The Impact of Building Envelope and Systems Design on Today's Bakery

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For years, building envelopes (walls, floors, ceilings, etc.) and building systems (e.g., HVAC, lighting, plumbing and other mechanical/electrical systems) of bakeries were minimally maintained and otherwise ignored until there was a problem. The process – getting product made and out the door – was key and everything else mostly an afterthought.

However, today bakery customers are requiring tighter controls of the manufacturing environment. The Food Safety Modernization Act (FSMA) is driving food manufacturers to take a closer look at their facilities and systems to make sure the manufacturing environment is sanitary and well-maintained. Customers are asking bakers to allow their facilities to be audited by Safe Quality Food (SQF) - certified organizations or by the American Institute of Baking (AIB). Some even have their own internal audit teams.

Technological advances are also driving changes in the baking industry. Most bakers have kept up with the effort of Bakery Equipment Manufacturers and Allieds (BEMA) to change equipment design to allow for better cleanability. In addition, most bakers have a good understanding of the considerable changes to equipment controls over the last few decades. However, the majority have not followed the major changes in building systems such as floor and wall coverings, lighting, HVAC and other envelope and system-related components. These advances in "non-electronic" technology are causing bakers to take a new, hard look at the building envelope and systems as a way to improve their ability to provide a food-safe process environment.

To meet these goals, facility owners must develop acceptable standards for each type of room or area in their facility and implement an improvement strategy that will bring the plant up to the established level of acceptable standards in a planned, coordinated manner. In particular, creating a food-safe environment requires the building envelope and systems to be:

- **Maintainable** - Easy-to-fix; requiring minimal repair and upkeep and only needing repair due to catastrophic event or age.
- **Cleanable** - Can be cleaned with standard cleaning soaps, tools and procedures; no cracks or crevices inherent in the design; having monolithic surfaces; minimal horizontal surfaces where dust could collect.
- **Durable** - Withstands daily abuse from operators, processes and chemicals with no noticeable wear.

Maintainability, cleanability, and durability can be accomplished by implementing the following design recommendations and strategies within key building components.

Key Building Component #1: Floors

In bakeries, as in most food processing facilities, floors are either wet or dry. The largest portion of a bakery floor is dry. Typically, water is not needed after the dough has been made and proofed. Once the dough enters the oven, the floors are flat with no floor drains. The concrete floors are sealed to make it easy for dry cleanup.

In wet areas such as dough makeup and pan washing, floors should:

- Be sloped with positive drainage (typically ¼" per LF slope, minimum 3/16").

- Have an applied finish (e.g., resinous, acid-proof brick). Type depends on the application. Brick is more expensive but wears better; resinous is less expensive but does not have the impact resistance of brick.
- Have drainage systems made of stainless steel, PVC, etc. Type depends on temperature and chemical composition of water going down drain.

Properly sloped floors will dry quickly, preventing water from ponding and therefore minimizing harborage opportunities. Floors can also impact productivity: Faster drainage means less time spent cleaning and more time making product. It also can prevent lost-time accidents due to slips and falls.

Key Building Component #2: Walls

Walls are similar to floors: a system is needed that has no harborage points, is easy to clean and is durable. Provided it is not abused by forktrucks or other dent-causing forces, walls should last a long time without requiring anything more than routine maintenance. Walls for bakeries need to:

- Be sealed to prevent water penetration (especially from a high-pressure hose). Acceptable finishes include epoxy-based paint on concrete block, ceramic tile, and Insulated Metal Panel (IMP).
- Have cleanable (e.g., wipeable using cloth or hose) finishes such as sealed concrete, or epoxy-painted concrete block.

Key Building Component #3: Ceilings

Ceilings in process spaces serve two purposes. A ceiling can be used to separate any horizontal surfaces (ducts, pipes, etc.) where dust can build up from the process area, reducing the amount of area to clean. Some ceiling types are structurally sound enough to allow a person to walk on. Utilities can be located above these "walkable" ceilings, allowing easier access for maintenance workers, and minimizing production disruption. A ceiling can also help control the environment of the room by limiting the volume of air that needs to be conditioned and filtered. As with floors and walls, the right ceiling type can reduce cleaning and maintenance needs.

There are two types of ceilings acceptable in process areas:

- IMP. A monolithic surface that provides the best solution, an IMP ceiling is 100% sealed and provides an area above the process area to run horizontal utility piping and duct work.
- Lay-In. Using either stainless or plastic grid and a wipeable surface on the ceiling pads, a lay-in ceiling is a lower cost solution than IMP, but should be avoided in dusty areas unless the pads are sealed to the grid.

Note, however, that an exposed roof structure is acceptable in lieu of a ceiling as long as a regular cleaning program is in place.

Key Building Component #4: HVAC and Filtration

The HVAC system should be designed not only for temperature control but also to control outside contaminants, humidity and room pressurization. HVAC and filtration recommendations include:

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- Ready-to-Eat (RTE) product areas have the highest food safety requirements and therefore need the highest level of filtration and room pressurization to push contaminants away from RTE products. Once the product is in a package, requirements can be reduced.
- Post-oven cooling should be done in a controlled environment, either using a spiral cooler or a separate room with its own HVAC. This will provide year-round consistent bread temperatures as it enters the slicers. It may be a benefit to have the slicing equipment in the same room so that it is tuned to the temperature of the bread.
- An often-missed energy savings opportunity is to install stack economizers on the oven exhausts. Hot water can be made that could feed the plant's boiler or hot water generator, reducing energy costs.

Key Building Component #5: Lighting

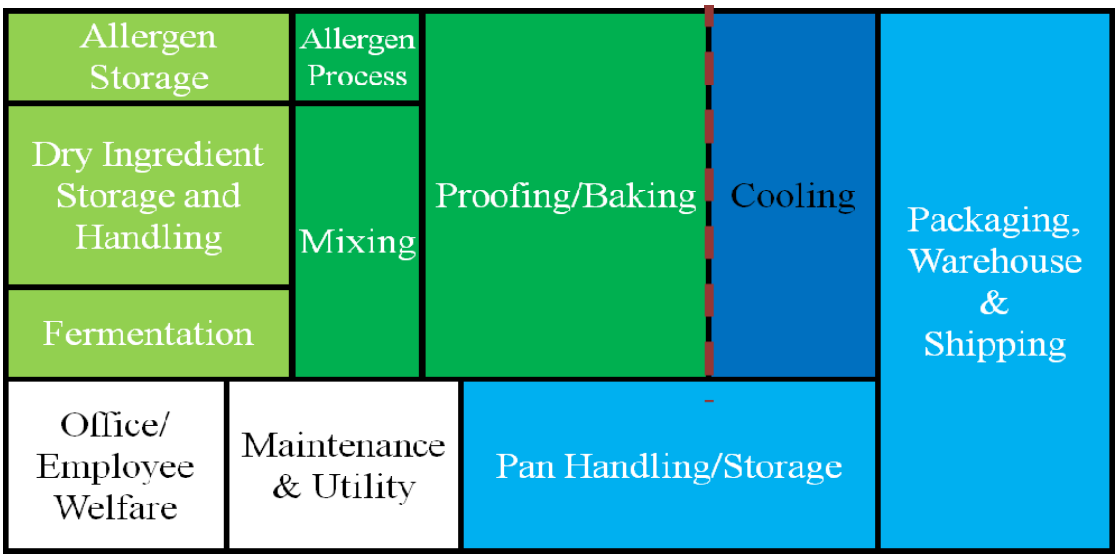
An appropriate level of lighting should be in place throughout the facility including in corners, behind equipment, under platforms as well as in aisles and other open areas. Proper lighting levels and light location will expose dirt so that it can be seen and removed. The mantra "if you can't see it, you can't clean it" is especially meaningful in food processing facilities. Two important lighting recommendations:

- Install appropriate levels of lighting throughout the bakery, e.g., 50 fc or higher in process areas, 20-30 fc in warehouses.
- Quality control areas of the plant may require brighter or whiter lighting for color rendering and other quality control checks. Two prime locations for additional lighting are at the end of the oven or at the slicing equipment.

Zones of Control and Area Classifications

All the different building and systems options listed above can be combined in multiple ways to create "Zones of Control" in the facility. Each zone is an area of the plant where similar operational requirements are shared and therefore can be operated and cleaned in a similar fashion. Figure 1 shows some typical Zones of Control.

Figure 1: Typical Bakery Zones of Control



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There are a number of ways to determine the boundaries of each Zone of Control:

- Packaged vs. unpackaged finished product
- Raw ingredients from finished product
- Dry areas from wet areas
- Hot or cold areas from ambient areas
- Allergen areas from non-allergen areas
- High filtration areas from low filtration areas
- Positive pressure areas from lower pressure areas

Each zone has different requirements. For example, a wet zone will have wall, floor and ceiling finishes that can handle water and cleaning chemicals where a dry zone may not. In addition, allergen and non-allergen zones will have different HVAC and filtration requirements.

Bakeries typically have five distinct Zones of Control, each with its own unique set of characteristics:

1. Class "A" Area: Intense hygiene areas where conditions almost always exist for bacteria/mold to grow easily. Typically for rooms where there is open finished product.
2. Class "B" Area: Regular hygiene areas where bacteria/mold growth is less likely but can occur (e.g., dough makeup).
3. Class "C" Area: Dry ingredient spaces where water is typically not desired (e.g., sifting rooms).
4. Class "D" Area: Ingredient and finished product storage spaces (e.g., coolers, freezers, warehouses).
5. Class "E" Area: Non-classified spaces such as offices, labs, and employee welfare areas.

Table 1 outlines the typical level of building envelope finish and system characteristics for each Zone of Control class. Note that there may be several different standards for Class "E" space due to the variety of areas covered. (For instance, a Quality Control laboratory will have different requirements than an employee break room.)

Table 1: GMP Area Classifications

Building Envelope or System	Class A: Intense Hygiene	Class B: Moderate Hygiene	Class C: Dry Ingredients	Class D: Warehouses, Coolers	Class E: All Non-Classified
Floors	Sloped w/SS floor drains; epoxy or brick finish	Flat w/area drains; may have epoxy or brick finish	Flat floor with no drains	Flat floor. May have drains in coolers	Depends on space
Walls	IMP, painted block, tile	IMP, painted block, tile	Sealed concrete, painted block	IMP, concrete	Depends on space
Ceiling	IMP, grid ceiling	IMP, grid ceiling	No ceiling; exposed structure	No ceiling; exposed structure	Depends on space
HVAC & Filtration	Temperature controlled MERV 13 final filters, highest room pressure	Temperature controlled MERV 8 final filters, 2nd highest room pressure	No temperature control, MERV 8 filters	Coolers and Freezers temperature controlled, MERV 8 filters	Depends on space
Lighting	50 fc; higher in quality control areas	50 fc; higher in quality control areas	30 fc	20-30 fc	Depends on space

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The characteristics of each Zone of Control class are dependent on the products made and the operation in the room. Bakeries that produce products that include fruit (e.g., pies, cakes) or products that are Ready-to-Eat when they are raw (e.g., cookie dough) will require more Class "A" spaces than a traditional white bread bakery. The following questions can help identify the classification for a particular area:

- Is the product in the room Ready-to-Eat?
- Is the Ready-to-Eat product open to the room (i.e., unpackaged)?
- Is it a raw product that consumers will eat (e.g., cookie dough)?
- Is water involved (daily cleanup)?

With each yes answer above, the risk of a food safety issue increases. Keep in mind that water use is a key indicator for area classification. Bacteria and other pathogens need water to live. The more water used in process or for cleanup, the higher risk to pathogen exposure and therefore, a higher risk classification is required.

Using a Gap Analysis

To effectively use the Zones of Control classification system, each baker needs to set up their own set of classification standards using the set of questions above as a starting point. Once set, each room in the facility should be evaluated to determine whether it is a Class "A" space, Class "B" space, etc. A comparison should then be performed comparing the rooms existing condition vs. the desired standard. The difference (or "gap") could require something ranging from as simple as more lights or a coat of paint, all the way up to a major renovation. A cost vs. benefit evaluation can be made for each gap allowing bakers to identify what projects should be performed first and which to put in a long range plan. Projects can be prioritized by risk and payback:

- "Must Do" to minimize risk
- Projects with an immediate payback
- Quick payback (6 – 18 months)
- Longer payback (18+ months)
- Larger projects to be included in long-range capital planning

"Gaps" that have quick or immediate paybacks should be given the highest priority and worked on first. Longer paybacks or larger projects need to be planned out and may end up in a future capital budget year.

Significant, Positive Impact

When properly considered and designed as part of the whole, the building envelope and building systems can have a significant, positive impact on bakery processes. These components can enhance food safety, personnel safety and productivity by working together to provide a maintainable, cleanable, and durable envelope around the plant's process areas. Additionally, a properly designed and maintained facility works hand-in-hand with FSMA requirements, BEMA Equipment Sanitary Design, and basic Good Manufacturing Practices (GMP) design principles to provide an overall sanitary and productive design solution for any bakery process.

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