

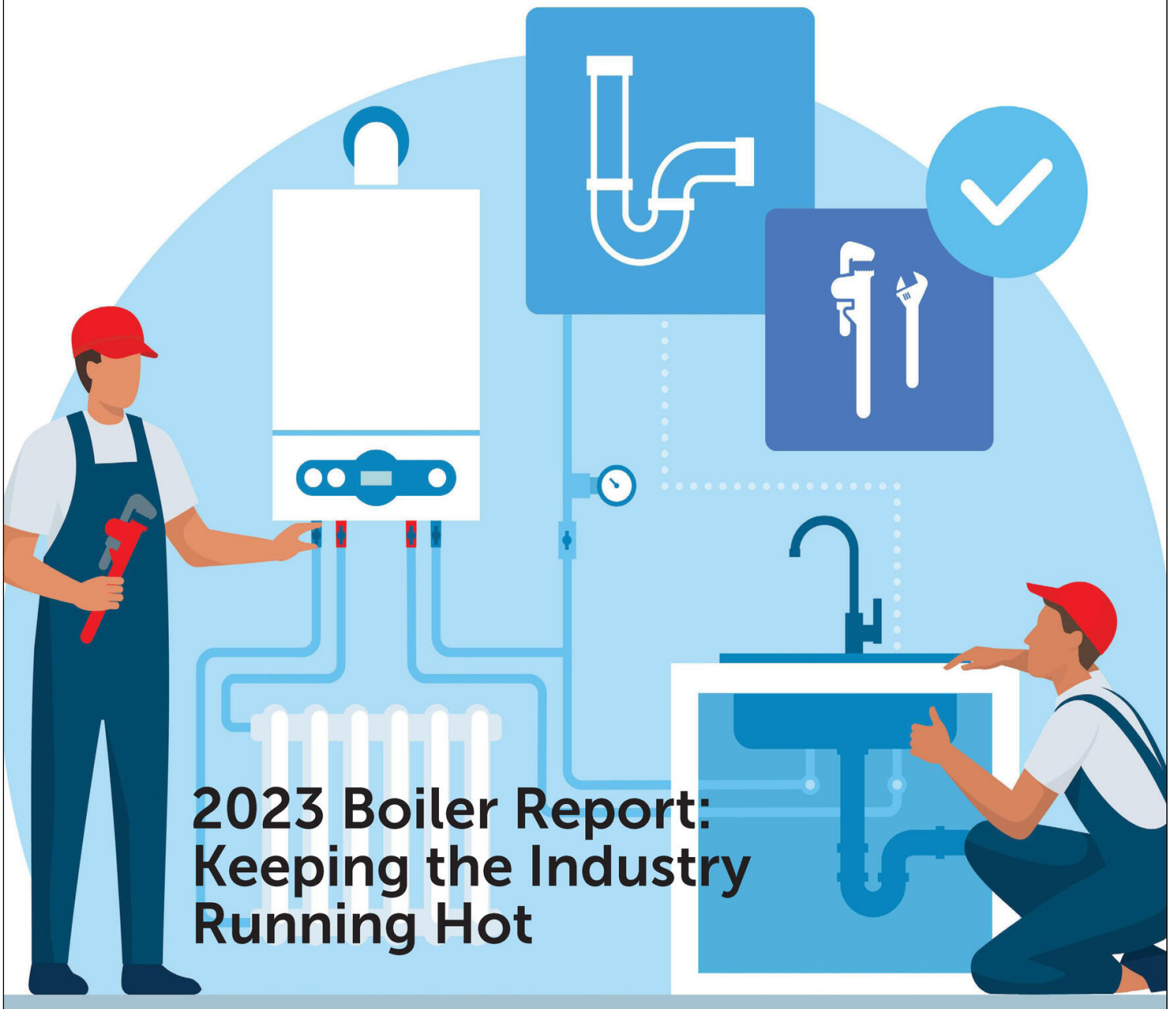
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Virginia Commonwealth University's College of Health Professions delivers world-class education and training to future health-care professionals. The eight-story, 154,000-gross-square-foot building is home to programs across 11 health-care fields. Photo credit: David Sunberg/Esto



Reaching New Heights in Plumbing Design

Engineering supports real-world learning at Virginia Commonwealth University's College of Health Professions.

By Charles J. Swope, PE, CPD, LEED AP BD+C

In the heart of downtown Richmond, Va., a few blocks from the state capitol, Virginia Commonwealth University's (VCU) College of Health Professions (CHP) delivers world-class education and training to future health-care professionals.

The building is home to programs across 11 health-care fields, such as gerontology, nurse anesthesia, occupational and physical therapy, and radiation sciences. Multiple departments have ranked as some of the best in the United States.

To mark the 50th anniversary of the program, VCU opened its acclaimed new CHP building in 2019, bringing together all its allied health profession programs under one roof for the first time. This state-of-the-art facility supports interdisciplinary research and scholarship and integrated health-care studies.

The CHP features advanced simulation labs, classrooms and research spaces. It also includes a double-height biomechanics research lab, several maker spaces, and a Smart Home apartment. Sophisticated technologies offer students hands-on training in a realistic environment, allowing them to gain

valuable experience and develop the skills needed to succeed in health care.

In 2015, VCU contracted with EYP Architecture & Engineering to lead the new building's design. Mueller Associates partnered with EYP to deliver mechanical, electrical, plumbing (MEP) and fire protection engineering services.

At eight stories and 154,000 gross square feet, the CHP's height and size make it feel more like a campus than a building. Given the building's scope and program complexity, the engineering team encountered several challenges in designing its plumbing systems. Many of these challenges were common for higher education laboratory spaces, while others were unique to a building of this size and complexity.

Acoustic Attenuation and Sound Lagging

One of the first challenges that Mueller's engineers addressed was acoustic attenuation.

A large, glass-front auditorium is prominent on the CHP's first floor, seating 160 and available to all college departments. While it can often be straightforward to avoid routing principal utilities through these sensitive spaces, Mueller's

Plumbing Design



A large, glass-front auditorium is prominent on the College of Health Professions' first floor. Due to the height of the building and the resulting need for sound attenuation, the plumbing engineering team designed the gravity drainage systems using cast-iron piping with sound lagging. Photo credit: David Sunberg/Esto

engineers had to devise an alternative solution given the auditorium's location.

In this case, the stormwater piping collected throughout the building culminates in an area adjacent to the auditorium, with one of the mains running directly through the space.

Due to the height of the building and the resulting need for sound attenuation, the plumbing engineering team designed a cast-iron drain piping system. "Using cast iron for waste piping will result in a system that is up to 11 times quieter as compared to an all-plastic system," notes the Cast Iron Soil Pipe Institute (<http://bit.ly/3TFZQyd>).

In addition to the intrinsic mass of cast iron, the team applied a mass-loaded vinyl blanketing to the piping, also known as sound lagging, which adds one pound per square foot to the piping system. As the system's mass increases, more sound energy is absorbed, and less is transmitted throughout the space.

Between Mueller's cast-iron drain piping system and sound-lagging designs, combined with architectural attenuation, looking outside the auditorium's windows was the only way to know it was raining!

Creative Zoning Leads to Significant Power Savings

The building's overall layout and footprint also challenged the plumbing systems design.

VCU's goal entailed unifying programs across five buildings and two campuses into one central hub. In addition, VCU's desired location for the building was on a tightly constrained edge of a quadrangle on the urban campus. The site offers easy walking access to VCU's health-care facilities and Bio + Tech Park.

To fit the programmatic requirements of 11 units into a single building within this compact area, the architecture team designed an eight-story building at 154,000 gross square feet.

From a plumbing perspective, the CHP's limited square footage and vast height required engineers to be creative with

the domestic water pressure zones. The incoming residual water pressure to the building was approximately 54 pounds/square gauge; the street pressure was not adequate for the complete needs of the building.

To meet the 40 pounds/square inch (psi) required by code at the water closet flush valves, engineers needed to provide an additional 58 psi for a total of 112 psi.

A domestic water booster pump was necessary to reach the top floors. Two conventional methods can achieve this, the most intuitive being to size the booster pump for the entire building load. This solution usually affords guaranteed water pressure crucial to the building's critical infrastructure. However, further evaluating the building's layout, the team discovered other ways to meet the CHP's needs and generate significant savings.

In the CHP, the essential fixtures and equipment are on the upper floors; the first and second floors mainly encompass lecture halls and a large public restroom. By serving the first and second floors from the street water pressure, engineers reduced the domestic water booster pump from 200 gallons/minute (gpm) to around 160 gpm, a 20% decrease in water flow.

This reduction in flow resulted in significant power savings, allowing this pump to be sized down from a triplex system with 15 horsepower pumps to one with 10 horsepower pumps.

Simulating Real-Life Conditions in Classroom Settings

The CHP's plumbing systems are unique in that they replicate real-life conditions in a health-care or home environment but in classroom settings.

Because a patient may need assistance from a trained medical professional at home, the CHP features a Smart Apartment on the second floor to train students to assist people with limited mobility. It is complete with a kitchen, bedroom and bathroom.

Students in physical therapy, occupational therapy, gerontology and other programs use the apartment to learn how to help people with disabilities — whether physical, sensory or cognitive — live as independently as possible.

For these controlled settings, such as the Smart Apartment, engineers took several special considerations into account in the design. For example, the water closet and carrier can withstand a static load of more than 500 pounds. The shower/tub combination includes a long-reach hand shower instead of a traditional showerhead.

While the kitchen sink and lavatory are more conventional, they feature lever handles and manual operation, compliant with ADA standards.

The CHP's programming also includes courses on bariatrics. To meet the requirements for this program, plumbing fixtures accommodate a patient's needs for weight capacity, accessibility, and dignity.

Plumbing Design



Simulation and imaging suites afford future surgical staff from the Nurse Anesthesia and Radiation Sciences programs to practice in realistic settings with the same equipment they will one day use to administer radiation to cancer patients. Photo credit: David Sunberg/Esto

Rigorous Requirements: Safety, Cleanliness and Emergency Preparedness

One of the more interesting spaces in the CHP is on the third floor. Simulation and imaging suites on this level afford future surgical staff from the Nurse Anesthesia and Radiation Sciences programs to practice in realistic settings with the same equipment they will one day use to administer radiation to cancer patients.

A prominent feature on this level is the Virtual Environmental Radiotherapy Training Simulation Lab, which allows Department of Radiation Sciences students to explore radiation therapy treatment techniques, similar to how pilots use flight simulators. This floor also includes an operating suite, scrub stations, recovery areas and more, where students train for a myriad of procedures and associated complications.

Each surgical suite has head wall units with oxygen, vacuum, compressed air and nitrous oxide (anesthesia) connections. “Continued breathing of the [nitrous oxide] vapors may impair the decision-making process,” notes the National Library of Medicine (<http://bit.ly/3z3IP8K>).

Due to these safety reasons, compressed air is substituted for nitrous oxide. Oxygen use is permitted in limited quantities because some of the equipment would be damaged by being supplied by an unintended gas.

Engineers could not strictly follow the *NFPA 99: Health-Care Facilities Code* because the CHP is not an actual medical facility. However, the standards were used to guide the design and installation requirements as closely as possible. For example, waste anesthetic gas disposal systems and the provisions dictated in Chapter 11 of this standard regarding emergency management were not required as neither problem exists in this facility.

Nonetheless, because this teaching space is similar to a medical facility, the design team followed all

recommendations for piping cleanliness. An oil-less, scroll-type air compressor ensures no oils contaminate the compressed air piping or the simulated nitrous oxide system.

All installed valves and piping were cleaned by the manufacturer, capped and kept sealed until installation. They were then purged with nitrogen during brazing, ensuring no foreign contaminants entered the piping system.

Special provisions were also installed in and near the control room for instructors to simulate a disaster, such as a loss of oxygen or power. Instructors can access the medical gas shut-off valves and remote electrical disconnects feeding the surgical suites. At their discretion, they can turn off or reduce the pressure of the medical gas systems, turn off circuits powering the medical devices, or combinations simulating earthquakes or other natural disasters.

Recognizing that a textbook may not be the best tool to teach future health-care professionals how to save a patient’s life during a power outage, students learn how to react to these emergencies through realistic simulations of these pressure-filled scenarios.

Polypropylene Waste, Vent and Water Purification Systems

The sixth floor contains the building’s most advanced plumbing systems. On this level, Medical Laboratory Sciences (MLS) students access a comprehensive teaching laboratory featuring a full suite of components and equipment.

MLS scientists play a critical role in our health-care system, with more than 70% of all physician diagnoses based on information provided by MLS procedures. Despite their importance, there is an acute shortage of MLS scientists because the field is relatively unknown.

Level six is primarily dedicated to the MLS program. A large classroom comprises the latest technology and an expanded research and lab area with 48 wet-bench spots. Here, students learn how to use microscopes, centrifuges and mass spectrometers to analyze body fluids and tissues, allowing them to help physicians determine the best treatment for patients.

As expected, this area includes substantial counter spaces with integral cup sinks and deep-basin epoxy laboratory sinks. During design, this space’s program had not yet been fully developed. However, engineers knew this space would use a chemically resistant polypropylene waste and vent system.

“Polypropylene has one of the widest chemical resistances of all materials commonly available,” explains the Plastics Pipe Institute (<http://bit.ly/3Z7Lyrf>). It does not require a coating or particular installation to achieve this resistance. When provided with a fire-resistant composition, it is a code-compliant material for use in air plenums.

In the CHP, these drains are piped separately to a location in the first-floor mechanical room for connection to the regular sanitary system. Since the current program did not use

Plumbing Design

harmful chemicals, the cost of a waste neutralization system was deferred, and a sampling port enables periodic testing.

The sixth-floor lab contains a water purification system for a clean, predictable medium for experimentation. The main design component is a reverse osmosis system with a circulation loop. Each outlet is designed to use as little uncirculated piping, also known as dead legs, as possible.

When water is allowed to stagnate, sediment accumulation or bacteria can grow. This minuscule amount may be acceptable (in limited amounts) in everyday potable water applications, but more stringent considerations were taken in a high-purity system such as this one.

Each outlet is piped in series by dropping the pure water piping in the wall down to the outlet, then back up again to the ceiling. The amount of uncirculated piping is limited to what is already contained in the tee.

While the purified water created by the reverse osmosis systems is sufficient for most lab applications, select lab sinks feature chemical analyzers. This solution includes point-of-use water polishers to remove impurities further via deionization cartridges, UV lamps and ultrafine micron particulate

filtration. These systems provided CLSI Type I, 18 megaohm water — one of the highest standards for pure water possible.

The new LEED Silver CHP building has enabled VCU to increase enrollment in the college, leading to more highly skilled health-care graduates entering the workforce. This landmark facility has become a nexus for collaboration and practicing team-based care, with a flexible educational environment and robust technology and support systems.

According to Susan Parish, Ph.D., MSW, dean of the College of Health Professions: "This building, which is gorgeous, is also incredibly functional, and will allow us to train our students to work together and collaborate so that they don't just live in the silos of their disciplines." ●

Charles (Chuck) J. Swope is a chief mechanical engineer at Mueller Associates, overseeing the firm's plumbing and fire protection engineering services. Since joining Mueller in 2009, he's managed mechanical, plumbing and fire protection engineering designs of infrastructure systems for major institutional projects. Chuck is the president of the Baltimore Chapter of ASPE and is an active leader in the A/E industry. He can be reached at cswope@muellerassoc.com.

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