Piping Systems – Designing for Human Health and Safety

Webinar with Architectural Record presented 9/22/2021 by Paul Hagar

Summary

Millions of piping systems across North America bring clean water to families, schoolchildren, doctors/patients, and workers. They also carry away sewage and other waste, among other essential functions. Water and drain/waste/vent piping infrastructure must safeguard human health and safety while also addressing sustainability and environmental concerns. **Recent piping crises such as lead contamination in Flint, Michigan, and benzene contamination in Santa Rosa, California, demonstrate that not all piping systems are created equal**. This session reviewed hidden costs and risks, provided an overview of key building codes, and illustrated appropriate applications.

Healthcare Pipes in Context

As illustrated by the latest report from the American Society of Civil Engineers, piping in many cities, communities and existing buildings needs work, With hospitals, urgent-care clinics, and other facilities depending heavily on municipal and regional infrastructure to operate safely. Lead pipes provide a relevant example for architects and engineers. Despite evidence that these pipes posed health risks, the "installed base" effect and resistance from the building supply and construction industry kept them in service, leading to crises in Flint, Newark, and elsewhere.

We need to make piping safe not only inside individual facilities, but also across healthcare campuses and their surrounding communities. **Low cost is not the most important factor for lifeline infrastructure.** We face different challenges for piping today, but **mistakes made using lead should inform future decisions**. The good news is that local, state, and national policymakers are now adding more money and support than they have in decades. **If we put piping in place that protects patient health, supports staff, and addresses environmental challenges, we can anticipate a new generation of non-toxic, resilient, and sustainable systems within healthcare facilities.**

Key Piping Considerations

- **Resilience:** The impact of severe weather and wildfires illustrates the growing need for resilience. Hurricane Ida caused power failures and pipe damage, leading to pressure losses and waste backup across Jefferson Parish, Louisiana. The burning of many pipes in Santa Rosa, California, led to benzene contamination that persisted for months and left thousands without access to safe water. In both cases, adsorption of contaminants onto more porous piping increased the difficulty of flushing the system.
- **Leaching:** Even in normal operation, research shows that some piping materials leach benzene and other harmful chemicals. Pipes made of complex plastic materials have additives to abate UV degradation, reduce corrosion, and improve ductility, making it hard to anticipate what leachates pass into the system. By contrast, common metal pipes have simple chemistries with low leaching characteristics that require no additives to meet the needs of most piping applications. This research has also begun to evaluate the long-term health impact of leaching, particularly on sensitive populations such as patients, the elderly, and young children. Dr. Andrew Whelton of Purdue University looked at emissions from heated pipes and found that 10 of the 11 most common plastic pipes leached chemicals into water. His findings corroborate earlier studies as reviewed by Stern and Lagos.
- **Health and Toxicity:** This is a significant issue for healthcare piping. The relevant programs addressing this include the following.
    - **Health Product Declarations** examine what goes into products. They red-list chlorinated polymers, several flame retardants, phthalates, and several other chemical categories.
    - **Declare labels** not only confirms what's in the product but also looks at where it comes from and where it goes at end of life. Declare labels on products show commitment to full transparency.
    - The **2018 Well V2 standard** from the Well Building Institute flags substances especially relevant for healthcare piping applications, including carcinogens like benzene and halogenated flame retardants,

phthalates that cause reproductive issues and increase infant mortality, and heavy metals that degrade cardiac and brain/nerve health.
    - **Toxnot, Mindful Materials, and California's OSHPD** provide additional resources.
- **Permeation and Adsorption:** More porous piping materials are more susceptible to incidence of permeation and adsorption, allowing increased amounts of environmental contaminants to go through the pipe wall supplies. As mentioned, porous piping materials also adsorb chemicals more easily, sponging up contaminants and creating an ongoing source that can spread from area to area.
- **Sustainability:** Using recycled content reduces the impact of production, which is a key consideration when evaluating sustainability. When it comes to product lifetime, which types of piping last longest? What happens to construction scrap and to the materials at the end of life? Does waste get discarded, incinerated, or recycled?

Healthcare Piping Applications

Piping systems inside individual healthcare applications include the following.
- **Potable water** has the widest impact on the most patients. These pipes must be non-porous, free of chemicals that can leach contaminants, and should maintain a pure taste and smell.
- Systems used for **medical gas** are among the most critical in acute-care settings. They must keep the gas pure, cannot corrode in contact with the supplies running through them, and need resist high temperatures.
- **Fire sprinkler** pipes should be noncombustible, rated for plenum use, able to withstand high heat, and resistant to corrosion, scaling and bacterial growth.
- A wide range of **drain systems** exist, from sewerage plumbing and lab waste to storm water. Some of their most important characteristics include structural strength and stability to resist accidental damage; limiting expansion/contraction in temperature changes to avoid stress to joints and fittings; and maintaining integrity of firestops.

Codes and Localization

Two main code bodies are the Universal Plumbing Code and the International Plumbing Code. Chapters 6, 7, and 9 of both codes contain the most important provisions for piping in all buildings including healthcare facilities, covering water supplies and DWV. One of the challenges is localization, leading to fragmented guidance. Examples:
- **California** chose to limit the application of plastic pipes to non-critical facilities such as commercial offices and residences, excluding healthcare.
- **Philadelphia** similarly restricts use of plastic pipes to smaller structures with less risk of large-scale impacts.
- **New York** looks more at building height. Structures five stories or taller must use metallic piping, while smaller buildings can use other materials such as plastic.

Examples of Piping in Healthcare Facilities
- **DuPont Children's Hospital** in Delaware specified copper piping for all water, medgas and HVAC lines not only for health and safety, but also for the ability of copper pipes to maintain shape and structural integrity while curving along a convex leaf-shape perimeter.
- **Lucille Packard Children's Hospital** in Palo Alto put a premium on water systems, specifying ductile iron piping, water-conserving appliances and a rainfall capture system to reduce water use while maintaining resilience and protecting patients.

Additional Information
- *Troubled Waters*, by Seth Siegel, provides an in-depth assessment of our water infrastructure in North America.
- Regarding the question on epoxy liners of pipes:
    - There are reports of issues with such solutions, but this 2013 article by Daniel R. Robles, PE, MBA, finds most issues appear related to non-conforming application.
    - This research by Andrea Dietrich in Water Science and Technology identified taste and smell issues with water and increased leaching of TOC, but further notes these issues dissipated over time.