

# FIRE-RESISTANCE-RATED DUCTS AS ALTERNATIVES TO SHAFT ENCLOSURES

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## Introduction

In a fire situation, horizontal and vertical ductwork serving HVAC or pressurization systems can, if not properly protected, facilitate the spread of fire, smoke and toxic gas between areas otherwise isolated from one another. For this reason, the International Building Code (IBC) requires the protection of ductwork by fire-resistance-rated (FRR) shaft enclosures.

This can be accomplished via the prescriptively permitted use of shaft enclosure assemblies consisting of gypsum, studs and fasteners that comply with Section 713 of the IBC<sup>1</sup>. Another potential alternative is for ductwork to be protected using fire-resistance-rated duct materials that are tested for the application in which they will be installed.

Since fire-resistance-rated duct materials do not have prescriptive requirements for acceptance listed in the code, one must request the use of an alternative material, design or method of construction in order to implement them. An approved request to apply IBC 104.11 (Alternative materials, design, and methods of construction and equipment) could allow for the use of an such an assembly. These types of assemblies can be more feasible and cost effective for the given application based on project conditions.

An approved request for a code modification per IBC 104.10 could allow for the use of an assembly based on the practical difficulty involved in carrying out the code provision. However, this is a distinct process from an IBC 104.11-based request which is more commonly used for these applications. This paper will explore the challenges associated with alternative means and methods requests for the use of fire-resistance-rated ducts and discuss best practices relating to the pursuit of such requests.

## Challenges with Code Compliance

Broadly, IBC 104.11 states that the code is not intended to prevent the installation of any material or prohibit any design or method of construction not specifically prescribed by the code. This is provided that the alternative has been approved. Several steps are involved in this process, which is sometimes known as the Alternative Means and Methods process.

First, the owner or owner's agent needs to submit to the building official a written proposal to provide substantiation for the alternative design. This proposal should include scientifically tested products and their performance, research reports, and supporting test data. The building official must then, based on the contents

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<sup>1</sup> All references to the International Building Code refer to the 2015 Edition for clerical purposes. The requirements discussed in this paper are consistent between the 2012 IBC, 2015 IBC, 2018 IBC and 2021 IBC.

of the request, confirm that the design is satisfactory, meets the provisions of the code, and is not less than the prescribed equivalent in strength, effectiveness, fire-resistance, durability, and safety.

The IBC states that supporting data in the form of valid research reports from approved sources need to be provided to the building official to support the submitters claim of equivalent strength, effectiveness, fire-resistance, durability and safety. Where there is insufficient evidence of compliance with code provisions, or evidence that a material/method does not conform to code requirements or substantiate claims for alternative means/methods, the building official shall have the authority to require tests as evidence of compliance.

When aiming to establish that an assembly performs equivalently to an ASTM E119 tested shaft enclosure, in the absence of a testing standard referenced by the IBC, manufacturers could turn to the International Code Council's (ICC) Acceptance Criteria for Metallic HVAC Duct Enclosure Assemblies (AC 179). The 2012 edition of AC 179 includes test methods and performance requirements covering:

- + Surface burning characteristics (ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials; ASTM C411: Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation).
- + Non-combustibility tests (ASTM E136: Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C).
- + Durability tests (ASTM C518: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus).

AC 179 also provides testing criteria based on how the ducts are intended to be used. The two primary methods are vertical ducts "in lieu of fire resistance rated shaft walls" and vertical and horizontal ducts "in lieu of required fire dampers".

Vertical ducts with fire protection enclosure systems in lieu of FRR rated shaft walls must be tested per ASTM E2816, Condition B<sup>2</sup> and Condition D<sup>3</sup>. Prior to the 2012 edition, assemblies were tested to ASTM E119 with fire exposure on both sides of the assembly (fabricated in the form of a wall) and the rating determined based on the lower rating established between the two sides.

Horizontal HVAC ducts with dedicated fire protection systems in lieu of required fire dampers must be tested per ASTM E2816, Condition A<sup>4</sup> and Condition C<sup>5</sup>. Prior to the 2012 edition, horizontal ducts had to be tested to Duct A and/or B conditions per ISO 6944<sup>6</sup>. Application was limited to horizontal ducts penetrating fire-resistance-rated barriers, fire partitions and smoke barriers.

Vertical HVAC ducts with dedicated fire protection systems in lieu of required fire dampers must be tested per ASTM E2816, Condition B and Condition D. Prior to the 2012 edition, vertical ducts had to be tested to Duct A and/or B conditions per ISO 6944. Application was limited to vertical ducts connecting not more than two stories each with a maximum rating of two hours.

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<sup>2</sup> Fire exposure from outside the vertical HVAC duct system without openings

<sup>3</sup> Fire exposure from outside with hot gases entering the inside of the vertical HVAC duct system

<sup>4</sup> Fire exposure from outside the horizontal HVAC duct system without openings

<sup>5</sup> Fire exposure from outside with hot gases entering the inside of the HVAC duct system with unprotected openings

<sup>6</sup> Fire Resistance Tests – Ventilation Ducts

The 2012 edition added requirements for fire protection for horizontal and vertical stair or elevator pressurization systems with dedicated fire protection systems. These ducts must be tested to Condition A and B per ASTM E2816 (i.e., tested both horizontally and vertically but only exposed to fire on the outside)<sup>7</sup>.

AC 179 requires that the manufacturer submit documentation<sup>8</sup> to the ICC Evaluation Service (ICC-ES) group for evaluation which then stipulates how the design may be used. Beyond this, documentation must be submitted to the building official who sufficiently determines that the proposed design is being used in alignment with the evaluation service report (ESR) and is suitable for the proposed project conditions.

With the integration of ASTM E2816, however, use of AC 179 has fallen out of favor with manufacturers. ASTM E2816 is a relatively new standard which has seen multiple technical revisions since replacing ISO 6944 in AC 179. To date, there have been no ESR reports issued by the ICC-ES for AC 179 since the integration of ASTM E2816. The framework of the AC 179 evaluation is still worth reviewing as it indicates what properties of the proposed product should be evaluated.

Additionally, once ASTM E2816 requirements stabilize moving forward, more manufacturers may join the limited number of manufacturers who are currently pursuing testing to AC 179 criteria. In the future, AC 179 may become a useful option once ESR reports are issued by the ICC-ES. This is a similar path that occurred years ago for fire-rated grease duct enclosures as part of ICC-ES AC 101.

## *Best Practices for Pursuit of Alternative Means/Methods or Code Modifications*

### DEBUNK MISCONCEPTIONS

#### **Alternative Means and Methods vs. Code Modifications**

Several misconceptions exist surrounding the use of alternative means and methods requests and code modifications. Alternative means and methods requests are not intended to be used for modifications to code requirements or hardships. These requests should only be pursued when the proposed solution can be shown to be equivalent in “strength, effectiveness, fire-resistance, durability, and safety”.

However, this does not mean that one cannot pursue a code modification which is covered under IBC 104.10. While process and standard of proof differ slightly, both involve in-depth analysis and justification to the authority having jurisdiction (AHJ) and are dependent on final AHJ approval. According to IBC 104.10, in cases “where there are practical difficulties involved in carrying out the provision of this code, the building official shall have the authority to grant modifications for individual cases, upon application of the owner or the owner’s authorized agent”.

The code modification process differs slightly from that of the IBC 104.11 process. The owner or owner’s agent must similarly provide a written proposal to the building official, but the proposal must determine the code modification for the individual project and provide substantiation for the code modification. The building official must then evaluate the code modification application to determine if they concur that compliance with the strict letter of the code is impractical and approve the design as satisfactory.

The building official must also determine if the submitted code modification meets the intent and purpose of the code and that the modification does not lessen health, accessibility, life and fire safety, or structural

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<sup>7</sup> Further information on fire damper omission and multiple floor penetrations for these kinds of pressurization ducts can be found in the paper “Proper Smoke Control System Design: Protecting Fans and Ductwork for Pressurization Systems” written by Tanner Burke from Jensen Hughes.

<sup>8</sup> See Section 2.0 “Basic Information” of AC 179 for further details.

requirements. Note that, in some jurisdictions, code modifications are not approved by the local building official but by a codified board of appeals that hear various cases including proposed building code modifications for individual projects.

### Understanding Equivalency

As IBC 104.11 requires the demonstration of equivalency across several dimensions, a single set of acceptance criteria alone may not necessarily prove equivalency. Proving full equivalency will require additional documentation in those cases. It is important to understand what the acceptance criteria evaluates and how that aligns with the properties described in IBC 104.11 (i.e., equivalent strength, effectiveness, fire-resistance, durability and safety).

Furthermore, any international testing codes or standards used must be fully evaluated against the codes and standards contained within the IBC deemed equivalent. For instance, some international standards do not incorporate a hose stream as part of their testing process nor do they consider firestop system requirements or evaluate the unexposed surface temperature. These requirements are vital for IBC compliance. Understanding what is and what is not included in alternative test standards is an important part of the evaluation process.

### Understanding Scope

Alternative means and methods requests are intentionally very narrow in scope to ensure that they are appropriately used. These requests are specific to the project, product(s), installation(s), and project condition(s) for which they are tested, evaluated, and approved. An approval of one design using one product in one location under one set of project conditions is non-transferrable.

Additionally, simply specifying a certain product/design on a set of drawings and not receiving comment from the AHJ does not constitute approval. Since these products are not referenced in the code, the intent to pursue an alternative means and methods request must be explicitly stated to the AHJ and complete documentation must be provided to them for their review and approval. AHJs should take note that use of these types of assemblies require an explicit request (most commonly via IBC 104.11 but also possibly via IBC 104.10) which must be accompanied by significant documentation.

### Understanding Documentation

Manufacturer marketing claims about their products should be taken with a grain of salt. In some cases, certain manufacturers may claim their products are tested to ASTM E119 or other standards and are allowed as-of-right. This is rarely the case. Any claim should be evaluated by a knowledgeable party (e.g., registered FPE, evaluation service, testing laboratory) and backed up by relevant testing documentation.

Any provided ICC-ES report should be fully reviewed to understand to what standards the product was tested. Any testing report should be fully reviewed to understand the sizes/configurations that were tested and whether the proposed condition falls outside any limits established by testing/evaluation reports.

### REQUIRE DOCUMENTATION

Documentation is a central component to any alternative means and methods request. The package submitted to the AHJ should contain detailed narratives and drawings of the proposed designs, including full descriptions of the elements to be protected by the proposed assemblies, as well as installation and inspection instructions. For a fire-resistance-rated duct system, this should include any associated design number, test standards used, fire resistance rating, direction of exposure, symmetry conformance (exposure to fire from the inside and outside) and orientation conformance (vertical and horizontal continuity). The description should also include the range of conditions that the design will be subject to.

From there, documentation should illustrate how the proposed design meets the requirements for equivalent levels of quality, strength, effectiveness, fire resistance, duration and safety. This will be accomplished primarily through the use of results from the testing of products to certain standards. If the product is tested to a standard not named in the IBC, one must name that standard and explain which standard the alternative is meant to be equivalent to.

Potential alternative test standards include ISO 6944, ASTM E2816, BS 476: Part 24 (“Method for Determination of the Fire Resistance of Ventilation Ducts”), and BS EN 1366 (“Fire Resistance Tests for Service Installations”). However, as previously noted, care should be taken to understand, identify, and account for any gaps between these international standards and the equivalent IBC-referenced standard. Keep in mind that unlike data may not be mixed. Gaps or other data limitations may require additional test data or scientifically backed extrapolation.

Similarly, one must demonstrate that the proposed design has been tested in a manner appropriate for the configuration in which it will be installed and does not exceed any stated product size limitations. For instance, one cannot use an assembly that has only been tested in a horizontal orientation vertically. If applicable, any associated evaluation service report should be provided along with a description of how the assembly in its installed condition meets the requirements of the report.

## REVIEW COST IMPLICATIONS

The alternative means and methods request not only requires an understanding of the specifics of test standards but also may sometimes require additional test data. Therefore, it is paramount to start this request process early in the design stage and with the assistance of knowledgeable parties (i.e., registered fire protection engineers, testing laboratories).

Starting this process early also allows one to forecast associated costs that may appear down the road, such as additional testing data in support of the alternative means and methods request. It also helps to avoid costly last-minute change orders, like removing and reinstalling systems due to changes resulting from AHJ review.

## *Looking Ahead*

A well-written alternative means and methods request coordinated early in the design process can provide flexibility in product choice, avoid prolonged back-and-forth with the AHJ, and prevent change orders due to lack of clarity in design intention. This process will only run more smoothly as both designers and AHJs become educated on how alternative means and methods must be requested.

In the future, alternative means and methods requests should hopefully be facilitated by the finalization of ASTM E2816 so manufacturers can pursue testing to AC 179 once more. In the meantime, education will allow designers to select products that are approved for their use. It will also help AHJs better understand the documentation they should be looking for, which will help them identify when products are not being implemented as tested.