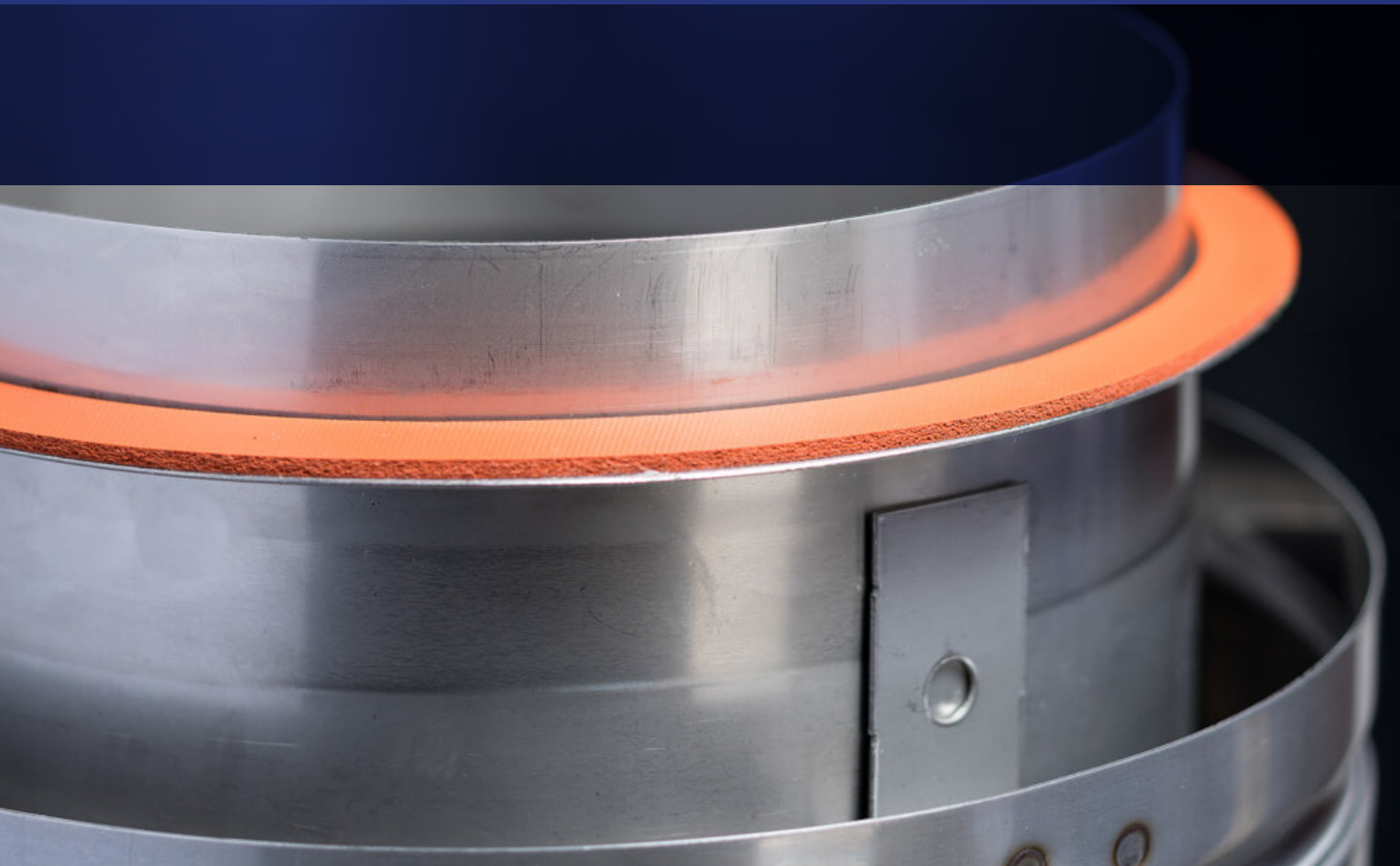




WHITEPAPER

# SPECIAL GAS VENTING SYSTEMS

**DOES STAINLESS STEEL PROVIDE  
MORE CERTAINTY THAN PLASTIC?**



The proper product selection regarding special gas vent exhaust systems for high-efficiency boilers and hot water heaters can be a challenging process. One must juggle costs, safety, regulatory requirements, installation guidelines and more. Relevant codes are not particularly helpful, as they lack many specific details, including the International Mechanical Code, Uniform Mechanical Code, NFPA 211, and National Fuel Gas Code/NFPA 54.



**For example, NFPA 211 defines a vent and special gas vent as:**

**3.3.142\* Vent.**

A flue gas-conveying system intended for use only with certain gas-, liquid-, or pellet fuel-fired appliances that do not produce flue gas outlet temperatures higher than a value specified in the listing vent standards.

**3.3.142.1 Gas Vent.**

A passageway composed of listed factory-built components assembled in accordance with the manufacturer's installation instructions for conveying vent gases from appliances or their vent connectors to the outdoors.

**3.3.142.1.1 Special Gas Vent.**

A gas vent for venting listed Category II, III and IV gas appliances.

## GAS VENTING REQUIREMENTS FOR BOILERS/HOT WATER HEATERS

There are four main categories of boiler/hot water heater vents; these are categorized by exhaust gas temperature and pressure. Per section 3.3.80 of NFPA 211, those categories are defined as follows:

**Category I**

An appliance that operates with a nonpositive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.

**Category II**

An appliance that operates with a nonpositive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

**Category III**

An appliance that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.

**Category IV**

An appliance that operates with a positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

To obtain maximum efficiency and flame stability, high-efficiency boilers and heaters are designed to operate as a category IV appliance. The design of its venting system will impact the appliance's ability to operate in this category.

To learn more, watch a detailed presentation on Schebler Chimney's YouTube channel at [www.youtube.com/watch?v=CUtMsPs0eb4](http://www.youtube.com/watch?v=CUtMsPs0eb4).



## ABOUT SAFETY AND UL LISTINGS

Safety is the most important aspect of a special gas venting system, but it is often overlooked. Gas-fired boilers and hot water heaters are used in high-occupancy buildings, including large residential complexes, schools and hospitals. While these venting systems have low emissions and relatively low exhaust gas temperatures, they carry the poisonous by-products of combustion, which are virtually undetectable without a carbon monoxide detector. To ensure building safety, special gas venting systems must be clearly engineered, specified, installed and inspected.

Special gas venting systems constructed from stainless steel materials have been used on condensing appliances under the UL 1738 listing for many years. This UL listing complies with National Fuel Gas Code/NFPA 54, which requires stainless steel constructed products to be able to handle corrosive condensate, withstand high operational temperatures of 480° F or higher, and be

pressure tested/rated. We should note that temperature testing is always done at higher than normal operational conditions to ensure maximum safety if exhaust gas temperatures rise beyond normal due to equipment malfunction or inadvertent high return water settings.

Because UL 1738 listed stainless steel venting systems cost more, they are often replaced by PVC, CPVC and PP to exhaust condensing appliances. (This shift started with residential furnaces and has slowly moved to commercial boilers and hot water heaters.) At first glance, using plastic for venting appears to be a safe, cost-effective and potentially leak-free option.

Let's see if that premise is true by taking a closer look at boiler operations, hot water heater operations, and venting system routing using various plastic materials compared to stainless steel.

# PLASTIC VS. STAINLESS STEEL

## Plastic vs. Stainless Steel Compliance with NFPA 54

The first thing that must be addressed with any product and installation is code compliance. NFPA 54/ National Fuel Gas Code states only approved plastic piping can be used to vent exhaust gas, as follows:

### 12.5.2 Plastic Piping.

Plastic piping used for venting appliances listed for use with such venting materials shall be approved.

### 12.5.3 Plastic Vent Joints.

Plastic pipe and fittings used to vent appliances shall be installed in accordance with the appliance manufacturer's installation instructions. Where primer is required, it shall be of a contrasting color.

### 12.5.4 Special Gas Vents.

Special gas vents shall be listed and installed in accordance with the special gas vent manufacturer's installation instructions.

It's important to note that both 12.5.2 and 12.5.4 must be followed, meaning plastic piping must be approved and also listed and installed per the special gas vent manufacturer's specific installation instructions. Just following the appliance manufacturer's installation directions could be a grave mistake, as those directions may do little to ensure the safety or effectiveness of the product and could put you at risk for selecting

and installing an inadequate system. Additionally, the plumbers installing the plastic venting likely have little knowledge of proper system configurations or materials needed for venting exhaust gases.

Per NFPA 54, metal chimneys have different requirements. Section 12.6.1 of NFPA 54 covers the listing or construction of masonry, metal and factory-built chimneys and incorporates the following provisions.

### 12.6.1.1

Factory-built chimneys shall be installed in accordance with the manufacturer's installation instructions. Factory-built chimneys used to vent appliances that operate at positive vent pressure shall be listed for such application.

### 12.6.1.2

Metal chimneys shall be built and installed in accordance with NFPA 211, Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances.

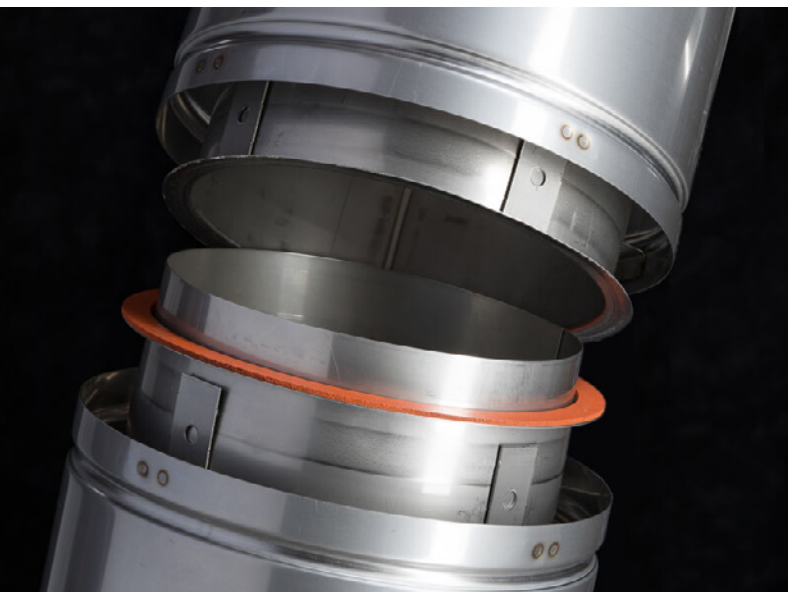
## Plastic vs. Stainless Steel and UL Listings

A special gas vent constructed of plastic that has obtained a UL listing for use as such is rare. In fact, if you perform a product or manufacturer search on the UL listing website, you'll only find manufacturers that use stainless steel. That's because the UL 1738 listing requires a product to pass at temperatures unobtainable for plastic materials. Yet, quite a few manufacturers of PVC, CPVC and PP claim their products comply with UL 1738 standards. In reality, those products are ETL listed, a similar but easier threshold as it does not take into account the temperature requirements contained in the UL standard.

## Plastic Products Safety Concerns

Knowing and adhering to UL standard temperature requirements are extremely important when it comes to plastic products. Simply put, plastic is much more sensitive to high heat than metal.

Exhaust gas temperatures from gas-burning boilers and hot water heaters vary greatly. For maximum efficiency, exhaust gas temperatures should be as low as possible.



These temperatures need to be below the dew point to obtain Cat II and/or Cat IV operation. You should also note that the exhaust water temperature is typically about 20 degrees higher than the return temperature setting.

The information in Table 1, taken from Engineering Toolbox, shows the operational temperatures for PVC, CPVC and PP, including the maximum operational temperature of each material that is allowed, with or without pressure. To account for the higher exhaust water temperature, the return water temperature should be set roughly 20 degrees below the maximum.

As you can see, the pressure in a gas venting system is very low and so has little impact on performance.

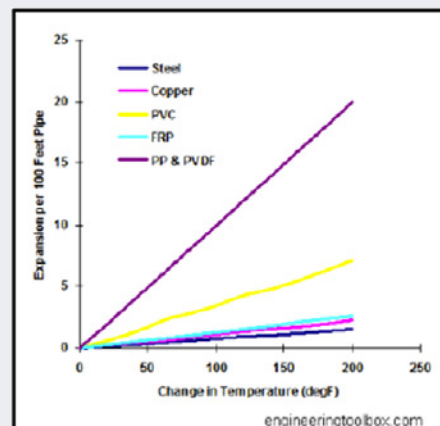
**Table 1**

Plastic Pipe Material	Operating Temperature			
	With Pressure		Without Pressure	
	(°F)	(°C)	(°F)	(°C)
PVC - Polyvinylchloride	100	38	140	60
CPVC - Chlorinated Polyvinyl Chloride	180	82	180	82
PP - Polypropylene	100	38	180	82

**Table 2**

Material	Expansion Coefficients
	$10^{-6} \text{ in/in } ^\circ\text{F}$
Aluminum	12.8
Carbon Steel	6.5
Stainless Steel (316L)	8.89
PP Polypropylene	45
PE Polyethylene	83.0
CPVC Chlorinated polyvinyl chloride	44.0
PVC Polyvinyl chloride	28.0

**Graph 1**



Some manufacturers of PP venting products publish max temperatures as high as 230° F. The temperature can be monitored, and if it exceeds the limit, the system will automatically shut down to avert a system meltdown. This is a simple setting on the boiler that can be done by most maintenance staff or a boiler tech. Unfortunately, this can force appliances to shut down during peak periods, when building heat is needed most.

The reaction of the plastic material to the cycling of appliances must be considered. Appliances will

cycle on and off based on the demand for heat or hot water. The cycling of these appliances strains the exhaust system as it will expand and contract.

The higher expansion coefficients for plastic materials make plastic pipes and tubes extremely sensitive to temperature changes. When using plastics, you must pay close attention to the pipes and tubes when the temperature varies. Table 2 shows the impact of the thermal expansion coefficients as represented in the accompanying graph.

## Design with Plastic Materials

The significant thermal expansion and contraction of plastic material due to extreme temperature changes requires a system layout that can accommodate them. To better understand this requirement, let's look at how thermal expansion can impact a vent constructed of PP (or of CPVC, as their expansion coefficients are roughly equal).

This example represents a simple exhaust routing for a boiler with a return water temperature of 120°F (given the expected 20-degree difference, this assumes the exhaust gas temperature is close to 140°F). The amount of expansion experienced in the exhaust would be determined by the rise in temperature between when the boiler is turned off and on, which in this example is 70°F. A 70°F rise in temperature would expand the polypropylene about 3/8" per 10 ft. of vent length. It should be noted that PVC, which has a low-temperature threshold, as shown in Table 2 earlier, would experience much less expansion in this scenario but would also be dangerously close to its maximum allowable temperature, per Table 1.

The thermal expansion will force the system to grow in the directions shown in Diagram B due to the secure attachment points at the boiler exhaust outlet and a support near the bottom of the stack. The problem is most noticeable at the intersection of the riser off the boiler to the breeching. This would place a perilous strain on the 90° elbow and reduce the pitch of the breeching, assuming the contractor installed the system within the code requirement of 1/4" per foot pitch.

To ensure the system can handle expansion and contraction, CPVC or PVC vents will be provided without supports. This puts these systems completely at the mercy of the installer to ensure they are supported correctly, can handle the forces of expansion/contraction on the joints and will retain the proper pitch for condensate to drain back to the boiler without dips or sags. Inspecting these systems to ensure proper design criteria and installation would be extremely difficult.

## Design with Stainless Steel Materials

Stainless venting would experience a much lower amount of expansion, as reflected in Diagram C.

UL listed stainless steel products have UL listed supports and are designed to handle expansion and contraction.

Manufacturers of these systems usually provide complete system engineering along with detailed system submittal drawings, which ensures a system will function correctly. These system drawings allow the contractor to properly install the system and provide the AHJ documentation to properly inspect during and after installation.

Diagram A

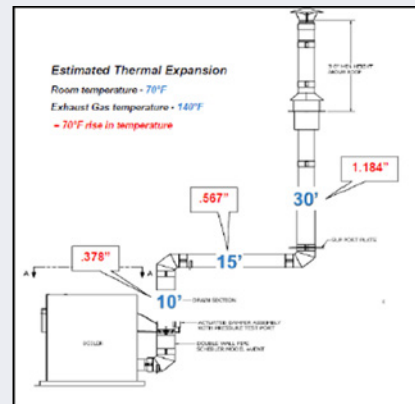


Diagram B

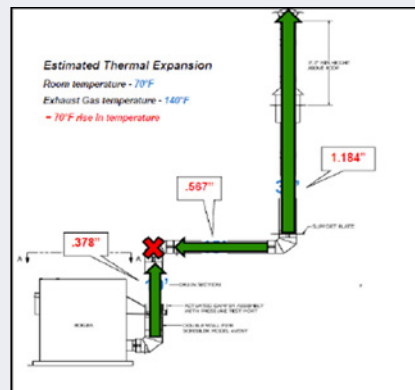
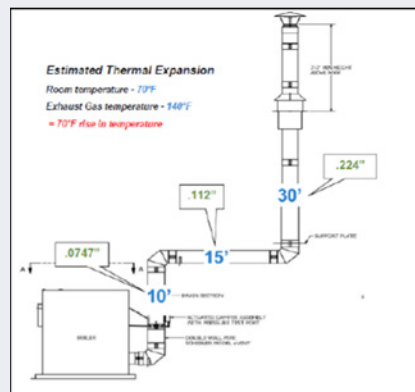


Diagram C



# WHEN IS A PLASTIC MATERIAL SAFE FOR USE AS A SPECIAL GAS VENT? FREQUENTLY ASKED QUESTIONS ABOUT PLASTIC MATERIALS.

## Exhaust Temperatures

### What plastics can handle my maximum temperatures?

Refer to Table 1. If anticipated exhaust temperatures might ever approach the maximum temperature, that material should not be used. Always focus on the potential maximum temperature when the demand for hot water is at its highest. The exhaust system should not be the reason an appliance must shut down to protect the system.

### Can the exhaust gas temperature be monitored, and the appliance shut down if the maximum temperature is exceeded?

The boiler or hot water heater must have an exhaust gas temperature sensor that allows for a maximum temperature setting based on the venting material. This must be locked during appliance start-up to ensure the setting is not inadvertently adjusted or disabled. This is very important since initial settings are often changed over time.

## System Design and Layout

### Can plastic be used for long runs?

This is not recommended. Long-length runs, horizontal and/or stacks will experience significant expansion. This will cause the system to sag, bow or move.

### Are there limits on changes in direction with plastic materials?

You should always minimize such changes. Each change in direction will place significant stress on the joints and elbows, greatly increasing the risk of system damage from expansion and contraction.

### How many supports will I need?

The recommendation for most plastic materials is a support every five feet of horizontal run and every other floor on stacks. If this is not possible or the contractor chooses to support against the guidelines, the system could experience damage during operation. A submittal drawing of the system must be available to ensure installation is done properly.

## WARRANTY INFORMATION

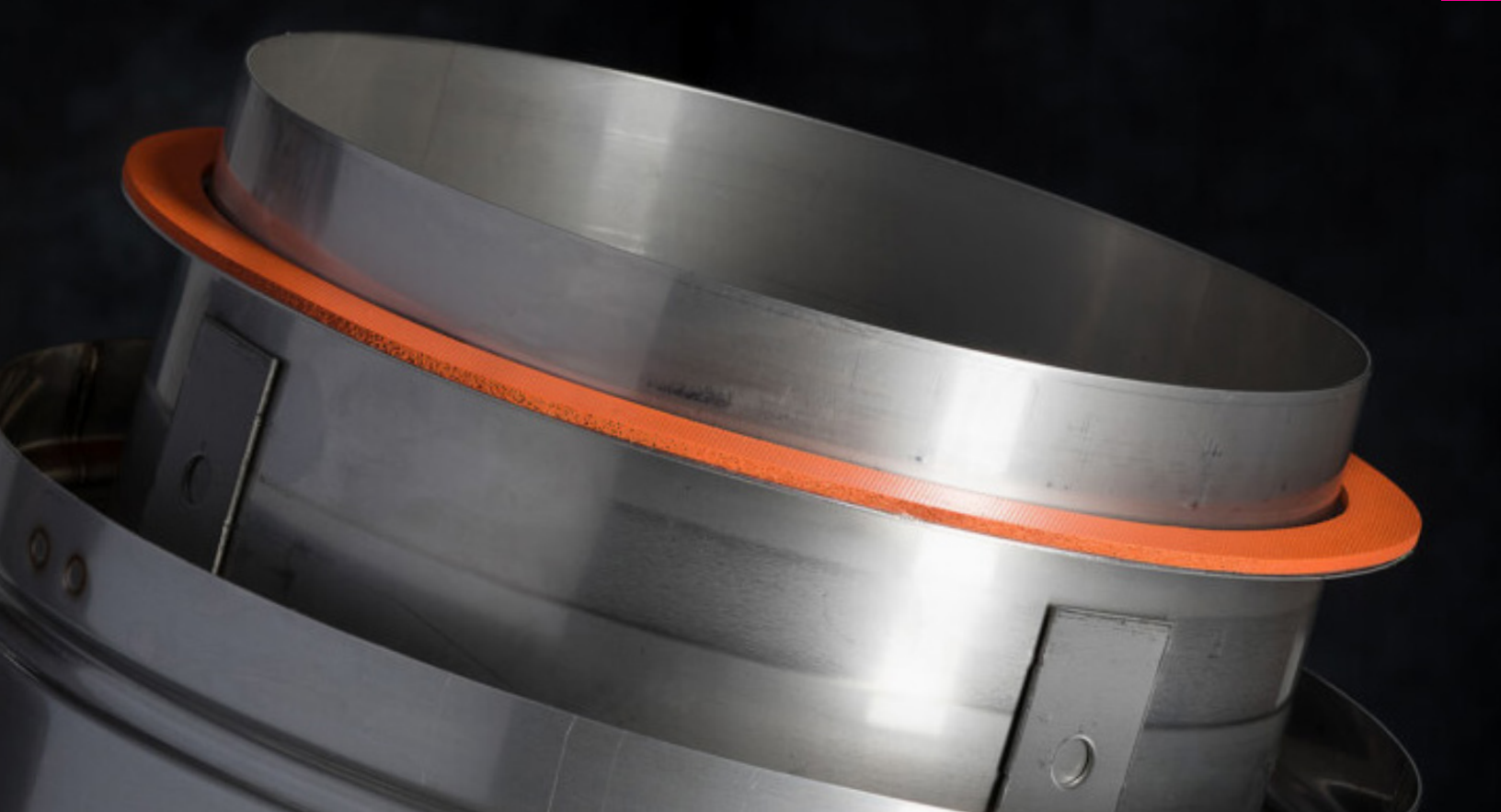
### What are the typical warranties for special gas vents?

Although all manufacturers may vary, below are typical warranty terms. A venting product should have a warranty at least as long as the appliance life it supports. Stainless steel UL 1738 listed products often come with limited lifetime warranties.

**PVC – CPVC: 10-year warranties**

**Polypropylene: 10-year warranties**





## SUMMARY

Cost always plays a factor in product selection for building materials, but looking at price alone can be dangerous. Plastic materials for venting can appear ideal from a cost and functionality standpoint but introduce safety, design responsibility, product lifespan and installation concerns. Simple straight-up system configurations with various safety mechanisms in place to limit exhaust gas temperatures can mitigate some of those concerns but can be unrealistic to install and end up greatly increasing costs.

It is important to remember that no matter how efficient and low-emission these appliances are, the special gas venting system still handles deadly exhaust gases, so its safety and effectiveness should always be your first priority.

Stainless steel UL 1738 listed products, when produced by a reputable manufacturer, are safer, perform more consistently, and may even come with a lifetime warranty. These systems can easily handle the exhaust gas temperatures without risk of shutting down or thermal expansion/contraction and ensure a safe, reliable system.

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