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*Steiner tunnel windows and cover*



# Code-compliant Solution for Combustible Plenums



**Sarah Brewer**

Unifrax | LLC

Fire protection wrap systems can provide a code-compliant solution for combustible items in commercial building plenums, areas above the ceilings or beneath raised floors in which various building services are often run.

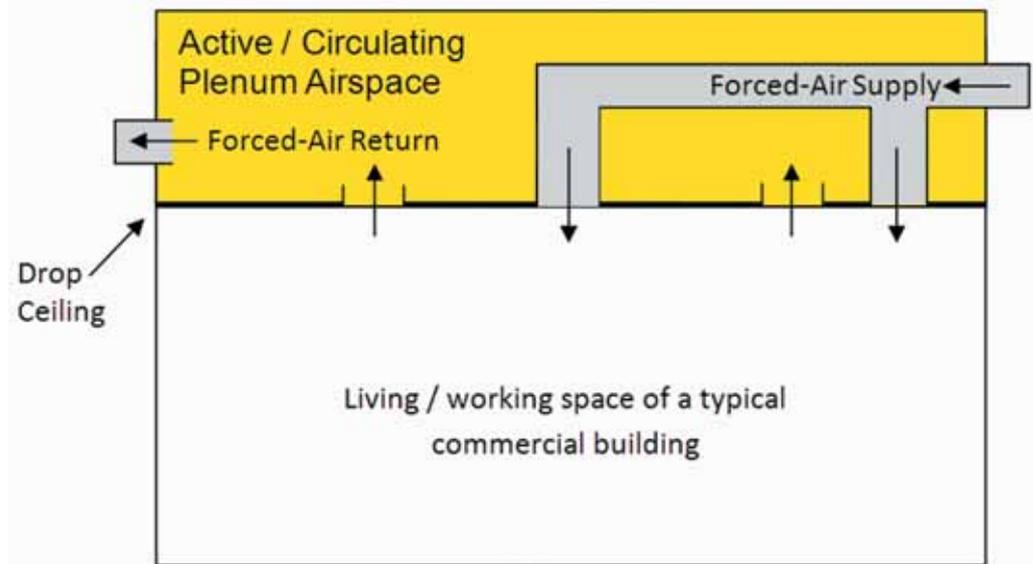
**T**he concealed nature of the plenum space, chemical composition of many plastic plenum items and the quantities in which items can be installed, create a serious fire and life safety challenge. National building construction codes recognise this threat and significantly limit, and in some cases prohibit, the installation of specific types of combustible items in plenum areas. For site errors, where non-plenum rated cables and pipes are mistakenly installed, fire protection wraps provide a tested solution that will bring the installation in to code compliance. Benefits of plenum protection (PP) systems go beyond “problem fixing” and can provide the entire construction team with justification for the proactive utilisation of fire protection wraps as a preferred plenum installation configuration.

### **What constitutes a plenum, and what are typical plenum items?**

A plenum is an enclosed portion of the building structure, other than an occupiable space being conditioned, that is designed to allow air movement, and thereby serve as part of an air distribution system. Supply, return, exhaust, relief and ventilation air plenums shall be limited to uninhabitable crawl spaces, areas above a ceiling or below the floor, attic spaces and mechanical equipment rooms are also used to house the building’s communications cables for computer and telephone networks and audio visual equipment. Since a plenum space cannot be used for storage, there are code requirements for the removal of abandoned, unused cable that could, over time, create an added hazard.

# PLENUM FIRE PROTECTION

Diagram of a typical plenum



Typical plenum items may include, but are not limited to:

- Plumbing: water supply lines, drain/waste pipe, fire sprinkler pipes, and pneumatic tubing.
- Electric Wiring: power cables, fibre-optic cables, communication and AV cables.
- Other items: restaurant beverage lines.

## Plenum testing requirements and compliance options

Building codes govern requirements regarding items located within environmental air handling spaces. The code imposes mandatory conformance to a construction requirement that is administered by a local governmental agency. Compliance is typically enforced through review of project submittals and on-site inspections.

The codes specify the fire test standard to be utilised to evaluate performance to a minimum set of criteria. Fire protection requirements for materials located in plenums can be found in a variety of buildings codes, including sections relating to mechanical, plumbing and electrical applications. In the United States, plenum regulations are covered in the International Mechanical Code (IMC), the National Fire Protection Associations' NFPA 70

National Electrical Code (NEC) and NFPA 90A. Other plumbing codes likely also apply.

Taking one code as an example, the IMC, Section 602 on plenums clearly states that materials (the exposed item) in plenums shall be non-combustible (no combustibility is verified through testing to ASTM E 136) or the item itself must achieve 25/50 flame spread/smoke developed ratings to ASTM E 84.

For a few specific plenum items (that typically contain some organics) compliance with other fire test criteria is required. The code clearly defines these requirements as:

- Peak optical density not greater than 0.50.
- Average optical density not greater than 0.15.
- Flame spread of not greater than 1.524 metres.
- The fire test standards to be utilised to evaluate these properties are dictated by the plenum item type and are listed below. Items that meet the performance criteria are referred to as "plenum rated". Plenum rated should not be confused with "riser rated", which covers cables that run between floors of non-plenum areas where the requirements are not as strict.
- Wiring: to NFPA 262.
- Fire sprinkler piping: to UL 1887.
- Pneumatic tubing: to UL 1820.
- Raceways: to UL 2024.

IMC Section 6.2.2.1, Exception 5 provides direction on the use of combustible items in plenums and states: "Combustible materials are to be fully enclosed within continuous non-combustible raceways or enclosures, approved gypsum board assemblies or within materials listed and labelled for such application".

Since in Exception 5, the code does not clearly define the fire test standard to be utilised for evaluation of a combustible item within the listed and labelled material, the above listed plenum test methods are used to evaluate the combustible item, together with the exterior applied fire protection wrap, as a tested system.

Therefore, to be code compliant, the following options are available for installation:

- 1 Non-combustible items.
- 2 Plenum rated items.
- 3 Combustible items enclosed in a non-combustible raceway (EMT).



Steiner tunnel burner

# PLENUM FIRE PROTECTION

Code Compliant Option	Limitations
Non-combustible Item	Weight – equipment to manoeuvre heavy item Labour – required joint connection technique
Plenum-rated Item	Cost – higher price of plenum rated item Performance limits versus combustible version
Combustible item enclosed in non-combustible raceway	Cost – of added raceway Labour – difficulty constructing horizontal shaft
Combustible item enclosed in fire-rated shaft	Labour – secondary installation of added raceway Space – needed for shaft, limited work area Temperature – gypsum limited to areas $\leq 125^{\circ}\text{F}$
Combustible item in fire protection wrap	Acceptance – appropriate test documentation Defining value of wrap versus alternate choices

- 4 Combustible items enclosed in a fire-rated shaft to isolate from the plenum area.
- 5 Combustible items enclosed in a fire protection wrap; a tested plenum protection (PP) system.

### Considerations and limitations of plenum options

Although there are a number of code compliant options, each has limitations that must be considered relative to the potential value it provides. Some of these considerations are captured in the table above.

These limitations may not be an issue for every project, but special conditions or the building design may create the situation where an alternative installation could or should be considered. Even non-combustible items, such as cast iron pipe, can be costly to install due to the weight of the item and need for equipment and labour to install. Plenum-rated versions of pipe and cable can offer reduced weight and simpler joint connection techniques. However, plenum-rated items are premium priced, which may offset potential labour savings. In addition, enclosing a combustible item in a non-combustible raceway is subject to the added cost of the raceway and secondary labour to install it.

In some jurisdictions, combustible items installed in plenums are permitted to be isolated from the rest of the plenum space by enclosing them in a fire-rated shaft. Shafts and plenum enclosures shall be constructed of materials permitted for the type of construction classification for the building. It should be noted that the use of gypsum board to form a plenum (or air handling duct) is limited by the code to systems where the air temperature does not exceed  $52^{\circ}\text{C}$  and the building and mechanical system design conditions are such that gypsum board surface temperature will be maintained above the air-stream due point temperature. This is instituted as a safeguard against mould growth. Therefore, the code-defined temperature limitation will likely restrict the option to use fire-rated gypsum board shafts if any part of the board enclosure is within a plenum subject to elevated temperatures. An alternate method of isolating and enclosing the combustible item, such as use of a fire protection wrap material, would alleviate the potential misapplication of the board.

One limitation for fire protection wraps is the lack of awareness of this code-compliant option and ensuring local approval of products is being made based upon appropriate testing and listing documentation. Defining the “general” value of

wrap systems versus alternate plenum choices is challenging due to the variety of conditions that can exist on projects. However, documenting the technical challenge and resulting savings for

# PLENUM FIRE PROTECTION

*Combustible pipe bundles protected with a wrap system that were undamaged by the fire test exposure*



specific project situations can provide powerful testimonials and data from which future informed decisions can be made.

## **Fire protection wrap as a problem solver**

Code allows combustible items to be fully enclosed within materials listed and labelled for such purpose. When combustible items are mistakenly installed in a plenum space, they are typically removed and replaced with compliant items. This is a very costly and time consuming process. As an alternate to replacement, materials have been developed that can be wrapped around the combustible item, keeping it from the degrading under fire conditions. These materials are qualified through fire testing of the combustible item and wrap together as a system to one of the plenum fire test methods dictated by the item type (such as NFPA 262, UL 1887, UL 1820 or UL 2024).

These fire tests are a modified version of ASTM E 84 and utilise the Steiner Tunnel furnace. Testing is conducted at a nationally recognised testing laboratory (NRTL) such as Intertek, ETL or UL. Passing systems are listed under the plenum protection (PP) category in the lab's Certifications Directory and can apply their listing mark to the material packaging and product. Listing marks provide specific details on the application for which it has been qualified. Care should be taken to ensure the listing is applicable for use in environmental air spaces and not for some other electrical or fire protection property.

## **Features of fire protection plenum wraps**

The product and system features of fire protection wraps make them popular and beneficial for use as a plenum protection system. Typical features include:

- Flexible, fibre insulation blanket.
- High temperature capability (1100°C) operating temperature.
- Thin, uses little space (12mm thickness).
- Light weight, easy to handle.
- Able to conform to complex configurations.
- Simple installation technique – 25mm material overlaps.
- Common attachment material – steel tie wire or banding.

- Non-combustible (wrap material).
- 25/50 flame and smoke ratings to ASTM E 84 (wrap material).
- Listed and labelled as plenum protection (PP).
- Testing on a variety of plenum items (cable, pipe, single, bundles).
- Testing on a variety of plastic chemistries.

Since code requires exposed plenum items to be non-combustible or have a 25/50 rating, some have assumed that a combustible plenum item can be covered with any 25/50 rated material to bring it in to compliance. This is a false assumption. The reason for this is that the offending combustible item needs to have been tested "as wrapped" to verify that the combined system can achieve the required flame and smoke ratings.

An individual material may pass the flame/smoke criteria but may not provide enough protection for the combustible item within the wrap to also pass the test.

Reasons for this may include shrinkage of the covering material, inadequate insulation properties or thickness to prevent the passage of heat to the inside and degrading the combustible item. Most insulation materials that have a 25/50 rating, have neither been tested as a system with the combustible item or items, nor can they provide any listings verifying testing "for such purposes" as the code requires. Only plenum protection (PP) listed systems provide the testing documentation that "Authorities Having Jurisdiction" (AHJ) need to confidently approve these materials for use on projects and to solve job site issues.



*Simple steel tie wire attachment method*

# PLENUM FIRE PROTECTION

Application	Potential Benefit
Roof drains	Run drain pipe inside structure to improve building aesthetics
Heating/cooling fan coil units	Substitute copper tubing with lower cost PVC plus wrap to provide both fire protection and condensation insulation (R value)
High purity water supply lines	Use of plastic formulas that exhibit superior low surface roughness, reducing incrustations or formation of bacteria
Water lines with corrosive or abrasive liquids	Use of plastic formulas more resistant to scale or corrosion due to exposure to household chemicals or industrial applications. Offers long, low maintenance service life.

### Fire protection wrap as a pre-engineered alternative

Fire protection wraps provide benefits that exceed the basic product features that suffice for its use as a project problem solver. These benefits can be significant enough that designers, building owners and contractors are proactively seeking approval of these systems, many of which are on high profile projects. The table above shows a few applications for which plenum wraps have justified their use and a proactive approach.

A fire protection wrap system is shown installed on combustible plastic roof drains that were relocated to the inside plenum area of a corporate headquarters building to improve design aesthetics.

### The future of fire protection wrap systems

Fire protection wrap systems that have been listed and labelled for plenum protection (PP) have recently become a viable code-compliant option for combustible plenum items. A growing portfolio of plenum installation case histories provide proof fire protection wraps offer value to designers, building owners, installers and code officials, evolving from "problem solver" to "engineered alternative". As awareness improves, fire protection wraps will provide a broader group of industry professionals the value and solutions they desire to achieve their project goals.

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