

# CHARLOTTE

PIPE AND FOUNDRY COMPANY

## VALUE ENGINEERING CONSIDERATIONS

for Cast Iron Soil Pipe and PVC in Commercial Sanitary and Storm Drainage Applications



# USE THE RIGHT MATERIAL FOR THE APPLICATION.

Plumbing design professionals, building owners, developers and others frequently face tremendous pressure to reduce building costs of commercial projects. An area that is commonly value engineered or “VE’d”, is drain, waste and vent (DWV) plumbing systems. Plastic materials are sometimes substituted in place of cast iron soil pipe (CISP) where cast iron was originally specified—without thoughtful consideration for the consequences of such a change. As common as this practice has become, it is sometimes lost that there were good solid engineering reasons that cast iron was originally selected as the most suitable material for a given client or application. The objective of this brochure is to provide all of these parties a brief and objective comparison of the capabilities and qualities of each system.

## GENERAL CONSIDERATIONS

### Maximum Working Temperature:

Plumbing codes restrict discharges into sanitary to 140° F, but the reality is that commercial condensate and equipment discharges can sometimes exceed these temperature guidelines. Consider if that exists on the project where PVC is being substituted.

- PVC has a maximum working temperature of 140° F.
- CISP with neoprene gaskets has a maximum temperature of 212° F.

### Thermal Expansion:

Designers must consider thermal expansion and characteristics for the piping system being used. Failure to accommodate system expansion and contraction may result in system failure.

- PVC will expand 3.6" per 100' of pipe with a 100° F temperature change. Compensation for thermal expansion and contraction should be designed into systems and is generally accomplished through the use of offsets or expansion joints.
- CISP will expand 0.745" per 100' of pipe with a 100° F temperature change. The movement of cast iron is close to that of structural steel and concrete, meaning it literally “moves with the building” and usually requires no compensation for expansion or contraction.



## HOW VALUE ENGINEERING AFFECTED A HEALTHCARE FACILITY

John Neal was the plumbing designer on a hospital addition. Six months after the owners moved in, he got a phone call. The floor in the hospital’s kitchen was collapsing. They discovered the contractor went

against the engineer’s specs for cast iron and instead connected PVC to a commercial dishwasher which discharged water at 190° F. The PVC was melting beneath the floor, causing both drainage problems and the floor to collapse.

The owners had to dig up the floor and replace the PVC with cast iron. The hospital spent additional money and time to redo the kitchen as well as having to manage disruption in patient meal service.

Learn more about this story and the dangers of value engineering: [charlottepipe.com/VE](http://charlottepipe.com/VE).



## A NOISY PLUMBING SYSTEM IS ANYTHING BUT RELAXING.

Nick Cantu was building a renovation for a two-story day spa --showers and bathrooms upstairs and massage rooms downstairs.

“Because noise was a factor, I wrote in my spec that vertical risers should be cast iron. They used PVC. On my observation report I wrote, ‘Not cast iron, may be a noise problem.’”

“A month later, we started getting calls. Customers were complaining that their spa experience was ruined by the sound of flushing toilets.”

Learn more about this story at [charlottepipe.com/VE](http://charlottepipe.com/VE).



## AGGRESSIVE WASTE.

Aggressive waste, commonly defined as DWV effluent with a pH 1 – 4 or pH 10 – 13, can be complicated for plumbing designers and specifiers. Aggressive waste can be found in common applications like commercial kitchens, hospitals / clinics, condensate drainage, casinos, parking garages, and other specialized systems.

Typically, the designer’s first impulse is to specify PVC due to its excellent chemical resistance. However, if the waste temperature is 140°F or higher or the system needs to be installed in a return air plenum, there is a trend to reach out to other products like Sch 40 CPVC. Sch 40 CPVC is listed for chemical waste drainage, not sanitary drainage.

Of greater concern, Sch 40 CPVC is susceptible to environmental stress cracking when exposed to most types of edible oils. PVDF or stainless steel are effective and code compliant but are expensive. Edge HP Iron™ is specifically designed to handle aggressive waste while maintaining all the other advantages of cast iron detailed in this brochure.

## Sound Attenuation:

A material’s ability to block the transmission of sound is a function of the material’s density. Cast iron is very dense, solid-wall PVC is much less so, and foam core materials are lighter still. Sound attenuation is especially important in main drainage stacks and storm systems in multifamily housing, office buildings, dwellings where individuals spend the night (hotels and hospitals) and in classroom settings. Consider having these two different systems in the ceiling of your project and decide if plumbing noise might be a consideration.

## Maintenance:

Proper maintenance is required to keep DWV systems performing optimally. Periodically, drain cleaning devices using auger bits are required to remove blockages. Repeated use of these devices could damage PVC pipe walls and fittings.



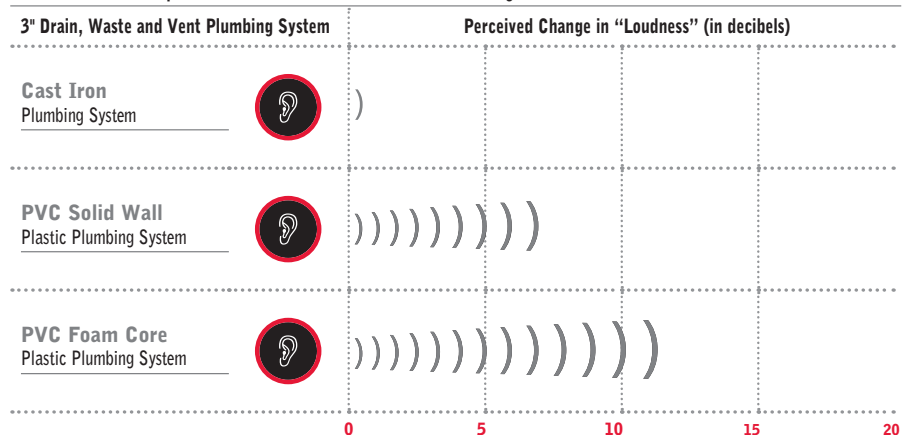
[www.charlottepipe.com/DWVsoundtest.aspx](http://www.charlottepipe.com/DWVsoundtest.aspx)

Watch the video of our DWV plumbing system sound test on our YouTube channel.



## The Quiet House® System Noise Comparison

Rule of Thumb: Most perceive a 10 dB increase in sound level as being twice as loud.

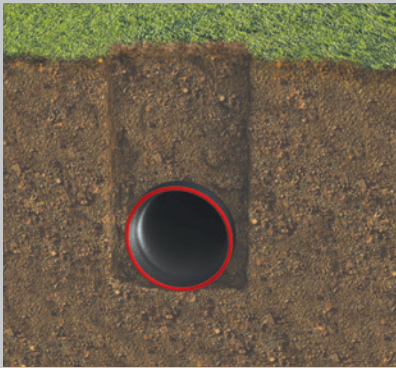


## **BURIAL OF PIPING SYSTEMS**

### **Failure Mode:**

The most significant difference between PVC and CISP in underground applications is the way that they support external loads. Defined by failure mode, piping systems are either classified as rigid or flexible.

- As a flexible piping system PVC is actually dependent on the backfill and bedding surrounding the pipe to support it. PVC pipe must always be installed per the requirements of ASTM D 2321, which details trench width, bedding depth, backfill and compaction, as well as other factors. Calculating maximum burial depths for flexible piping systems is very complex and requires the use of external loading software, which requires input of many project parameters to estimate resistance to external loads. Additional information and free software is available at [www.uni-bell.org](http://www.uni-bell.org).
- Rigid piping materials like CISP fail when they crush, and specific strength charts are published irrespective of soil, bedding or backfill. Reference charts for burial of CISP are available in The Cast Iron Soil Pipe Handbook at [www.cispi.org](http://www.cispi.org).



### **CAST IRON SOIL PIPE**

Correct burial of CISP requires a trench only wide enough to work in, a smooth trench bottom with uniform support, and adequate fall and holes dug for hubs or couplings.



### **THERMOPLASTIC PIPE**

As a flexible material, plastic piping is dependent on sidefill stiffness to limit deflections. ASTM D 2321 recommends a trench width of the pipe's outside diameter plus 16", or the pipe's outside diameter times 1.25, plus 12".

## **CONSIDERATIONS FOR PIPING SYSTEMS ABOVE GRADE**

### **Hanger Spacing/Fall:**

Properly installed DWV piping systems require consistent fall without flat or low points in the piping system that can impede flow. The cost of hangers, anchors and other materials plus the labor to install them is also a significant consideration.

- Model Plumbing Codes require PVC DWV pipe to be supported horizontally every four feet.
- CISP offers greater structural strength, which significantly reduces hanger requirements and provides consistent fall. CISP only needs to be supported within 18" of each joint and every 10 feet horizontally.

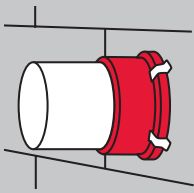
### **Combustibility & Use in Plenum Spaces:**

Combustibility of construction materials is defined by ASTM E 136 and is a consideration for selection of materials when penetrating fire-rated separations or for inclusion in unducted return air plenum spaces. Materials classified as combustible must pass the ASTM E 84 test protocol with index values of less than 25 flame spread and 50 smoke developed.

- PVC, like all plastics, is classified as a combustible material per ASTM E 136. PVC has low flame spread, but smoke developed ratings may be as high as 900, so PVC will not pass the 25/50 criteria of the ASTM E 84 test and may not be installed in plenum spaces.
- CISP is classified as noncombustible and can be installed in plenum areas without further consideration.

## Fire Wall Penetrations:

The cost and complexity of penetrating fire-rated assemblies adds significant costs to the installation of DWV systems in commercial construction. When considering the use of combustible materials vs. noncombustible, the additional care and costs involved in using combustible materials must be considered.



### COMBUSTIBLE

When combustible piping systems like PVC pipe penetrate fire-rated assemblies, fire-stop devices or collars conforming to the requirements of ASTM E 814 and specifically listed for use with that piping system must be used and must be installed around the PVC pipe on both sides of the fire-rated wall per the requirements of the listing.



### NONCOMBUSTIBLE

Because CISP is noncombustible, it will not burn away, leaving a hole in the fire-rated assembly. Therefore, installers are only required to seal the annular space between the wall and the pipe when CISP penetrates fire-rated assemblies. Typically mineral wool batting and fire-resistant caulking are used to fill the annular space.

## DON'T RISK LIFE SAFETY THROUGH VALUE ENGINEERING.



Warren Maddox owns an independent forensic engineering firm and cautions on the risks of penetrations of fire-rated assemblies.

In his recent work, he's noticed a dangerous pattern of code violations in apartment buildings, finding that many of the firewall penetrations for both the PVC sanitary and CPVC distribution lines weren't properly sealed.

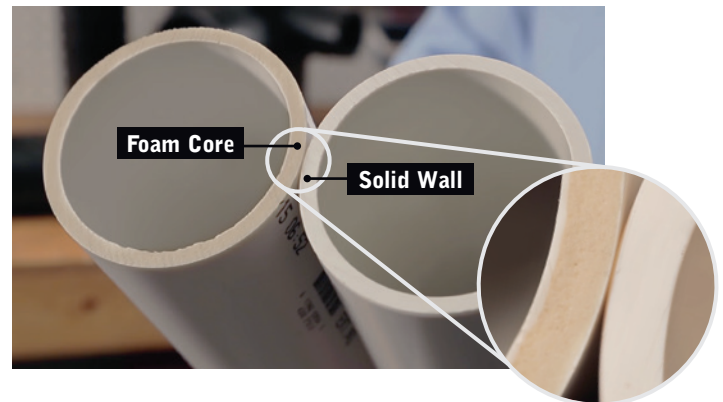
"The disturbing thing was the randomness. Some had the correct seal, but many just had caulk. Or were only sealed on the sides where it was easy to reach. Many of the pipes just went through a bare hole. It's like each crew just did whatever they felt like.

"This would be a key reason why a fire can spread so fast. If you don't seal the firewall penetrations, that'll do it.

"Sadly, I've seen this same thing at multiple sites. If it was a noncombustible material, like cast iron soil pipe, there would have been no cause for concern with just caulking around the pipes."

Learn more about this story and the dangers of value engineering: [charlottepipe.com/VE](http://charlottepipe.com/VE).

## OTHER CONSIDERATIONS




### Cellular Core PVC Pipe:

Cellular or foam core PVC pipe conforming to ASTM F 891 is produced by extruding a layer of foamed PVC between two layers of solid PVC, thereby reducing the weight and cost of the product. Cellular core pipe is designed for drainage (nonpressure) service only. The stiffness of cellular core pipe in most diameters is lower than that of solid-wall PVC pipe. Pipe stiffness is a key factor in determining the ability of pipe to resist external loads such as earth or live loads in underground installations. For this reason many specifiers believe that solid-wall PVC pipe is more robust and better suited to the rigors of commercial construction.

### Extra Heavy Cast Iron:

Extra Heavy (XH) hub and spigot CISP is available and preferred in demanding installations requiring the ultimate in rigidity and strength. XH is useful to designers working with applications subject to high live or earth loads, sheer forces in filled or unstable soil, and where pipe is suspended from a slab. Charlotte Pipe and Foundry offers XH CISP and a full range of fittings up through 15" size.

A photograph showing two men in a construction setting. The man on the left is wearing a yellow hard hat, a grey hoodie, and an orange and yellow safety vest. The man on the right is wearing a white hard hat, a blue and white striped shirt, and a blue patterned tie. They are both looking down at a clipboard held by the man in the safety vest. The clipboard contains several sheets of paper with red and white sections. The background is a brick wall.

**CONCLUSION:  
GIVE CAREFUL CONSIDERATION  
TO ALL ASPECTS OF A PROJECT BEFORE  
“VALUE ENGINEERING” CISP TO PVC.**

# CHECKLIST FOR CAST IRON TO PVC VE DISCUSSION

		YES	NO
<b>Maximum Working Temperature (at 0 psi)</b>	Will the system always remain below 140° F? <i>Consider both system design and a mechanical failure of a device such as a tempering valve. Consider boiler condensate, commercial dishwashers, commercial washing machines, and autoclaves.</i>		
	<b>Fact:</b> PVC maximum working temperature is 140° F.		
	<b>Fact:</b> CISP systems maximum working temperature is 212° F. Cast iron itself is capable of well beyond 212°. A CISP system is limited by the gasket material.		
		YES	NO
<b>Thermal Expansion</b>	For PVC only:		
	Have you calculated the amount expansion and contraction based on the change in temperature and length of run?		
	Have you accounted for the calculated expansion and contraction by designing in a loop, offset, change in direction, or other approved method?		
	Does contractor have expansion couplings and/or offsets figured into bid?		
	<b>Fact:</b> PVC will expand 3.6" per 100' of pipe with a 100° F temperature change.		
	<b>Fact:</b> CISP will expand 0.745" per 100' of pipe with a 100° F temperature change.		
	<b>Fact:</b> The Charlotte Pipe Tech Tools App includes an automated expansion calculator.		
		YES	NO
<b>Sound Attenuation</b>	Have you considered and designed for the impacts of sound on the building occupants who may be sleeping, convalescing, studying, or working? <i>Consider hotels, dormitories, schools, libraries, hospitals, office buildings, correctional facilities, condos/apartments, etc.</i>		
	<b>Fact:</b> PVC requires added insulation wrap and isolation brackets for quiet performance required in many buildings.		
	<b>Fact:</b> Cast iron requires no insulation wrap because of its natural noise-dampening qualities with consistent sound performance levels in the 25 dB range (utilizing neoprene gaskets).		
			YES
<b>Underground Installation</b>	For PVC only: Have you specified that the contractor must install PVC per ASTM D2321?		
	Will someone inspect the underground installation to ensure proper trench width, trench bottom, and soil compaction?		
	Has the contractor accounted for proper backfill material in the bid?		
	Have you considered the consequences of a failure under a concrete slab?		
	<b>Fact:</b> As a flexible piping system, PVC requires greater care in underground applications. It is dependent upon proper compaction of the surrounding soil (soil pipe mechanism) in order to withstand an external load. PVC pipe is considered to be in a failed condition when earth or live loads have caused the pipe to deflect beyond a certain point, generally 5%. Calculating maximum burial depths for flexible piping systems is more complex and requires the use of the Iowa Formula, pipe stiffness values for the system employed and knowledge of local soil conditions. Additional information on the Iowa Formula is available within the Uni-Bell Handbook of PVC Pipe.		
	<b>Fact:</b> As a rigid material, CISP fails when it crushes. Rigid piping systems can be evaluated with a ring crush test, and the derived values can be used to verify that the pipe will withstand the required external load.		
		YES	NO
<b>Hanger Spacing</b>	For PVC only: Has the cost of additional hangers and the associated installation cost been considered?		
	<b>Fact:</b> Model Plumbing Codes require PVC DWV pipe to be supported horizontally every four feet.		
	<b>Fact:</b> CISP offers greater structural strength, significantly reducing hanger requirements and providing consistent fall. Cast iron needs to be supported within 18" of each joint and every 10 feet horizontally.		
		YES	NO
<b>Plenum Spaces</b>	Does the building utilize a ducted HVAC system (i.e., it does not have unducted return air plenums)?		
	If wrapping PVC to meet ASTM E 84 is permitted by code, will a post-cable/telecomm/HVAC installation inspection occur to make sure pipe/fitting wrap is not damaged or disturbed?		
	<b>Fact:</b> PVC should not be installed in a plenum. It is classified as a combustible material per ASTM E 136 and does not meet 25/50 when tested to ASTM E84.		
	<b>Fact:</b> Cast iron is a noncombustible product which can be installed in a return air plenum.		
		YES	NO
<b>Fire Wall Penetrations</b>	Has the contractor added the cost of fire stopping materials and the associated labor?		
	<b>Fact:</b> PVC requires listed fire-stop materials or collars conforming to the requirements of ASTM E 814 on both sides of the fire-rated wall. The collars utilize intumescent fire-stopping materials.		
	<b>Fact:</b> Cast iron requires installers to only seal the annular space between the wall and the pipe. Typically mineral wool batting and fire-resistant caulking are used to fill the annular space.		
		YES	NO
<b>Aggressive Waste Applications</b>	For Aggressive Waste Applications only (see section on page 3 for additional details).		
	Will the system always remain below 140° F?		
	Does the building utilize a ducted HVAC system (i.e. it does not have unducted return air plenums)?		
	<b>Fact:</b> PVC maximum working temperature is 140°F.		
	<b>Fact:</b> CPVC is not listed for sanitary drainage and can suffer chemical attacks.		
	<b>Fact:</b> Cast iron is not combustible even with the special coatings and can be installed in a return air plenum.		

If you answered "yes" to every question, PVC is likely to be suitable for the application. Alternatively, if you answered "no" to any of the questions, you should consider specifying cast iron. Please visit <https://www.charlottepipe.com/resources/value-engineering> or contact your Charlotte Pipe Field Technical Service Representative for additional information.

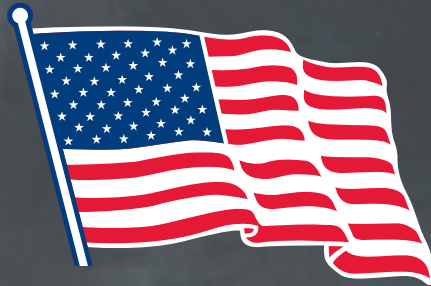
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