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Navigating the PVC VE Proposal

A White Paper for The Commercial Plumbing Industry

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Navigating the PVC VE Proposal

While planning and designing buildings, plumbing engineers walk a fine line when it comes to value engineering. Do these proposed VE items provide true value or are they cheap alternatives? Are these substitutions in line with the original basis of design or are they a major deviation? Are there hidden costs involved? If the engineer acquiesces, does he open himself up to liability?

A simple way to evaluate the VE decision is to apply the "Yes, if..." rule. By applying these two words engineers can set the ground rules for choosing the right product for the right application, and hopefully avoid litigation or costly system failures.

"Yes If" Questions

Should I allow a PVC VE if I have concerns about elevated temperatures? Yes, if the maximum possible temperature of liquid being dumped into the system is 140 degrees or less. PVC is rated at a maximum temperature of 140° F, while Cast Iron Soil Pipe is rated at 212° F. While the system will likely have controls limiting the maximum temperature in a system, can these systems be manipulated to override these max limits? What happens if a T&P relief valve on a laundry water heater is purged, potentially dumping 175° F water into PVC? What happens if an autoclave or boiler condensate is errantly drained into a PVC piping system? Additionally, quick-cure concrete can also exceed 140° F.

> Case Study: Cast Iron Soil Pipe was specified by an engineer on an addition to a small Midwestern hospital. Late in the construction process the contractor suggested using PVC for the underground piping, seeking a $5,000 savings on a $20,000 project, while keeping the above-ground DWV piping Cast Iron. The engineer acquiesced. Prior to the completion of the project the boiler contractor dumped 180° F condensate into the system, causing the PVC to fail, leading to a $29,000 bill to fix the failed piping system.

Should I allow a PVC VE if I have concerns about Hanger Spacing and Fall? Yes, if you can be sure the calculations and installation will be done correctly. Cast Iron Soil Pipe requires hanger/support within every 18 inches of a coupling or hub. Hanger spacing for PVC and other plastics requires a thoughtful evaluation of pipe size relative to the operating temperature. For instance, a four-inch PVC pipe operating at 60° F will require hangers every 7.5 feet and at 140° F every 4 feet. A number of considerations including supporting concentrated loads, expansion and contraction, restrictive hangers versus hangers allowing movement, proving maximum bearing surface, and keeping plastic piping systems away from high-temperature systems such as steam, hot air and hot water lines are essential.

Should I allow a PVC VE if I have concerns about combustibles installed in Plenum Spaces? Probably not. Cast Iron Soil Pipe is a non-flammable and non-combustible material, and all model codes allow for it to be installed in this type of application. PVC has admirable flame performance but struggles with smoke-development performance. Therefore, most engineers agree that PVC should never be installed in a return air plenum. Some state and local codes will allow for the use of certain wrapping materials. Because of the high level of potential liability involved, the engineer should cautiously approach this installation. Questions to consider should include: Will the wrap be applied by a trained installer? Who will verify that the installation was done properly? Is there input from the code official, post-cabling trades inspection (potential wrap becoming dislodged)? Are there instructions for repair/rewrap later?

Should I allow a PVC VE if I have concerns about Fire Wall Penetrations? Yes, if you consider the potential added costs and experience necessary to install intumescent fire stopping. Cast Iron Soil Pipe, like most metal pipe, typically requires an endothermic fire-stopping material to fill the annular space between the pipe and the wall penetration. This product is widely used in the construction industry, inexpensive, simple to install and usually has a long life of useful performance. Combustible pipes such as PVC typically require an intumescent fire stop, which in the unexpected event of a fire, will fill in the original cavity created when the pipe collapses because of the heat and/or temperature.

Intumescent fire stop is significantly more expensive than endothermic because of the performance and material requirements. Further, many engineers and general contractors have experienced situations where the contractor has not included the additional intumescent requirements as a result of the VE proposal, requiring a hidden cost often passed on to the fire stop trade. Having a small number of fire wall penetrations can make the PVC VE a viable alternative. Having a large number of fire wall penetrations makes the PVC VE less viable because of the added costs of the more expensive required system components.

Should I allow a PVC VE if I have concerns about Pipe Robustness? Yes, if robustness is not a major concern. Cast Iron Soil Pipe is considered by engineers to be a very robust product capable of handling rough duty better than most plastics. The design engineer needs to review the requirements of his or her project based upon what goes on inside of the building. In applications such as hospitals, schools, retirement facilities and hotels, maintenance staff will often be required to operate an aggressive impact drain snake to clear the drain lines of unexpected debris such as gauze, wipes and diapers. Because of the toughness of Cast Iron Soil Pipe, it should perform well with this activity for the life of the building. PVC pipe, like all plastics, will become brittle over time due to natural aging and can be more susceptible to cracking.

Should I allow a PVC VE if I have concerns about Thermal Expansion? Yes, if the proper calculations and additional materials are used, and it stays within the original integrity of design. Will your DWV system have expansion and contraction due to changes in temperatures? Cast Iron Soil Pipe expands ¾" per one hundred feet per one hundred degrees Fahrenheit change (approximately the same as concrete). As a result, thermal expansion is not typically a concern with Cast Iron Soil Pipe systems. On the other hand, PVC will expand and contract approximately 4.5 to 5 times more than steel or Cast Iron Soil Pipe, often requiring the need for expansion loops, offsets or changes in directions. These are difficult to use with gravity systems and the calculations required for installation for compensation are difficult for installers to calculate. The calculation is $\Delta L = LpC\ \Delta$, where: ΔL = Change in length due to change in temperature (in.), Lp = Length of pipe (in.), C = Coefficient of thermal expansion (in./in./°F) = 3.8 x 10-5in./in./°F for PVC ΔT = Change in temperature (°F)

Costly mechanical expansion joints may also be used. Unfortunately expansion and contraction are typically ignored until the system later fails.

Should I allow a PVC VE if I have questions about Sound Issues? Yes, if sound is not really a concern. According to a study by Polysonics Acoustical Engineers, Cast Iron Soil Pipe is 750% more effective in silencing plumbing noise when compared to PVC. Travelers have complained of bothersome late-night or early morning noises from nearby showers and toilets in hotels where the Cast Iron Soil Pipe was VE'd to PVC. Now more engineers are becoming aware of the same sound issues in buildings such as hospitals, dormitories, condos, apartments and any type of mixed-use buildings. This issue is exacerbated when you or a loved one is recovering in a hospital or convalescent facility. Research is growing in the field of disruptive sounds in hospital settings as the science recognizes the relationship between sound and healing. This is an excellent consideration when evaluating the PVC VE issue.

> Case Study: Kenyon College Cottage Dorms. Cast Iron Soil Pipe was specified by the engineer. The engineer reluctantly agreed to allow the PVC VE on this "light commercial" application. During the first quarter students complained of excessive noise from toilets and showers late at night. One option was to replace the PVC pipes with cast iron. A second option was to retro-wrap the PVC with sound-insulating products. The designers struggled with issues like the costs to wrap the pipe, which proprietary systems to use (one required overlapping while another required butt wrapping), all of which included a pricey process. The designers questioned how a local contractor might repair and replace the wrap down the road, leading to the comment that they could always use 100 MPH duct tape. They questioned if the wrap was compatible with the PVC and whether the wrap would ultimately guarantee quiet. Ultimately, the university decided to tear open the walls, wrap the PVC where they could, patch and paint the walls and hope for improvement.

Should I allow a PVC VE if I have questions or concerns about Underground Installation? Yes, if you can be certain it will be installed using the proper trench preparation and backfilling procedures. Also, are you certain it will withstand the application? Rigid pipe, such as Cast Iron Soil Pipe, have standard charts for crush rating. Trench preparation and backfilling for cast iron systems are simple to complete with minimal instructions. On the other hand, flexible piping systems such as PVC have very specific instructions for the width of the trench, the quality of the base of the trench, and the proper back-fill methodologies.

> Case Study: Winnipeg Airport. PVC pipe was installed below grade on a new airport in Winnipeg Canada. Prior to the grand opening the engineers discovered widespread failures of PVC pipe, which was bowed, bent, crushed, separated or damaged, much of it under thick concrete. One option was to cut the floor and replace the pipe. Many airports utilize Terazzo flooring, which cannot typically be patched. Another option was to reline the pipe, which is difficult to do if the pipe has collapsed. A third option was to dig a subterranean trench and replace the pipe. Each option would be costly, cumbersome and time consuming. The failed system resulted in a twenty-week delay in the opening of the airport, as well as litigation that will require years to resolve. It is not known if the installers utilized ASTM D 2321 to bury the PVC.

VE and Litigation:

Litigation and subrogation are growing every year, affecting architects, engineers, contractors and manufacturers alike. Many engineer principals comment that they feel like they spend more time in their practice mitigating liability than they do designing safe, efficient buildings and building their business. Presenting to the AIA in Los Angeles, attorney Robert Stellwagen of CCM+S says that litigation trends in [complex] projects such as hospital design might be moving toward a perfect storm as projects become more collaborative in delivery methods and projects become more advanced.

Ashley Hurd of the professional liability insurance broker Hall and Company notes that value engineering has become synonymous with cost cutting. He adds that this trend is problematic from a risk-management perspective because it shifts the original intent of value engineering and puts into practice a less judicious methodology focused more on saving money than optimizing the project.

> Case study: A commercial building in upstate New York was designed with high performance glazing. Late in the process the contractor substituted standard performance glazing for a substantial cost savings. Ultimately, the HVAC system was unable to handle the increased cooling load. The engineer and contractor are facing litigation.

Many agree that a VE proposal accepted late in the construction process has a greater potential to disrupt the DD and CD processes. Camilleri & Clarke says that decisions rendered in this state usually require rethinking fundamental decisions, leading to subsequent redesign and reproduction of CD's to reflect the changes. This will require additional time, which will impact schedules and budgets. The introduction of new players late in the design process usually introduces new agendas, sometimes undisclosed, with perhaps a different set of values. The result can mean reduced quality, increased life-cycle costs, and threatened project safety — all resulting in increased liability.

Download our PVC VE checklist as a reference guide and tool. This checklist provides useful information and criteria to help guide the engineer who is navigating his or her way through the minefield of value engineering. The checklist will also provide a useful tool that can be passed along to the owner, general contractor and the plumber to provide solid support as to why Cast Iron Soil Pipe was specified in the first place, or to give guidance when PVC is an acceptable alternative.

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