Applying Alternative Decontamination Methods in Vivarium Design

Lessons Learned When Implementing AIHP

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While designing a new vivarium for a leading cancer research institution in Boston, we had the opportunity to integrate several new technologies to advance the overall efficiency, quality, and design program of the facility. One of the technologies used is an Activated Ionized Hydrogen Peroxide (AIHP) decontamination system, tested, and applied as an alternate to the institution's more traditional decontamination method.

RATIONALE FOR A CHANGE

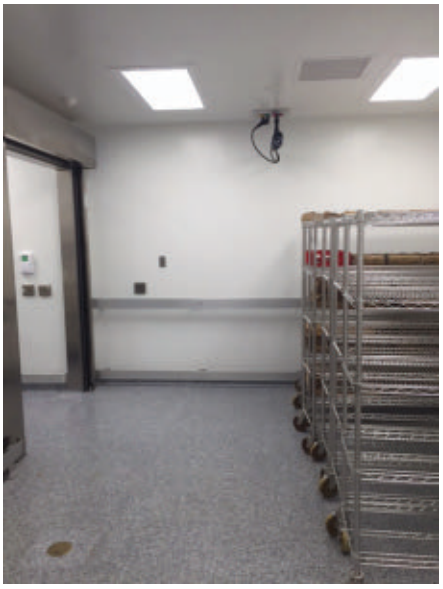
As designers, we are always looking for new efficiencies in the systems that support sensitive, controlled research spaces. Because this is a new facility, the client wanted us to push the boundaries as much as possible and explore the benefits of adopting new technology where appropriate.

To improve throughput and increase reliability, we researched and later decided, together with our client, to implement a new Activated Ionized Hydrogen Peroxide system. Among other improvements, the AIHP technology is capable of decontaminating large amounts of materials coming into the facility on pallets.

BENEFITS OF AIHP TECHNOLOGY

The AIHP system can process a large amount of supplies in a significantly shorter amount of time, adding much-needed efficiency to vivarium operations. Benefits include:

- Throughout of supplies can be accomplished on a larger scale by utilizing fogging pods



The pre-decontamination room is where the AIHP process occurs.

- Aerated disinfection technology provides greater range, achieving decontamination of all surfaces
- The combination of a dry process and lower concentrations of hydrogen peroxide used versus traditional misting translates to greater safety for employees. In this facility, rooms are set up with interlocking and automated sliding doors to protect staff from the AIHP process, and to assist in transferring large amounts of supplies through the space.

The new AIHP system is incorporated into a variety of other support systems throughout the facility, increasing operation efficiencies. For example, it integrates easily with one of the large dry heat sterilizers that is solely dedicated to decontamination of the ABSL-2 space. This unit can decontaminate ABSL waste as well as decontaminate large pieces of equipment coming into the facility, such as biosafety cabinets and animal transfer stations.

To provide maximum flexibility, we also incorporated the AIHP decontamination beyond the barrier as a mechanism to bring disinfection to needed areas in the facility where a risk of contamination from within existed. The scale is defined by sizing the subject area in three ways:

1. **Large-scale application** - Used as a "first line of defense" when there is a sizeable space such as a single room to decontaminate.
2. **Medium-scale** - In these applications, a dry heat sterilizer is used to decontaminate with AIHP using a pod in the side of unit to decontaminate ABL2 items as well as larger equipment coming into the facility.
3. **Small-scale** - Successful disinfection for smaller concentrations can be completed using a stand-alone mobile unit to sterilize fixed equipment in the facility.

DESIGN AND LAYOUT CONSIDERATIONS

Designing the overall facility when an AIHP system is utilized requires multiple considerations and actions to support the success, efficiency, and practical integration. For starters, it needs to be located so it can be accessed from beyond the barrier, and then contained within the barrier once items are processed.

In addition, providing adequate set up and lay down space is critical. Of particular importance is providing

Figure 1: The sequencing of the decontamination process through each of the three phases.

enough space on the back end of the decontamination process to receive and store the products. We had to make sure there was adequate space to get a large amount of metro racks plates of supplies in the space. And then make sure once these items were processed, they had a place to be stored. We incorporated high density stainless steel storage and shelving units to house post-decontamination supplies prior to distribution throughout the facility.

To ensure safety, doors need to be tied into the systems controls. This is essential so that access can be restricted once the decontamination cycle is on, and to make certain that decontaminated items are not contaminated again. The doors into the suite, many of them automated interlocked sliding doors, are designed to get large items in and quickly through the transfer process.

Autoclave equipment needs to be located within the facility. It is important that the autoclave can be accessed from beyond the barrier, and contained within the barrier once items are processed.

A final key consideration is to establish a standard operation practice to prevent back travel of supplies once decontaminated, and to prevent the opening of any doors to the outside barrier. Placing doors on an interlock or timer can be a part of these SOPs.

SEQUENCE OF OPERATIONS FOR AIHP PROCESS

The sequencing of the decontamination process is informed by the choice of a decontamination system. With an AIHP system, the sequence involves a step-by-step process based on maintaining safety and achieving operations efficiency. A graphic (Figure 1) shows the sequencing:

- **Phase 1:** Loading - Doors from service corridor (non-barrier) open while doors between pre-decontamination and post-decontamination (barrier) remain closed via an interlock
- **Phase 2:** Cycle – Doors from service corridor close and lock. Doors from pre-decontamination to post-decontamination remain closed and locked until purge is complete. Cycle dwells and purges. Once the purge is complete, doors from pre-and-post open while doors to the service corridor remain closed.
- **Phase 3:** Unload - Supplies are unloaded to post-decontamination. Once unloading commences, doors between pre-and-post close. Doors to service corridor open and now a new load process can begin.

LESSONS LEARNED

Early adoption of any new technology provides exciting opportunities to advance the status quo and accomplish desired outcomes in ways that are faster, safer, and more inventive. Yet because the technology is in the early adoption stage, there are considerably fewer benchmarks to guide the adopters.

In our experience with the cancer research facility, we learned that the Activated Ionized Hydrogen Peroxide decontamination system, including its supporting infrastructure elements, needed additional tweaking once installed. Without years of precedents to rely on, the manufacturer, facility professionals, design team, and other stakeholders worked together to make the adjustments needed for maximum efficiency.

Emerging technologies across all building types today allow us to achieve new heights of innovation for our clients. To ensure we take full advantage of technology's potential in vivarium settings, it is essential that we continually ask the What If questions, and remain open to designing alternative approaches. Each environment and application is best considered as an opportunity to create new best practices that will benefit technology integration by those who follow. ALN

During her 14 years at ARC, ***Nancy Cottone, AIA, LEED AP*** *has worked on a wide range of science and technology projects with a specific focus on lab planning. Particularly relevant, Nancy specializes in laboratory and vivarium design coordinating highly technical and sensitive spaces.*