Product Selection and Materials Choices in the Modern Zebrafish Facility

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Considering the specialized nature of the modern zebrafish facility, it should come as no surprise that the selection of materials, finishes, and equipment require particular attention. Some terms that you should look for in the descriptions of these materials and finishes include: *impermeable, stainless*, and *suitable for wet locations*.

For a material to be impermeable means simply that substances, such as liquids or gases, cannot pass into or through. This is a desirable and often required characteristic of many of the materials and finishes found in zebrafish labs.

While the term stainless steel implies that it does not corrode (rust), in reality there are over 150 different grades of stainless steel, not all of which are tough enough for all areas of a zebrafish lab. All of these alloys have a minimum chromium content of 10.5%, but there are two grades in particular that are best suited to a project like this. Grade 304, also known as A2, is perfectly suitable for drawer pulls, doorknobs, door hinges, shelf brackets, and equipment cowlings. However, in areas where the highly corrosive brines and purified (RO/DI) water are found, only grade 316 will do. It is important to note that when stainless steel is cut, welded, or otherwise machined, it must be properly conditioned if it is to retain its corrosion-resistant properties. This conditioning, called passivation, may be performed in-situ, but only after the materials have been properly cleaned or "pickled". An important and often overlooked step in building a new facility is verifying that the materials delivered to your job are indeed stainless. Although using magnetism is an imperfect means of field verification, it is inexpensive and mostly reliable when the more costly liquid reagent tests are not an option.

Wet location is an Underwriters Laboratories (UL) rating that indicates an electrical fixture is suitable for "an interior or exterior location in which water or other liquids may drip, splash or flow on or against the electrical components of a lighting fixture or ceiling fan." There may be additional caveats on equipment that bears this rating, so be sure to do your research.

Keeping all of this in mind, let us look closely at some of the major areas where making the proper choices of materials and products will make your project successful.

Floors finishes: The gold standard in zebrafish labs are quartz aggregate epoxy floors. This choice allows for seamless construction, an integrated cove base of 12" or more, and makes imparting the desired slopes for proper drainage a relatively easy task. The finished product can have a customized color scheme and texture, is fully impermeable, and tolerates even the harshest of disinfectants found in zebrafish labs. Avoid bare or even sealed concrete, tile, or other hard floor choices.

Walls finishes: Another area where impermeability is critical is wall finishes. This is an ideal place for water-based epoxy finishes. As a result of normal wear and tear, the finish may need to be repaired occasionally, but the very low VOC content of water-based epoxy will prevent possible contamination of the various recirculating aquaria and live-feeds systems found in zebrafish facilities. Glossy finishes should be chosen over eggshell or satin to allow for better shedding of moisture, easier cleaning, and more effective disinfection.

Ceilings: The open plenum or exposed ceiling design is preferable to hard or suspended ceilings in the fish holding rooms. This choice allows for ready access to all utilities and infrastructure, and avoids the falling debris associated with moving ceiling tiles or cutting sheetrock to access a leaking pipe or broken HVAC component. All the items found in this space should be coated with the same finish that is applied to your walls or otherwise be rated for

wet location use. If you must have a ceiling, be sure that the materials specified are up to the task and have accurate drawings of where critical HVAC, electrical, and plumbing components are located.

Casework: All of the cabinets, shelves, drawers and work surfaces in the facility should be made from impermeable materials. Examples include epoxy resin counter tops, phenolic or composite resin panels, and high-density polyethylene plastic (HDPE). The plastic laminate surfaces common in residential applications should be avoided as it simply cannot stand up the conditions found in a zebrafish lab. The openings made for sinks should be under-mount rather than drop-in, and back splashes should be either coved or sealed at the seam to prevent water from seeping behind the casework. It is common for water to stand on these countertops all day , and when they need to be squeegeed into a sink you do not want a lip or seam preventing a clean sweep. Mobile storage racks and work carts and their casters should be made from stainless or impermeable materials and designed to maximize drainage and air circulation to prevent unwanted growth of algae and mold. Shelving should be made from the same impermeable materials as the casework, and the brackets and standards should be made from stainless steel.

Fixtures, Hardware and Fittings: Drawer glides, shelf rails, hinges, doorknobs, and sink fixtures should all be made from stainless steel. All of the mounting hardware and fasteners for plumbing, HVAC, and electrical components should be made from stainless steel rather than galvanized steel or copper. Exposed electrical conduit and fittings should be made from aluminum or plastic and should be rated for wet location/outdoor use. Pay special attention to anchors and toggles; this is an area where a contractor may be tempted to save money by using a galvanized or mild steel component. The coupling of two metals with dissimilar electrode potentials in wet environments like a zebrafish lab can result in galvanic or bimetallic corrosion, and could lead to materials failures. The piping carrying purified water should be rated to handle this corrosive liquid and may need to be protected from UV exposure as well. Wrist blade style sink taps are a wise choice, and the tap for purified water will be used with enough regularity that it is best to avoid the spring-loaded valves that are commonly associated with RO/DI taps.

Lighting: The technological improvements in lighting design and controls over the last decade are truly remarkable and the zebrafish lab is in a position to benefit from this progress. We can divide the lighting needs in the facility into three distinct camps:

1. General use areas: In these areas, such as corridors and mechanical rooms, it is desirable to have good light coverage throughout the entire space, with either occupancy sensor switches or simple on/off switches. Some of these areas may still require wet location rated fixtures and switches.

2. Fish holding areas: Considering the library-like layout of most zebrafish holding areas, and the vertical orientation of the fish racks, it is important to use linear lighting fixtures designed for wall-washing/asymmetric or shelf/stack illumination. This design will provide the most consistent lighting from floor to ceiling and can still provide enough light to keep the pathway illuminated.

Light intensity will need to be carefully managed since excessive light in these areas will facilitate the abundant growth of unwanted algae in the fish tanks and in turn create animal welfare concerns, as well as an increase in labor needed to keep the tanks clean. Because of this, it is wise to choose dimming fixtures and sensors that allow for the normal lighting in these areas to remain quite dim until someone enters the aisle, when the light can brighten quickly until the person leaves, at which time the light can return to its normally dim state. The effect can be carefully programmed to prevent startling the fish, and in practice resembles the passing of a cloud in front of the sun on a nice day. In my experience, the dim setting may provide as little as 8 foot candles and the activated setting may be as high as 90 foot candles, with the change occurring in as little as 3seconds.

Choosing a color temperature close to that of daylight (5000-5500 K) makes color-dependent tasks like sex-sorting fish easier, and is preferable when performing delicate work where fine detail is involved.

The photoperiod needs to be carefully managed in zebrafish rooms since the regular and predictable spawning that zebrafish are renowned for is heavily influenced by photoperiod. The various control systems available for theater and architecture lighting systems can provide the solution to a potentially complex grouping of lights and zones, and when paired with the proper fixtures, can even simulate dawn and dusk in the animal rooms. Many of these now feature tablet and smartphone apps, and can be managed strictly from your device or a web interface.

The choice of LED over fluorescent lighting will be influenced by factors such as budget and product lead-times, and it is still common for fluorescent lighting to be more affordable for smaller projects. Regardless of the technology choice, be sure that the fixtures are properly rated for the location, and that the desired light color temperature is available.

3. Task/work areas: These areas may be found inside the fish holding rooms, and in near enough proximity to the fish tanks that special consideration of reflector will be required. As described above, we want to avoid casting additional light onto the tanks and fish wherever possible. Whether you opt for focused or diffused light, it will need to be intense enough for staff to perform regular and often delicate or precise tasks, and should be color matched to the fish holding areas.