, the applicable codes and standards may have varying criteria with respect to specific design assumptions. Provide technical justification if any portion of the design basis does not conform to CBC/ CFC (e.g. NFPA 92). The design fire(s) must be identified in the BoD. Engineers may use either steady fires with constant heat release rates, unsteady fires with heat release rates that vary with time, or a combination thereof. The design fire(s) should be determined by considering the type of fuel, fuel spacing, and configuration. Another critical factor to be determined is the location of the fire(s), which also will impact the rate of smoke

mass production depending on the type of plume resulting from the fire location.

- 4.4 Per CFC 909.4.6, all portions of active or engineered Smoke Control Systems shall be capable of continued operation after detection of the fire event for a period of not less than either 20 minutes or 1.5 times the calculated egress time, whichever is greater.
- 4.5 While the applicable codes and standards prescribe criteria by which Smoke Control Systems are to be designed, a number of common oversights frequently occur:
- 4.5.1 **System start-up time:** The system start-up time needs to include the time for detection of the fire, signal processing time, and the system activation time. Specific oversights involve improperly estimating the time to detection or assuming that system activation commences immediately upon activation, thereby ignoring signal processing time, fan start-up times, or the time needed for dampers to open or close. (CFC 909.17)
- 4.5.2 **Big fires dictate the design:** While bigger fires may result in higher smoke production rates and pressure differences, smaller and slower developing fires may result in delayed detection times or a longer time for the sprinkler system to activate. There are some instances in which a smaller or slower developing fire may present challenges to the system.
- 4.5.3 **Makeup air:** While some designs fail to even consider the need for providing makeup air for exhaust systems, others fail to consider the impact of the makeup air. What will be the impact of makeup air? What impact will the velocity have on plume dynamics and doors opening or closing? When answering these questions, consider the periodic testing and inadvertent operations of the system. (CFC 909.7)
- 4.5.4 **Interaction with other systems:** These may include other systems, typically HVAC systems, in the building and other Smoke Control Systems. CFC section 909.4.7 requires one to consider the interaction effects of multiple Smoke Control Systems.
- 4.5.5 **System reliability:** Reliability data for various fire protection systems and the components of such systems is often hard to obtain. Even where data may exist, the range of reliability of such systems documented in various studies may be significant. As an alternative, the Design Engineer might consider evaluating fire scenarios in which individual systems and features fail. This is consistent with a design fire scenario often required for performance-based designs (see paragraph 5.5.3.8, NFPA 101: Life Safety Code-2018 for reference).
- 4.5.6 **Coordination of design documents:** Frequently, the design of a Smoke Control System is not prepared by a single engineer, such as a Fire Protection Engineer, but instead by multiple engineers, each practicing within their areas of expertise. The BoD must demonstrate the coordination effort by business name, responsible party full name, and signature of all participants on the last sheet of the drawing set.

## 5.0 Smoke Control Report

- 5.1 A written report, titled Smoke Control Report, shall be authored by the smoke control consultant or the Mechanical Engineer of Record and submitted to the Building and Fire departments for review and approval. The Smoke Control Report is typically a multi-phased approval process and submitted as follows:
- 5.1.1 The Smoke Control Report shall be submitted as part of the review and approval process of the Building Permit. Submit the Smoke Control Report and Special Inspection Program with the Architectural, Mechanical, and Electrical drawings, as part of the drawings' review and approval process.
- 5.1.2 If the Smoke Control Report is revised after approval, the revised report shall be resubmitted with all items required and provided in the original submittal and revised plans showing applicable, **clouded** changes.
- 5.2 The Smoke Control Report shall include the following information:
- 5.2.1 **Cover Page:** Provide a cover page showing the facility name, address, revision number, permit application number, date of submittal, and preparer.

- 5.2.2 **Signature Page:** Provide a completed signature page with final report. Signatures shall include all of the following: Architect of Record, Mechanical Engineer of Record, Electrical Engineer of Record, Smoke Control System Designer, and Owner.
- 5.2.3 **Code References:** List all applicable codes standards including editions, approved equivalencies, and pre-application agreements for the project. Provide reference to and include copies in appendices of all approved variances, AMMCs, and pre-application agreements relating to smoke control.
- 5.2.4 **Building Description:** Provide a general narrative overview of the building and its uses.
  - 5.2.4.1 Include the building height; number of stories; basement levels; gross floor area; types of occupancies and type(s) of construction; and approved variances and equivalencies.
  - 5.2.4.2 Identify the architectural features that affect Smoke Control Design and Life-Safety: size of atriums; location of fire/smoke barriers; fire-safeing; engineering judgments; make-up air openings; operable windows; vents; floor and wall openings; door closers; ceiling heights; pressurized and non-pressurized stair enclosures; open stairs; shafts used as ducts; duct construction and material; exiting; horizontal exits; heights and types of surrounding structures/buildings; elevators for firefighters use; etc.
- 5.2.5 **Fire Suppression Systems:** Provide a concise narrative overview of the Fire Suppression System(s).
  - 5.2.5.1 Identify the types of systems and areas served (zoning); major equipment; design criteria; and basic operation.
  - 5.2.5.2 Identify the type; location and quantity of flammable or combustible fuel; and hazardous/toxic materials, if any.
- 5.2.6 **HVAC and Ventilation Systems:**
  - 5.2.6.1 Provide a concise narrative overview of the HVAC systems whether or not they are used for smoke control.
  - 5.2.6.2 Identify the types of systems and areas served (zoning); major equipment; fire and smoke dampers type and class including link temperatures; design objectives; and basic operation.
  - 5.2.6.3 Identify where fire dampers have actuating devices with increased operating temperatures (not more than 350F) due to smoke control (CBC 717.3.3.1) and specify the actuating temperatures for each type of fire damper.
  - 5.2.6.4 Specify damper response time design per CBC 909.17.
  - 5.2.6.5 Identify where fire/smoke dampers are not provided due to smoke control (CBC 717.2.1; 717.5.3, #1.3, #4).
  - 5.2.6.6 Identify where fire/smoke dampers are not provided at shafts due to 22-inch sub-ducts and continuously operating exhaust fans connected to the standby power system (CBC 717.5.3, #1.1, #2.2, #2.3).
  - 5.2.6.7 It should be noted, that the building industry commonly distinguishes between active and passive dampers. This has no basis in the CBC as neither Section 717 nor 909 distinguish between active and passive fire/smoke dampers. As such, all fire/smoke dampers within a building requiring a Smoke Control System shall comply with all requirements of Section 909 including, but not limited to individual monitoring of open/close status using limit or proximity switches and incorporation into the UUKL self-test function required per UL 864 (CBC 909.12). This is particularly important where the fire/smoke damper is the primary means of preventing smoke migration.
- 5.2.7 **Power Supply Systems:** Provide a concise narrative overview of the primary and standby power sources for the Smoke Control Systems.
  - 5.2.7.1 Include the locations of the standby power source; transfer switches; normal power transformers and switchgear; and describe the independent routing of the normal and standby power distribution systems (CFC 909.11).
  - 5.2.7.2 Each stairway pressurization fan power shall be supplied through a raceway separate from other stairway pressurization fan power supplies beginning at the automatic transfer switch.



- 5.2.7.3 Address the need for uninterruptible power supplies and power surge protectors (CFC 909.11.1).
- 5.2.7.4 Provide a table to indicate all equipment required to be connected to emergency power.
- 5.2.7.5 Specify the required duration the Stand-by/Secondary Power supply is required to operate the Smoke Management System (CFC 909.4.6).

*Note: Standby power is usually required for continuously running (sub-ducted) exhaust fans per Exception 2.3 of CBC 717.5.3*

5.2.8 **Fire Alarm, Detection, and Control Systems:** Provide a concise narrative overview of the Fire Alarm, Detection and Control Systems as they relate to the Smoke Control System.

- 5.2.8.1 Include the Building Management System (BMS) where used for or interconnected to the Smoke Control System. Identify the smoke control components that must be monitored for proper operation (supervised end-to-end) and the method of supervision. Address the listing of fire detection and control systems (in UL category UUKL) including the building management system where used for smoke control (CFC 909.12).
- 5.2.8.2 Damper supervision and control at the Firefighters Control Panel is required for all active-passive zone boundaries (e.g., corridor to residential units). Group control and interlocking on fans with dampers is allowed. The minimum acceptable supervision and control required will indicate proper damper operation and fault condition for smoke control operation i.e. open and closed. These dampers shall be included in the UUKL Self-Test and fail-safe in the closed position.
- 5.2.8.3 Fan supervision and control at the Firefighters Control Panel is required for all fans used in the Smoke Control System (CFC 909.16). Each fan and damper shall have a separate annunciator lights and controls, unless otherwise approved. Power (amperage and voltage) shall be supervised at the downstream side of the electrical disconnects (CBC 909.12.1) and a positive means of verifying airflow shall be provided (pressure switch/airflow sensor) (NFPA 92 6.4.5.4) at each fan and indicated on the Firefighters Control Panel as a fault condition if failure occurs.

*Note: Supervision and control of additional fans may be required in cases where an alternate/ equivalent method is approved (e.g., where garage CO exhaust is utilized for smoke control, and use of supply fans are necessary for adequate smoke exhausting).*

5.2.9 **Firefighters Control Panel:** Include a narrative description of the Firefighters Control Panel. Refer to the Fire Alarm Plan, Detection, and Control Systems section above for additional information. See CFC 901.6.2.2 for integrated systems.

5.2.10 **Smoke Control/Management Systems:** Provide a concise conceptual narrative overview of the Smoke Control/ Management Systems: concepts, approaches, and design objectives; types of systems; zoning; major equipment; analysis methods; and basic operation and activation sequences.

- 5.2.10.1 As applicable provide a detailed description of each smoke control zone including: occupancy; fire suppression and fire alarm systems, including specific design criteria required by the Smoke Control System; construction type, ratings, and leakage values; door and window types, ratings, leakage values, and closing methods; operable and fixed exterior openings; expected fire size/loads, combustible materials; means of egress; method(s) of smoke control; analyses methods, with referenced equations for hand calculations, name and version of software; design scenarios addressed, including specific weather data used for each scenario; summary of results including but not limited to tenability, timed egress (i.e., ASET vs. RSET); sprinkler type and activation times; activation methods.
- 5.2.10.2 Provide small-scale drawings, 11" x 17" minimum, showing the location of all smoke zones, including passive smoke zones; include the drawings as an appendix to the Smoke Control Report.
- 5.2.10.3 Provide rational analyses of the design; address the stack effect, temperature effect of the fire, wind, HVAC interactions, climate and minimum duration of operation (CFC 909.4, 909.10). This includes any HVAC or non- smoke control related ventilation equipment such as fans intended to run continuously even during a fire event.

- 5.3 For Smoke Control Systems using the passive method, identify the total leakage area for typical smoke barriers (CFC 909.5.1), and provide calculations, simulation results (CONTAM, FDS, etc.), and other technical justification as necessary to demonstrate that tenability is maintained in zones adjacent to each passive zone in the event of a fire with the given minimum leakage areas.
- 5.4 Address the probable temperatures to which fans, dampers and ducts may be exposed in a fire (CFC 909.10).
- 5.5 Identify smoke zone openings which must be open or closed for proper operation (e.g., doors, windows, dampers, and louvers). Identify smoke zone openings that are supervised in the open and/or closed positions.
- 5.6 Address the piston effect of elevators. For single car elevator shafts provide calculations to show the Smoke Control System is not overcome by the piston effect.
- 5.7 For Smoke Control Systems, identify the system components tested weekly by the automatic self-test feature (CFC 909.12; UL 864).
- 5.8 **Design Fundamentals:** Where applicable the following Guidelines shall apply:
- 5.8.1 **Design Fire:**
- 5.8.1.1 A hazard analysis shall be provided in the Smoke Control Report to determine smallest to largest fires expected. Provide a rational analysis of design fires. Address the fuel characteristics (e.g., toxicity, particulate yield, and growth rate); fuel spacing and configurations (radiant heat); heat-release assumptions (HRR); and sprinkler effectiveness assumptions (CFC 909.9).
- 5.8.1.2 Justify all assumptions and performance-based approaches.
- 5.8.1.3 Identify the computer program(s) and version(s) used, if any.
- 5.8.1.4 Include calculations and an input and output summary for each computer analysis design case. Specify the maximum ceiling jet temperatures and time lag expected before sprinkler activation. Provide supporting calculations.
- 5.8.2 **Tenability:** Tenability criteria shall be established based on documented studies. Items to be included, but not limited to, determining tenability criteria are the following: temperature and humidity, visibility (KS=3, light reflecting), toxicity assessment of combustion products and Fractional Effective Dose (FED).
- 5.8.3 **Egress Analysis:** Timed egress analyses shall be based on established engineering methods as provided in the listed references. Calculation of Available Safe Egress Time (ASET) and Required Safe Egress Time (RSET) with a minimum safety factor of two (2). ASET and RSET shall be calculated in phases/time segments: ignition-detection, detection-alarm, alarm-perception, perception-interpretation, interpretation-action, action-movement, and tenability limit only for ASET. Occupancy loads shall be determined by the CBC/ CFC or actual occupant load, whichever is greater. Consideration shall be made for handicapped and disabled occupants by reduction of travel speeds and flow rates. Lastly, duration of the smoke management system operation shall be the code required minimum or the maximum RSET, whichever is greater.
- 5.8.4 **Pressurization Method**
- 5.8.4.1 Stairway pressurization systems: Comply with CFC 909.20 for design of stair pressurization systems. Stairway air-injection points should be equally distributed with and shall not be located at the barometric relief vent level. Provide computer analyses for stairways greater than 50-feet in height. Stairway pressurization systems shall be dedicated. Use of vestibule transfer grills is not acceptable except for pressurization of large stairway transfer passageways.
- 5.8.4.2 Pressurization calculations may be based on maximum leakage values provided in the CBC/ CFC. However, architectural specifications for construction leakage may be used if documented in report (CFC 909.5).
- 5.8.4.3 A minimum pressure differential of 0.05-water gauge is required across all smoke barriers in fully sprinklered buildings. Un-sprinklered buildings shall comply with CFC

909.6.1 for pressure differentials. (CBC 909.6, 909.20.2.4). Identify the minimum and maximum pressure differences across smoke zone boundaries (smoke barriers) separating smoke zones. Include calculations for each smoke zone where appropriate. Analyses shall include openings (e.g., Z-ducts, operable windows, and/or doors). Openings such as fire smoke doors with automatic closers may be assumed closed.

*Note: Two sets of analyses shall be performed. The 1<sup>st</sup> set assumes openings in the closed position. The 2<sup>nd</sup> set shall assume possible openings equal to at least 25% on each side of the building of each floor throughout the building.*

- 5.8.4.4 Computer calculations and simulation files shall be provided for all buildings utilizing a zone model program that is valid for the application (e.g., CONTAM). State all variables used/required in the calculations and additional modifiers are available and used in the calculations and provide the information in the report (e.g., Wind Tunnel data). Hand calculations may be provided and/or required to verify computer calculations.
- 5.8.4.5 Base input data on the 1% annual extreme wind speeds and winter/summer dry bulb temperatures of 99.6% and 0.4% (See Table 2.1 of the Handbook of Smoke Control Engineering by John H. Klote, James A. Milke, et al.). Include prevailing winds, summer and winter, and all other wind directions considered critical to demonstrate wind effects. Current wind data shall be obtained from a nationally recognized authority (e.g., ASHRAE) and included in the report. Use of site-specific wind data is recommended.
- 5.8.4.6 For verification of commissioning and testing data, provide design calculations for the temperature(s) and wind condition(s) experienced during the testing.
- 5.8.4.7 All exterior openings and non-smoke management fans in smoke control zones and sub-zones that are operable in smoke control mode shall be included in the analysis in their normal position (e.g., windows, doors, scavenger fans, z-ducts and vents).
- 5.8.5 **Exhaust Method** Typically used in large volume areas (e.g., atriums (CFC 909.8)).
  - 5.8.5.1 Where space is a simple geometry (no obstructions, simple air supply/makeup air and exhaust, symmetrical square construction), exhaust of smoke may be done using NFPA 92 algebraic calculations.
  - 5.8.5.2 In spaces with complicated geometries and/or where tenability is used as design criteria, CFD analysis is required. A complicated geometry is where airflow is obstructed, multiple air supplies, or construction is asymmetrical.
  - 5.8.5.3 All exterior openings and non-smoke management fans in smoke control zones and sub-zones that are operable in smoke control mode shall be included in the analysis (e.g., windows, doors, scavenger fans and vents).
- 5.8.6 **Natural Ventilation**
  - 5.8.6.1 Designs that utilize natural ventilation (not applicable to CFC 909.20.3; Smokeproof enclosures) in whole or part of the smoke management system will require CFD or physical (scale) model analysis.
  - 5.8.6.2 The effect of outdoor wind, temperature, design fire size, and the surrounding structures are especially important in the design of natural ventilation smoke control. Multiple design scenarios that reflect a complete range of operating conditions are required to demonstrate the validity of the Smoke Control Systems' function.
  - 5.8.6.3 Wind speeds shall range from zero to the 1% annual extreme. Include prevailing winds, summer and winter, and a minimum of 4 other wind directions considered critical to demonstrate wind affect at the required wind speeds. Current wind data shall be obtained from a nationally recognized authority (e.g. ASHRAE) and included in the report.
  - 5.8.6.4 Ambient temperature used in calculations shall range from low to high annual extremes, dry bulb temperatures of 99.6% and 0.4%, as reported by the most current data obtained from a nationally recognized authority (e.g., ASHRAE).
  - 5.8.6.5 For verification of commissioning and testing data provide design calculations for the temperature(s) and wind condition(s) experienced during the testing.



- 5.8.6.6 A minimum pressure differential of 0.05-water gauge is required across all smoke barriers in fully sprinklered buildings. Un-sprinklered buildings shall comply with CFC 909.6.1 for pressure differentials. (CBC 909.6, 909.20.2.4). Identify the minimum and maximum pressure differences across smoke zone boundaries (smoke barriers) separating smoke zones. Include calculations for each smoke zone where appropriate. Analyses shall include openings (e.g., Z-ducts, operable windows, and/or doors). Openings such as fire smoke doors with automatic closers may be assumed closed.
- Note: Two sets of analyses shall be performed. The 1<sup>st</sup> set assumes openings in the closed position. The 2<sup>nd</sup> set shall assume possible openings equal to at least 25% on each side of the building of each floor throughout the building.*
- 5.8.7 **Airflow Method:** Typically used in tunnels or spaces connected to large volume spaces to manage the flow of smoke from fires. (See CFC 909.7)
- 5.8.7.1 For simple geometrical spaces (no obstructions, simple air supply and exhaust, symmetrical smooth construction) the critical air velocity calculation required to prevent the backflow of smoke may be per CFC Section 909.7.1.
- 5.8.7.2 In spaces with complicated geometry (rough, asymmetric construction) and/or where/when tenability is used as design criteria, Computational Fluid Dynamics (CFD) analysis is required. A complicated geometry is where airflow is obstructed, multiple air supplies, or construction is asymmetrical.
- 5.8.7.3 A minimum pressure differential of 0.05-water gauge is required across all smoke barriers in fully sprinklered buildings. Un-sprinklered buildings shall comply with CFC 909.6.1 for pressure differentials. (CBC 909.6, 909.20.2.4). Identify the minimum and maximum pressure differences across smoke zone boundaries (smoke barriers) separating smoke zones. Include calculations for each smoke zone where appropriate. Analyses shall include openings (e.g., Z-ducts, operable windows, and/or doors). Openings such as fire smoke doors with automatic closers may be assumed closed.
- Note: Two sets of analyses shall be performed. The 1<sup>st</sup> set assumes openings in the closed position. The 2<sup>nd</sup> set shall assume possible openings equal to at least 25% on each side of the building of each floor throughout the building.*

## 6.0 **Plans**

- 6.1 A complete, comprehensive and coordinated set of Smoke Control Compliance drawings shall be created and submitted to the Building and Fire Departments for review and approval with the initial building permit submittal. The Smoke Control Compliance set shall include all relevant Architectural, Mechanical, Electrical, Fire Systems, and any additional drawing to demonstrate the concept and effectiveness of the proposed design.
- 6.2 **General Requirements**
- 6.2.1 Plans and attachments shall be clearly labeled and legible to the satisfaction of the fire code official.
- 6.2.2 Plans and all revisions to the plans shall be dated. If utilizing an existing drawing or portion of a drawing, the area of work shall be highlighted and clouded with an appropriate symbol (delta). Provide a revision list with a symbol, date, description, and initials.
- 6.2.3 When making alterations, additions, or deletions to an existing system, all existing devices and equipment shall be shown and properly identified on the floor plan, and system riser (single-line) diagram.
- 6.2.4 Smoke control plans shall include a title sheet, an equipment list, a written sequence of operation or functional matrix, floor plan(s), a system diagram, and secondary power configuration.
- 6.2.5 Attachments shall include the manufacturer's specification sheets and California State Fire Marshal (CSFM) listing sheets for all equipment and devices requiring listing.
- 6.3 A complete **Special Inspection Program** with sample reports shall be submitted with the plans for review and approval prior to issuance of the permit(s).
- 6.4 **Title Sheet: Plans**
- 6.4.1 The front sheet shall contain the following information:

- 6.4.1.1 Project name and address of the project.
- 6.4.1.2 The Designer's full name (no initials, pseudonyms, acronyms, or aliases) and signature. The Designer of Record shall be responsible for the entire system being worked on.
- 6.4.1.3 Business name, address, and California Contractor's License number of the installing contractor.
- 6.4.1.4 If the Designer of the Smoke Control System is not the installing contractor, the following shall be clearly indicated/printed on the plans:
  - 6.4.1.4.1 **DESIGNED BY** - followed by the Designer's business name, address, Designer of Record's full name and signature.
  - 6.4.1.4.2 **INSTALLING CONTRACTOR** - followed by the installing contractor's business name, address and California Contractor's License number.
- 6.4.1.5 Occupancy group(s) of building or area as defined by the California Building Code.
- 6.4.1.6 Building information such as number of basements, number of stories above basement, building height, total building area, and building construction type.
- 6.4.1.7 Scope of work and why the system is being installed. Include the BoD which should include documentation of the performance objectives; applicable scenarios; all calculations; modeling files and results; and all other technical substantiation used to determine the design criteria and life safety performance per NFPA.
- 6.4.1.8 A note stating that the design and installation complies with, the 2019 CFC; the 2019 CBC; 2015 NFPA 92; the 2019 CEC; and the SJFD Ordinances and Standards.
- 6.4.1.9 A clear site map and/or vicinity map.
- 6.4.1.10 A key plan of the building and/or complex indicating the street location and the area of work within the building shall be provided.
- 6.4.1.11 Any other pertinent notes.

6.5 **Equipment List:**

- 6.5.1 Provide the model number, manufacturer's name, description, quantity, CSFM listing number, and symbols to be used (legend) for each device, equipment, and conductors proposed to be installed. *Note: The Fire Department reserves the right to disallow any listed product due to past performance.*
- 6.5.2 The symbols used on the plans and the fire alarm riser diagram shall match the legend. Strike out any "typical" symbols that do not pertain.
- 6.5.3 Provide the wiring schedule.

6.6 **Attachments:**

- 6.6.1 Manufacturer's specification sheets for all devices, equipment, and materials to be used shall be submitted. Highlight on the cut sheet which device or equipment is being used, the listing information, and the application per listing.
- 6.6.2 Submit copies of the CSFM listing number sheets for all devices and equipment requiring listing.

6.7 **Floor Plan(s):** the following shall be clearly indicated:

- 6.7.1 Scale used and a graphical representation of the scale. The minimum scale for plans is 1/8" = 1'-0". Metric scale shall not be accepted.
- 6.7.2 The locations of doors, partitions, non-rated walls, and rated walls. If not full height, indicate the heights of the wall and the ceiling.
- 6.7.3 The location of all equipment, devices, and appliances.
- 6.7.4 Use of each room or space (room description).
- 6.7.5 Type of ceiling or roof construction (i.e., smooth, solid joist construction, beam construction, sloped ceiling, and/or high ceiling).
- 6.7.6 Scaled cross-section or elevation-plan(s).

## 6.8 **Architectural Sheet(s):**

- 6.8.1 As part of the architectural drawings provide smoke barrier drawings showing the location of all smoke zones:
  - 6.8.1.1 Delineate each zone as passive or active and provide a zone designation for each active zone.
  - 6.8.1.2 Show occupancies of each smoke zone and all openings required (e.g., doors required to open for make-up air).
  - 6.8.1.3 The zones and designations used in the architectural drawings shall correspond to zones and designations used in the Smoke Control Report.
- 6.8.2 Depict fire barriers installed in coordination with trade installation of materials and/or equipment enclosures by code reference (e.g., X-hour fire barriers constructed to accommodate Power System-CFC 909.11)
- 6.8.3 Provide sufficient detail in the drawings to support engineering calculations (e.g., leakage values for walls, ceilings, and doors; locations and heights of surrounding buildings; sizes and locations of make-up air openings; and smoke- barrier wall construction details).

## 6.9 **Mechanical Sheet(s):**

- 6.9.1 In addition to the information that is typically provided in mechanical drawings provide the following information in the drawings:
  - 6.9.1.1 Show coordination and rated construction with the Architectural Plans.
  - 6.9.1.2 Show the location of all smoke zones, including passive smoke zones.
  - 6.9.1.3 Provide a schematic riser diagram of the Smoke Control/Management Systems.
  - 6.9.1.4 Provide a narrative summary and sequence of operations of the Smoke Control/Management System operation.
  - 6.9.1.5 Identify the major mechanical components used for Smoke Control in appropriate schedules. Include fans; drivers; variable frequency drives (VFDs) and their locations; and louver and damper operators. Indicate the minimum service factor for fan motors (1.15) and the minimum number of fan belts for belt-driven fans (1.15 times the number of belts), and temperature rating of fans and ducts (CFC 909.10.5).
  - 6.9.1.6 Identify the ducts and shafts used for smoke control in the schematic riser diagrams and plan drawings. Indicate the minimum test pressure for ducts and shafts used for smoke control (1.5 times the maximum design pressure) (CFC 909.10.2).
  - 6.9.1.7 For Smoke Control Systems with VFDs, locate the VFDs outside the smoke zone they serve. Alternatively, protect VFDs within the smoke zone they serve from smoke and heat, so they are capable of continued operation after detection of fire for at least 20 minutes or the time set by the required safe exiting time (1.5 times RSET), whichever is greater (CFC 909.4.6). VFDs shall not serve more than one end device unless listed for smoke control service.
  - 6.9.1.8 For air-moving systems greater than 2,000 cfm, identify where automatic shutoffs are not provided due to smoke control (CMC 608.1 Exception #4).

## 6.10 **Electrical Sheet(s):**

- 6.10.1 In addition to the information that is typically provided in electrical drawings provide the following information in the drawings:
  - 6.10.1.1 Show coordination and rated construction with the Architectural Plans.
  - 6.10.1.2 Identify the major electrical components used for smoke control including standby (or emergency) power source, transfer switches, and control system(s).
  - 6.10.1.3 Provide load calculations for the standby/emergency power source.
  - 6.10.1.4 Show the layout of the standby generator room (or other secondary power source). The standby generator and its transfer switches shall be in a separate room from the normal power transformers and switchgear (CFC 909.11, 909.11.1).

- 6.10.1.5 Show the routing and fire rating of the normal and standby power distribution systems. The normal and standby power systems shall be routed independently (CFC 909.11).
- 6.10.1.6 Show the locations of the Fire Alarm Control Panel (FACP), Firefighters' Smoke Control Panel (FSCP) and Fire Alarm Annunciator(s).
- 6.10.1.7 Provide a 1-line diagram showing feeder conductor sizes, overcurrent protection sizes, ampacity calculations, and the connected loads on each feeder supplied by the standby (or emergency) power source (CEC 215-5, 310, 700-5, 701-6).
- 6.10.1.8 For high-rise buildings, show the layout of the Fire Command Center (Central Control Station). See CBC 403.4.6 and 911, for required equipment and furnishings.
- 6.10.1.9 For buildings with passive smoke zones, connect the motor operators for smoke dampers to the building power panel and emergency/standby power – not the tenant space power panels.
- 6.10.1.10 Each stair pressurization fan (and any other smoke control fans) shall be provided with independent power and control wiring. Wiring for control and power may be installed in an exit enclosure only if it serves that particular exit enclosure.

**6.11 Fire Sprinkler Sheet(s):**

- 6.11.1 Sprinkler system submittals shall be in accordance with SJFD Policy, "Fire Sprinkler Systems Design, Installation, & Plan Submittal Requirements".
- 6.11.2 In addition to the information that is typically provided in Fire Sprinkler drawings provide the following information in the drawings:
  - 6.11.2.1 Show coordination and rated construction with the Architectural Plans.
  - 6.11.2.2 Sprinkler zones shall be coordinated and match the Smoke Control Report.
  - 6.11.2.3 For atriums, provide separate sprinkler zones for the atrium and non-atrium spaces (CFC 907.2.13).
  - 6.11.2.4 For malls, provide separate sprinkler zones for mall and tenant spaces (CBC 402.5, 909.12.3).

**6.12 Fire Alarm Sheet(s):**

- 6.12.1 Fire Alarm system submittals shall be in accordance with SJFD Policy, "Fire Alarm Systems Permit Application, Plan Submittal, Design, Installation, & Inspection Requirements".
- 6.12.2 In addition to the information that is typically provided in Fire Alarm drawings provide the following information in the drawings:
  - 6.12.2.1 Show coordination and rated construction with the Architectural Plans.
  - 6.12.2.2 For atriums show the simplified fire alarm/smoke control matrix per the Smoke Control Report.
  - 6.12.2.3 Sequence of Operation – a written description or matrix chart shall be provided to define the events that occur when various initiating triggers are activated concerning the Smoke Control System.
    - 6.12.2.3.1 Show every Fire Alarm/Smoke Control System input in a column on the left. Include every initiating device by address. Inputs may be combined with prior approval. Include manual operation of control switches for fans and dampers where the switch controls multiple outputs.
    - 6.12.2.3.2 Show every Fire Alarm/Smoke Control System output in a row across the top. Include every notification appliance by zone, every fan and damper (or group of dampers) by identifier, every monitored device by identifier and every other event that must occur for proper operation of the Smoke Control System. Outputs may be combined with prior approval.
    - 6.12.2.3.3 Show automatic fan shutoffs per CMC 608 where required or provided.
    - 6.12.2.3.4 Show supervised conditions for required smoke control components such as fan power disconnect, pressure differentials, switches, fans not full

- speed, and doors/windows/dampers open or closed.
- 6.12.2.3.5 Alarm, supervisory and trouble signals shall be transmitted to an approved supervising station in accordance with NFPA 72 (CFC 907.6.5).
- 6.12.2.4 Provide a full-scale color drawing of the Firefighters' Smoke Control Panel (FSCP) for review and approval prior to fabrication (CFC 909.16).
  - 6.12.2.4.1 Show individual control switches for fans and dampers or multiple dampers with identical actions, and automatic closing/opening doors required for smoke control (CFC 909.16.1).
  - 6.12.2.4.2 Show status indicators for all smoke control equipment by pilot lamp-type indicators as follows:
    - 6.12.2.4.2.1 GREEN: Fans, dampers and other operating equipment are in their ON or OPEN status. Provide a green light to indicate Smoke control Mode and another for Manual Mode.
    - 6.12.2.4.2.2 RED: Fans, dampers and other operating equipment are in their OFF or CLOSED status.
    - 6.12.2.4.2.3 YELLOW: Fans, dampers and other operating equipment are in a fault status
    - 6.12.2.4.2.4 WHITE: Fans, dampers and other operating equipment are in their normal status (use of the white light on panels will be reviewed on a case by case basis and designed to what makes the most sense without creating confusion.)
    - 6.12.2.4.2.5 Add two visual indicators on the top right corner of the FSCP to indicate panel status. Green visual – Panel Normal, Red Visual – Panel in smoke control mode
  - 6.12.2.4.3 Provide a legend or matrix either on the panel or separately mounted showing the configuration of fans, dampers and doors in normal status mode and smoke control status mode.
  - 6.12.2.4.4 Alternate designs of the FSCP may be approved on a case-by- case basis by SJFD.
- 6.12.3 Smoke Control Systems shall have an automatic weekly self-test feature. The self-test feature shall automatically command activation of each associated function(s). An audible and visual trouble signal shall be annunciated at the FSCP identifying any function that fails to operate within the required time period (CFC 909.12, 907; UL 864, 49.7)

## **7.0 Design and Installation**

- 7.1 Smoke Control Systems shall be designed and installed in accordance with the 2019 CFC, 2019 CBC, 2015 NFPA 92, 2019 CEC, 2019 CMC, and the SJFD ordinances, policies, and standards.  
*Note: Refer to the fire and building codes to determine when a Smoke Control System is required.*
- 7.2 Retroactivity of Smoke Control: Like most installation codes and standards, smoke control as described in CFC, CBC and NFPA 92 is not intended to be enforced retroactively on existing buildings. However, we routinely receive questions on how to address new Smoke Control Systems in existing buildings. SJFD does not specifically address this complex issue. Requiring that a Smoke Control System in an existing building meet the requirements intended for new systems can be difficult. The need for occupant evacuation, the evacuation capabilities of the occupants, and the cost of the upgrades should be considered when applying the requirements of the California codes including NFPA 92 to an existing building. While it is ultimately up to the Smoke Control System Designer to provide a code compliant system, SJFD regulates as follows:
  - 7.2.1 When a new system is required due to change of occupancy or CFC mandate, the premises shall be brought up to current code.
  - 7.2.2 When the existing system is no longer serviceable and hence, must be replaced as a maintenance repair, a new system may be installed in the same configuration to the existing layout and function provided it does not diminish what was the original systems capability. The scope shall be clearly demonstrated on the plans and acceptance testing shall be the same as if the system were new.



## 8.0 Inspection

- 8.1 A test protocol shall be developed by the system design and installation team and presented to SJFD for approval with the BoD.
- 8.1.1 Improper Acceptance Test Protocols: It must be recognized that smoke bomb tests do not provide the same heat, buoyancy, and entrainment of a real fire. As such, a properly designed system may not pass a smoke bomb test. It also is possible that a system that does pass a smoke bomb test may not perform as intended during a real fire. The design and installation team shall identify the appropriate system commissioning procedures in the BoD.
- 8.2 An operations and maintenance manual shall be developed for all Smoke Control Systems to ensure proper operation of the system over the useful life of the building and comparison to the commissioning test criteria.
- 8.3 Special Inspection Submittals - Two submittals are required to document special inspection:
- 8.3.1 A written inspection and test program, and
- 8.3.2 A report describing the inspection and testing performed (as required by CBC, Section 909.18.8).
- 8.3.3 A complete pre-test report shall be available to the SJFD inspector before the inspection.
- 8.4 Special Inspection Program – General.
- 8.4.1 A written Special Inspection Program shall be submitted to SJFD for review and approval.
- 8.4.2 The Special Inspection Program shall be prepared by the Smoke Control Designer. The Program may also be prepared by the special inspector if duly qualified [CBC 909.18.8.2].
- 8.4.3 The Special Inspection Program shall be submitted with the complete Smoke Control Report for review with the Smoke Control Drawing set. The issuance of the permit is dependent on approval of the submittals of the Smoke Control Report and Special Inspection Program.
- 8.4.4 The Special Inspection Program shall include at least the following information:
- 8.4.4.1 Provide a cover page showing the facility name, address, revision number, date of submittal and preparer.
- 8.4.4.2 Provide a signature page as outlined in 5.2.2 of this policy.
- 8.4.4.3 Identify the components and systems that must be inspected to demonstrate proper installation.
- 8.4.4.4 Samples of Inspection Reports and time limits for submission of reports.
- 8.4.4.5 Provide an overview of test methods and test approach.
- 8.4.4.5.1 When leakage testing of residential smoke barriers is to be performed, the Special Inspection Program shall define the number or percentage of units (minimum of 10% of the units or 1 per floor, whichever is greater) to be tested. Include the method of testing, percentage of smoke barriers to be tested and pass/fail criteria.
- 8.4.4.5.2 If cold/hot smoke visualization testing is required by SJFD, this must be specifically addressed in the Program description. Provide testing details and methods proposed.
- 8.4.5 The Special Inspection Program shall be submitted in digital booklet form. A copy will be returned when approved. The permit application number, project name and address, report title, date and revision number shall be clearly marked on the submittal.
- 8.5 Special Inspector.
- 8.5.1 CBC, Section 909 requires a special inspector to perform inspection and acceptance testing of Smoke Control Systems.
- 8.5.2 The special inspector is responsible for verifying that the Smoke Control System is installed in accordance with the requirements of CBC, Section 909, and that the system achieves the performance defined in the Smoke Control Report.
- 8.6 Field inspections shall be scheduled only after a permit has been issued. A complete inspection protocol shall be provided and pre-approved by SJFD.

- 8.6.1 Inspection and Test Process - Two inspection and testing processes are required for Smoke Control Systems:
- 8.6.1.1 Special inspection/testing by a special inspector  
*Note: SJFD may also witness any smoke control related tests such as, but not limited to: duct leakage test, door fan test; garage CO exhaust test; fire alarm as related to smoke control; stair pressurization; barometric damper operation; fire/smoke damper operation and construction features such as penetrations of smoke barrier walls; etc.*
  - 8.6.1.2 When the special inspector is satisfied that the Smoke Control System is properly installed and functioning per design, SJFD inspectors witness final acceptance testing
- 8.7 Inspections shall be scheduled by the Special Inspector only. When scheduling for inspection, request for sufficient time to complete a thorough inspection of the work performed. Travel time is included in the inspection time.
- 8.7.1 Inspections may be scheduled by calling (408) 535-3555. The following information is required:
    - 8.7.1.1 Permit Number.
    - 8.7.1.2 The amount of time required for inspection (including travel time).
    - 8.7.1.3 Name and number of contact person.
  - 8.7.2 Missed inspections or inspections canceled or rescheduled within 48 hours shall be counted against inspection time.
- 8.8 Documentation to Support Final Inspection
- 8.8.1 When the special inspector determines that the Smoke Control System is complete and operating properly, then they shall write a letter documenting its status. The letter shall be provided to the city inspectors.
  - 8.8.2 The letter is required prior to SJFD starting their final inspection.
  - 8.8.3 Satisfactory completion of final inspection of the Smoke Control System by SJFD inspectors is a prerequisite for Temporary Certificate of Occupancy (TCO) or Certificate of Occupancy (CoO).
- 8.9 Final Report for Special Inspection and Testing (Commissioning Report for CoO)
- 8.9.1 A complete Smoke Control System Commissioning Report meeting the requirements of CBC 909.18.8.3 shall be submitted to SJFD for review and approval.
  - 8.9.2 Acceptance of the Report by SJFD is a prerequisite for Final Occupancy.
  - 8.9.3 Include a completed attachment 2, “Special Inspection and Testing Checklist”, for each Smoke Control System.
  - 8.9.4 Two copies of the Report shall be submitted in booklet format for logging-in.
  - 8.9.5 A copy of the Report shall be provided to the SJFD inspector.
  - 8.9.6 A hard copy of the Report shall be maintained in the Fire Control Room.
- 8.10 During the inspection by SJFD, there shall be a minimum of two technicians. One technician will be at the F/A control panel while the other will be testing the effects. Two-way radios shall be provided (by the technicians) and the technician at the panel shall communicate to the SJFD inspector which devices are activated on the panel.
- 8.11 Necessary coordination shall be made such that representatives of other contractors whose equipment are involved in the testing are present (e.g., fire/smoke damper, air handlers, elevator, emergency generators, etc).
- 8.12 After the successful completion of the tests/inspections, provide the following to the SJFD inspector:
- 8.12.1 The permit card (for inspector’s signature).
- 8.13 After final completion and acceptance of the project, the contractor shall provide the following to the owner:
- 8.13.1 All literature and instructions provided by the manufacturers describing proper operation and maintenance of all devices and equipment.
  - 8.13.2 A copy of the approved plan and as-built plan, if applicable.
  - 8.13.3 A copy of the operations and maintenance manual.
  - 8.13.4 The signed and finalized permit card.

## **9.0 Document Revisions**

9.1 This document is subject to revisions. For general information and to verify that you have the most current document, see SJFD development website, or call (408) 535-7750 and request the current version date.