Number 20

BUILDER INSIGHT

Fire Smoke Dampers

Builder Insight is a series of bulletins and companion videos designed to provide practical information on new technologies, research results, good building practices and emerging technical issues in residential construction to Licensed Residential Builders and others in the industry.

This bulletin was prepared in collaboration with Senez Consulting Ltd, GHL Consultants Ltd, and Pento Consulting.

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Overview

The 2024 BC Building Code (BCBC) requires that in residential building ventilation systems, a smoke damper or combination smoke/fire dampers be installed at various locations. This requirement, adopted from the 2015 National Building Code of Canada (NBCC), aims to prevent smoke from spreading through ventilation ducts during a fire (also known as fire compartmentation).

Figure 1: Rendering of fire compartmentation during a fire incident. (Source: https://quelfire.co.uk/can-firefighters-trust-compartmentation/)

This new requirement poses a significant challenge to new multi-family residential buildings which utilize a centralized energy or heat recovery ventilation system (ERV/HRV). Most significantly, it would mean installing tens to hundreds of new combination smoke/fire dampers. This would increase the complexity in design and the need for ongoing maintenance, annual inspection, and replacement. In turn, this would increase the capital and lifecycle costs of the building. Furthermore, installing numerous combination smoke/fire dampers would challenge current building designs aimed at achieving BC Housing and provincial energy objectives while keeping housing affordable.

This bulletin provides an overview of alternative smoke control measures that would not require the installation of numerous combination smoke/fire dampers. This alternative would allow the installation of ERVs/HRVs while at the same time achieving the objectives of the BCBC requirements with respect to limiting the spread of smoke.

Fire Compartmentation

Fire compartmentation divides a building into smaller areas to limit the spread of fire and smoke and provide occupants with time to escape. This is achieved by fire-resistant wall and floor assemblies and protection of penetrations in those assemblies. The ventilation ducts of a centralized ventilation system are one of the penetrations that require fire and smoke dampers to maintain the integrity of the fire compartmentation.

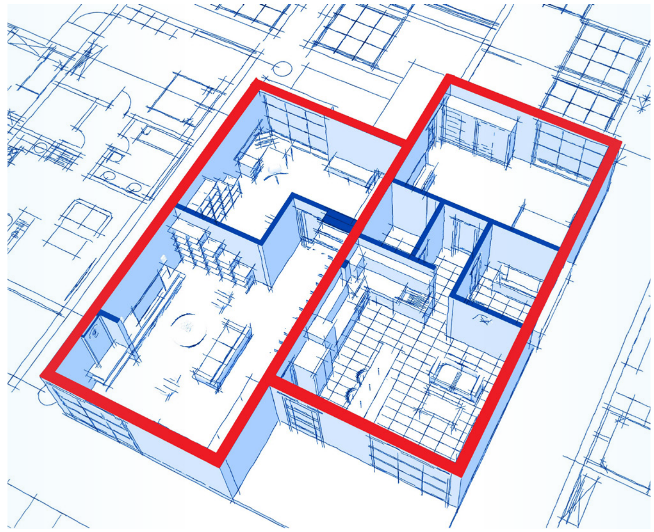

Figure 2: Compartmentation dividing a building into smaller areas. (Source: https://www.ventrogroup.com/blog/understanding-the-importance-of-compartmentation)

Centralized Ventilation System

Centralized ventilation systems are used in some construction projects as they are easy to maintain and cost-effective.

A central system offers advantages such as:

- Partial cooling for residential suites
- Higher efficiency compared to individual in-suite systems
- Adherence to energy objectives outlined in BC Housing guidelines

Centralized Energy or Heat Recovery Ventilation (ERV/HRV) units* are generally located on the roof or in parkades and provide a practical and energy-efficient method of delivering partial mechanical cooling to residential suites.

One main benefit of centralized ERVs is that they provide more energy efficient cooling. They offer free night cooling and longer service life. In turn, centralized units eliminate the need for access to individual residential suites for maintenance.

This reduces operational costs and is more cost-effective in meeting energy efficiency, GHG reduction, and indoor environment quality (IEQ) targets for building projects. Figure 3 shows a typical design of centralized ERV/HRV units located on the roof, emphasizing their components and functionality. However, centralized ERV/HRV units create a fire compartmentation challenge due to the duct system.

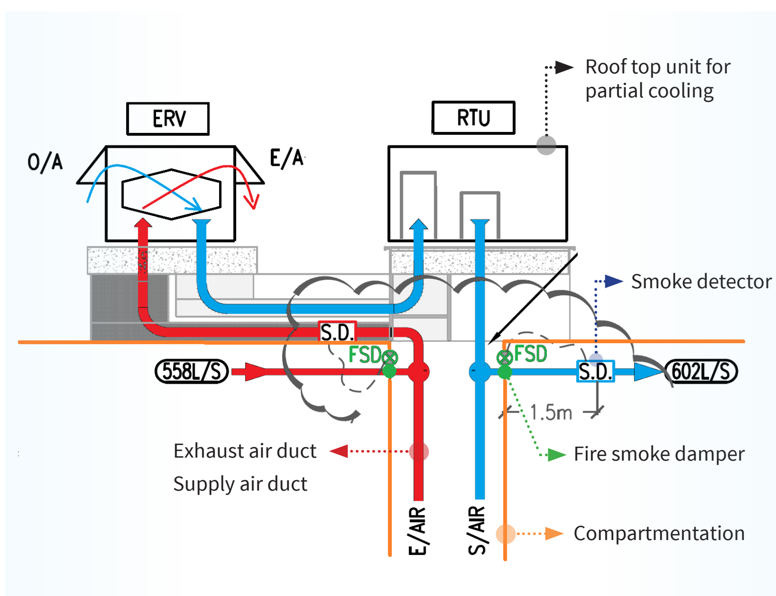

Figure 3: Air distribution schematic from the ERV to the nearest fire smoke dampers.

* HRV and ERV Guide for Multi Unit Residential Building, CMHC
* Heat Recovery Ventilation Guide for Houses, BC Housing

Understanding Fire Smoke Dampers

Fire/smoke dampers are devices installed in ventilation ducts to close automatically when activated by a smoke detector. The primary function of fire smoke dampers is to maintain the integrity of the fire compartmentation and limit the spread of fire and smoke. This is important for centralized systems that have ducts that pass through the fire compartment barriers.

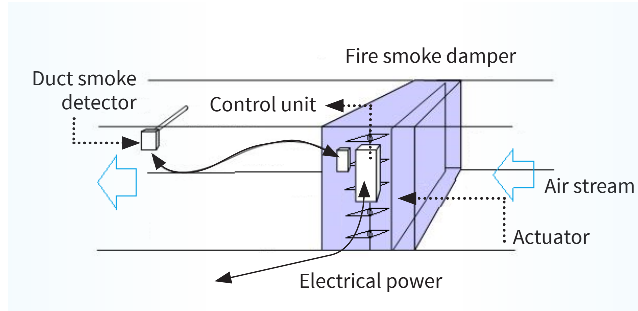

Figure 4: Fire smoke damper schematic and its components. (Source: https://blog.belimo.com/blog/blog/bid/76528/modulating-control-of-fire-smoke-dampers-in-smoke-control)

BC Building Code Requirements

Refer to the BC Building Code (BCBC) for specific requirements related to fire smoke dampers. Sentence 3.1.8.7.(2) of the 2024 BCBC, requires that a smoke damper or a combination smoke/fire damper be installed in conformance with Article 3.1.8.11. in ducts or air-transfer openings that penetrate an assembly required to be a fire separation (i.e., fire compartmentation), where the fire separation:

a) Separates a public corridor
b) Contains an egress door referred to in Sentence 3.4.2.4.(2)
c) Serves an assembly, care, treatment, detention, or residential occupancy, or
d) Is installed to meet the requirements of Clause 3.3.1.7.(1)(b) or Sentence 3.3.3.5.(4)

Sentence 3.1.8.7.(2) applies to residential occupancies; therefore, Clause 3.1.8.7.(2)(c) will be applicable to all duct and air-transfer openings that penetrate an assembly required to be a fire separation in these residential buildings.

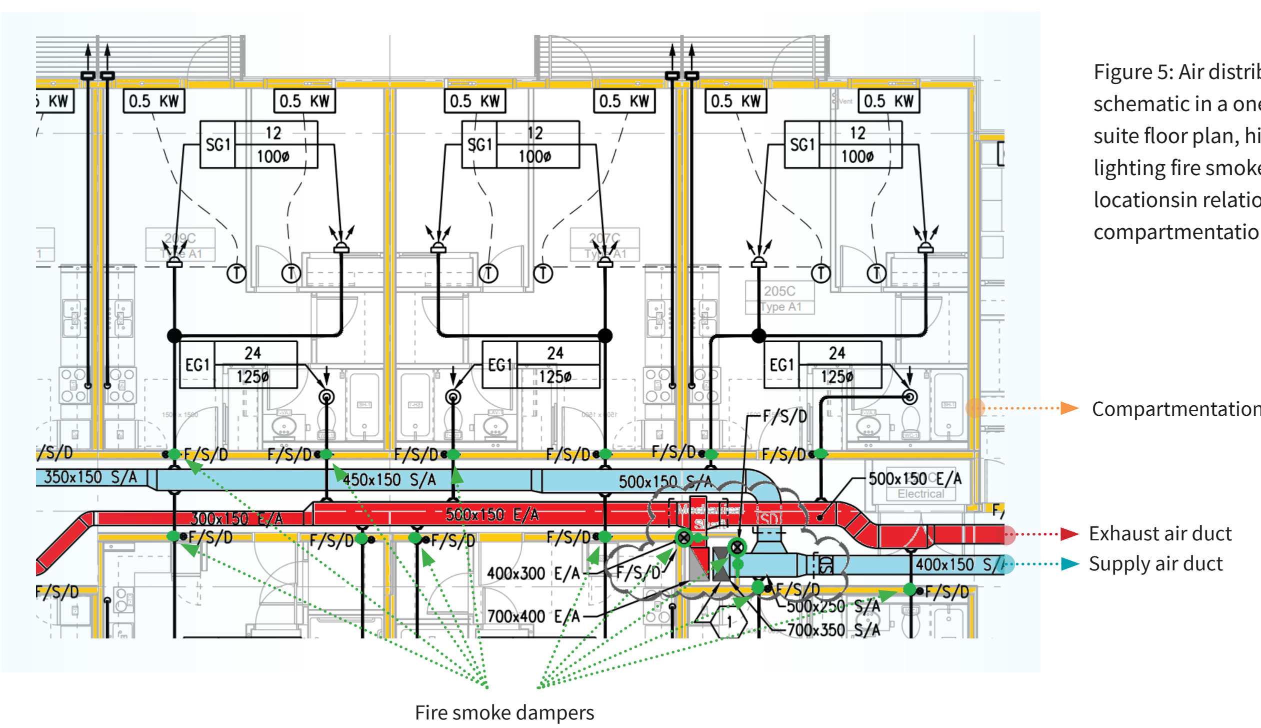

Figure 5: Air distribution schematic in a one-level suite floor plan, highlighting fire smoke damper locationsin relation to compartmentation.

Article 3.1.8.11. requires the following relative to the installation of smoke dampers:

Damper Location and Access:

Air Transfer Opening: Where smoke dampers are used as a closure in an air-transfer opening, they are required to be installed in the plane of the fire separation [Sentence 3.1.8.11.(1)].

Combination Smoke/Fire Dampers: Combination smoke/fire dampers are required to be installed within 610 mm of the plane of the fire separation, provided there is no inlet or outlet opening between the fire separation and the damper [Sentence 3.1.8.11.(2)].

Damper Position: Smoke dampers or combination smoke/fire dampers are required to be installed in the vertical or horizontal position in which they were tested [Sentence 3.1.8.11.(4)].

Damper Access: A tightly fitted access door shall be installed for each smoke damper and combination smoke/fire damper to provide access for their inspection and the resetting of the release device [Sentence 3.1.8.11.(5)]. The access door is intended to be provided in the duct and, if the duct is enclosed with an architectural finish, that a second access door be provided through that finish [Note A-3.1.8.11.(5)].

Damper Activation:

Except as required by a smoke control system, smoke dampers and combination smoke/fire dampers shall be configured so as to close automatically upon a signal from an adjacent smoke detector located as described in CAN/ULC-S524, "Installation of Fire Alarm Systems," within 1.5 m horizontally of the duct or air-transfer opening in the fire separation [Sentence 3.1.8.11.(3)]:

- On both sides of the air-transfer opening, or
- In the duct downstream of the smoke damper or combination smoke/fire damper.

Challenges and Alternatives:

For further details on fire smoke dampers installation, please see the Guidance for the Development of a Performance-Based Solution for Smoke Dampers published by BC Housing. This guide provides a methodology and technical information to support the development of alternative smoke control measures. These measures allow the installation of centralized ERVs without the numerous smoke dampers required by Sentence 3.1.8.7.(2). Furthermore, these alternatives are based on existing smoke control principles permitted by the 2024 BCBC for high buildings.

The proposed design detailed in the Guidance for the Development of a Performance-Based Solution for Smoke Dampers (Smoke Damper Guide) intends to create a pressure differential through continued operation of a central ERV during a fire condition. The continued operation of the system provides opposed airflow from the supply duct, and exhaust of smoke through a physically separate duct system.

The following design elements and parameters are proposed in the Smoke Damper Guide to provide a design that achieves the objectives, functional and intent statements of the 2024 BCBC:

- Provision of a smoke detector in the centralized ERV's supply fan section
- Continued operation of the system following initiation of the fire alarm system
- The provision of 100% outdoor air to each unit with no recirculation
- Confirmation that no isolation dampers be installed on the supply and exhaust sides of the central ERV unit
- Continuous noncombustible ducts and branch ducts up to the interface with the residential suite it serves
- Provision of fire dampers in conformance with Sentence 3.1.8.7.(1) and Article 3.1.8.10. In the remote event that backflow occurs, provision of a fire damper will limit the extent of smoke spread in the duct by closing the damper and limiting backflow
- Testing of the ERV and associated equipment in accordance with the Integrated testing requirements of the 2024 BCBC

Additionally, the main guide includes a detailed cost analysis comparing combination fire smoke dampers (FSD) and traditional fire dampers (FD). The cost analysis of utilizing combination FSDs versus regular FDs in ductwork distributions from central ventilation systems indicates the extra construction cost of between 1.2% to 1.6% of the total project cost and between 11% to 12% of the mechanical cost. These costs do not include the maintenance costs of annual testing of FSDs as a part of testing the life safety systems. Typically, it is considered that the operation and maintenance costs for the lifecycle of a building can be up to 80% of the total project lifecycle cost whereas 20% is only capital costs.

About BC Housing Research Centre

BC Housing's Research Centre collaborates with industry, non-profit, and public sector partners to foster excellence, innovation, and affordability in British Columbia's housing sector. We share leading-edge research, advance science and technologies to encourage best practices, and provide data analysis to understand and find solutions to housing issues across the province. The Research Centre identifies and bridges research gaps in the following topic areas: populations & communities, built environment & design, sustainable & resilient housing, housing assistance & policy, housing & wellbeing. Mobilizing knowledge and research expertise accelerates innovation and facilitates the adoption of new housing models, building methods, and standards. Housing studies and program evaluations drive policy changes and support access to affordable housing in British Columbia. Sign up to receive the latest news and updates from BC Housing's Research Centre at www.bchousing.org/subscribe.

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