CHARLOTTE
PIPE AND FOUNDRY COMPANY

Value Engineering Considerations

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

The Correct Material for the Correct 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 VE'd, or "Value Engineered," is the drain, waste and vent (DWV) plumbing system. 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 lines to 140° F, but the reality is that commercial kitchens, condensate and equipment discharges can sometimes exceed these temperature guidelines. Consider if that possibility 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 working temperature of 212° F.

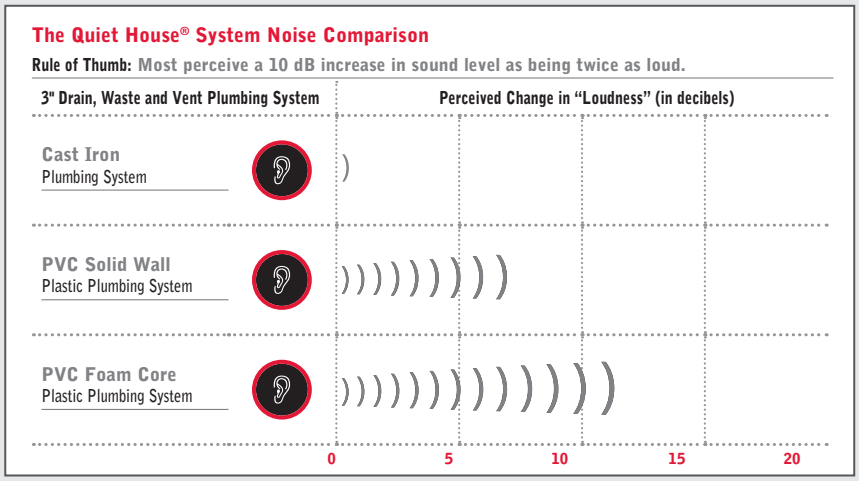
Thermal Expansion:

Designers must consider thermal expansion and contraction 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.

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 multi-family 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.

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.
- 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.

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 inches, or the pipe's outside diameter times 1.25, plus 12 inches.

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 4 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.

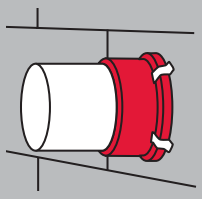
Combustibility & Use in Plenum Spaces:

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 un-ducted 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 non-combustible 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. non-combustible, 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.

NON-COMBUSTIBLE

Because CISP is non-combustible, 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.

Other Considerations

End of Life Recycling:

While both PVC and Cast Iron Soil Pipe are capable of being recycled at the end of their service life, only cast iron is routinely recycled in the United States at present.

- The market for post-consumer recycled PVC is not well developed in the U.S. at this time but is evolving rapidly, and in the future an increased amount of this material will be recovered. The dominant standards for PVC pipe and fittings in the U.S. are ASTM D 2665 and ASTM F 891; these standards require that conforming products be composed of virgin materials with zero percent recycled content. Charlotte Pipe® produces RePVC® conforming to ASTM F 1760 with post-industrial recycled content ranging from 30% to 80%, depending upon pipe diameter.
- CISP has an advantage in that scrap iron has significant economic value and a well-established market and infrastructure for its recovery. CISP from Charlotte Pipe has been verified by the ICC Evaluation Service to be manufactured of 95.81% post-consumer recycled content.

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 (non-pressure) 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.

Case Study:
Winnipeg Airport

In 2010, wide-spread PVC pipe failures were discovered beneath the new $585 million Winnipeg Airport, which ultimately delayed opening of the airport for many months and resulted in litigation that will require months or years to resolve. While the cause of a failure may be unclear and may be the result of unstable soil or poor installation practices, the design and material specification are certain to be questioned. The ultimate result is a failed system under many feet of concrete that can only be accessed by cutting through the concrete or tunneling under the structure, all at an exorbitant cost.

Conclusion:
Give careful consideration to all aspects of a project before "Value Engineering" CISP to PVC.

Checklist for Cast Iron to PVC VE Discussion

Item: Maximum Working Temperature (at zero psi)	YES	NO
Will system exceed 140° F by design or accident? *Boiler condensate, comm. kitchen, washing machine, autoclaves?*		
Fact: PVC maximum working temperature is 140° F.		
Fact: CISP maximum working temperature is 212° F.		
Item: Thermal Expansion	**YES**	**NO**
What is the air temperature at the time of installation?		
What is the maximum temperature of the system?		
What is the potential maximum change in temperature?		
Does contractor have expansion couplings and/or off-sets figured into bid?		
Access to expansion couplings for possible replacement/maintenance?		
Fact: PVC will expand 3.6" per 100' of pipe with a 100° F temperature change.		
Fact: CISP will expand .745" per 100' of pipe with a 100° F temperature change.		
Item: Sound Attenuation	**YES**	**NO**
Will anyone be sleeping, convalescing, studying or working in the facility (*i.e., Hotels, Dormitories, Hospitals, Schools, Libraries, Retirement, Convalescing Facilities, Shared Wall Condos & Apartments, Correctional Facilities, Quiet Work Areas, etc.)?*		
Fact: PVC requires added insulation wrap & isolation brackets for quiet performance required in many buildings.		
Fact: 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).		
Item: Underground Installation	**YES**	**NO**
Will contractor be installing PVC with ASTM D 2321 protocol?		
Will contractor be supervised during installation of underground PVC to assure required trench width, trench bottom and proper soil compaction?		
Does contractor have proper backfill material figured into his bid?		
Will the DWV system be installed under concrete? *Are the consequences of an underslab failure significant?*		
Fact: As a flexible piping system PVC requires greater care in underground application. It is dependent upon 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 of the Iowa Formula is available within the Uni-Bell Handbook of PVC Pipe.		
Fact: 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.		
Item: Hanger Spacing/Fall	**YES**	**NO**
Has the cost of additional hangers and their installation been considered?		
Fact: Model Plumbing Codes require PVC DWV pipe to be supported horizontally every 4 feet.		
Fact: 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.		
Item: Plenum Spaces	**YES**	**NO**
Does the building utilize plenum spaces for return air?		
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?		
Fact: PVC should not be installed in a plenum. It is classified as a combustible material per ASTM E 136.		
Fact: Cast iron is a non-combustible product, which can be installed in a return air plenum.		
Item: Fire Wall Penetrations	**YES**	**NO**
Has contractor added the cost of fire-stopping materials and labor or will that be passed along to another trade?		
Fact: PVC requires listed fire-stop devices 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.		
Fact: 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.		

If you answered yes to any one of these questions, please consult a Charlotte Pipe technical services rep to further discuss the best material for your project. You may download this checklist at www.charlottepipe.com/vechecklist.

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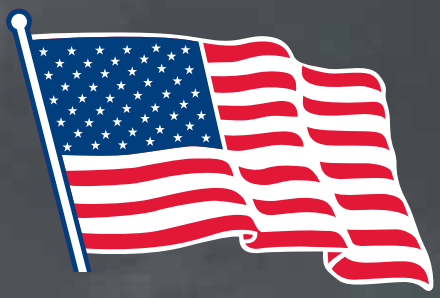

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