

Yes, if ...

Navigating the PVC value-engineering proposal.

Plumbing engineers walk a fine line when it comes to value-engineering in the planning and designing of buildings.

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, I hope, avoid litigation or costly system failures. Let’s look at how to apply, “Yes, if ...”

Question: 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° F. PVC is rated at a maximum temperature of 140° whereas cast-iron soil pipe is rated at 212°. While the system will likely have controls limiting the maximum temperature in a system, can these systems be manipulated to override maximum limits?

What happens if a T&P relief valve on a laundry water heater is purged, potentially dumping 175° water into PVC? What happens if an autoclave or boiler condensate is errantly drained into a PVC piping system? Additionally, quick-cure concrete also can exceed 140°.

Hospital addition 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, potentially saving \$5,000 on a \$20,000 project. The contractor kept the above-ground DWV piping cast-iron. The engineer acquiesced.

Prior to completion of the project, the boiler contractor dumped 180° condensate into the



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system, causing the PVC to fail. This led to a \$29,000 bill to fix the failed piping system.

Question: Should I allow a PVC VE if I have concerns about thermal expansion?

Yes, if the proper calculations and additional materials are used and the PVC VE stays within the original integrity of the design. Cast-iron soil pipe expands 3/4 in. per 100 ft. per 100° F 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 1/2 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 perform.

The calculation is $\Delta L = LpC\Delta T$, where:

ΔL = Change in length due to change in temperature (in.)

Lp = Length of pipe (in.)

C = Coefficient of thermal expansion (in./in./°F) = 3.8×10^{-5} in./in./°F for PVC

ΔT = Change in temperature (°F).

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

Question: Should I allow a PVC VE if I have questions about sound issues?

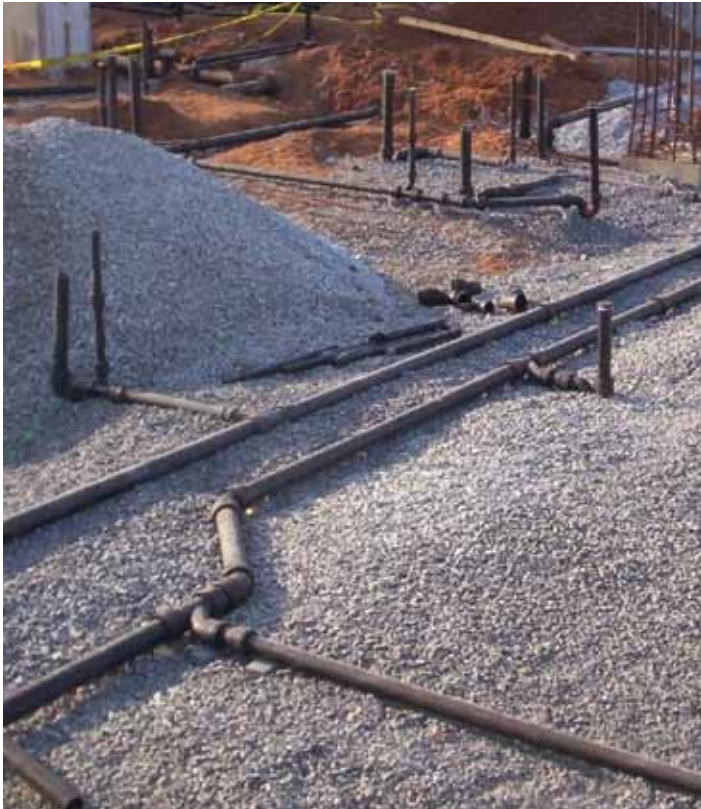
Yes, if sound is not really a concern. According to a study by Polysonics Acoustical Engineers, cast-iron soil pipe is 750% more effective in silencing plumbing noise when compared to PVC. Travelers have complained of bothersome late night or early morning noises from nearby showers and toilets in hotels where the cast-iron soil pipe DWV was value-engineered to PVC.

More engineers are now becoming aware of the same sound issues in hospitals, dormitories, condos, apartments and other types of mixed-use buildings. 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.

Kenyon College dorms case study: 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.

guest editorial



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The designers struggled with issues such as the costs to wrap the pipe and which proprietary systems to use (one required overlapping, while another required just butting the wrapping pieces up next to each other), as each was a pricey process.

The designers questioned how a local contractor might repair and replace the wrap down the road, leading to the comment that the contractor could always use 100-mile-per-hour duct tape. They questioned if the wrap was compatible with the PVC and whether the wrap would ultimately guarantee quiet. The university decided to tear open the walls, wrap the PVC where possible, patch and paint the walls and hope for improvement.

Question: Should I allow a PVC VE if I have 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, has standard charts for crush rating. Trench preparation and backfilling 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.

Winnipeg Airport case study: PVC pipe was installed below grade on a new airport in Winnipeg, Manitoba, 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 was costly, cumbersome and time-consuming. The failed system resulted in a 20-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.

Many agree that a VE proposal accepted late in the construction process has a greater potential to disrupt the design development and construction documents processes. Camilleri & Clarke, an insurance agency involved in liability and risk management for the architectural and engineering industries, says that decisions rendered in this state usually require rethinking fundamental decisions.

This leads to subsequent redesign and reproduction of construction documents to reflect the changes, which requires additional time, impacting 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.

VE and litigation

Litigation and subrogation are growing every year, affecting architects, engineers, contractors and manufacturers alike. Many engineer principals feel they spend more time mitigating liability than designing safe, efficient buildings and building their business.

Presenting to the AIA in Los Angeles, attorney Robert Stellwagen of CCM+S says 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 Co., notes that value-engineering has become synonymous with cost-cutting, a problematic trend 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.

Commercial building 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. **pme**

Paul Riedinger, LEED AP BD+C, is a field technical representative for Charlotte Pipe and Foundry. For more information on value-engineering, visit www.charlottepipe.com/value_engineering, where an extensive whitepaper and VE checklist can be found.

