FoodEngineering

Sanitary Equipment Design

By Wayne Labs, Senior Technical Editor
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The onus has been placed on machine designers and builders to make industrial food handling equipment easier to clean and sanitize—quickly, efficiently and according to the rules. But, which rules?

Food and beverage industry machine builders know they can't design and build equipment like they would for a machine shop, but they face a smorgasbord of rules and standards—sometimes not so well defined—that can make it difficult to meet the specifications of auditing bodies and government regulators. And if they can't design and build safe, easy-to-clean equipment for food processors, they may as well be building equipment for a machine shop.

FSMA brings food safety into limelight

"FSMA has certainly gained the attention of food processing and packaging operations, as well as the processing and packaging equipment manufacturers supporting those operations," says Dave Root, application engineering manager for National Bulk Equipment, Inc. (NBE). "Both parties have interests in

ensuring their equipment is designed, built, operated and maintained in a way that proactively responds to FSMA."

As FSMA is a work in progress, all food manufacturing plants and OEMs are keenly watching, waiting and listening for a final mandate, according to Jim Monaweck, Walker Custom Sheet Metal project manager. "Until that time, we are all motivated by the obvious need to manufacture equipment that is more user-, sanitary- and maintenance-friendly."

In addition, more immediately tangible design objectives, such as reducing changeover times, optimizing throughput, improving OEE, doing a performance analysis, and speeding and simplifying the cleaning access for sanitation crews, are supplementing FSMA as drivers in altering the way equipment is designed for sanitary and non-sanitary processing and packaging operations, adds Root.

"More attention is being paid to surfaces in direct contact with finished food, and the industry is rethinking things like the grade of stainless steel [SS] and metal finishes," says Monaweck. "Finishes that were acceptable in recent years are now being questioned because they can hold biofilm, the start of microorganism growth."

"Our industry has seen heightened awareness around all aspects of food safety. This is mostly due to incidents in the industry," says Tom Perdue, product development manager, Cambridge Engineered Solutions, which makes conveyor belts for the food processing and packaging, baking, beverages, meat and poultry industries. "The enactment of FSMA and other government regulations further contribute to the increased awareness. Consequently, we need to heavily critique our product designs and design changes in light of the new regulations with a focus on making sure we are in compliance."

"FSMA has most definitely had an impact on the way we design our equipment today," says Steve Blackowiak, food safety manager at Bühler Aeroglide. "We have an even higher awareness of cleaning, access, hygienic design and microbiological safety." As a result, the equipment maker has assembled its own food safety team, a group of R&D engineers focused exclusively on food safety.

Not always black and white

Even so, equipment costs and hygienic design are often at odds with each other. "Our customers expect the equipment we supply to be food safe and cost-effective," adds Blackowiak. "The challenge is defining what is required to meet our customers' needs, and these can differ from customer to customer, even for similar applications."

The lack of a clear understanding of hygienic requirements can result in over- or under-specifying equipment. "This means suppliers may quote different levels of hygienic support for food processors

when comparing apples to oranges, and this is where current US regulations fall short," continues Blackowiak. "For example, there is no single source regulation or guideline accepted by low-moisture food producers for hygienic equipment design." (For more information about the AIOE workforce group working on this topic, see page 88.)

For machine builders that work in the meat processing or dairy industries, conforming to food safety design parameters is somewhat due to generally accepted universal standards. According to Brent Bell, JMP Engineering mechanical and applications manager, building equipment that goes beyond meeting increasing USDA regulatory demands that equipment be cleanable to microbiologically safe levels is the new normal. "We're seeing food producers increase preventive control measures to perform their due diligence to ensure food safety. Cycle times and throughput are always considerations as business drivers and ROIs, but the foundation is food safety. All you need is one incident to sink the entire organization."

Recently, state and federal health inspectors have been relying on the 3-A Sanitary Standards to a much greater degree, according to Gabe Miller, principal, Process Innovation-Food Safety, LLC. "The regulatory authorities are more frequently requiring 3-A certification of new equipment prior to its implementation in processing plants." The 3-A Sanitary Standards for dairy equipment are promulgated jointly by the Sanitary Standards Subcommittee of the Dairy Industry Committee, the Committee on Sanitary Procedure of the International Association for Food Protection and the Milk Safety Team, FDA, Public Health Service, CFSAN and the Department of Health and Human Services.

US vs. European design standards

Multiple independent factors make it difficult to compare European and US sanitary design standards and regulations, even when the equipment functions and applications may be the same, complicating the job of machine builders that make the same equipment for both markets. "For a particular equipment design specification, the European standard may be more stringent; yet for a different specification, the US standard may be more stringent," says NBE's Root. "One could conceivably opt for the more stringent standard in every case, but another interdependent factor is the acceptance of these design standards by the prevailing authority having jurisdiction [AHJ]. Even so, it is definitely possible, with a thorough understanding of all codes and requirements, to design and manufacture sanitary processing and packaging equipment that meets US and European regulations and standards."

"USDA 3-A are the highest standards for food equipment manufacturers, and any equipment manufactured to them would be acceptable not only in the US but in Europe, too," says Walker's Monaweck. A significant effort is underway to harmonize the 3-A Sanitary Standards with the European EHEDG standards, but the two organizations take a different approach, says Miller. On one hand, the 3-A Standards establish design criteria regarding materials, surface finish, radii and other aspects of food processing equipment that can be cleaned and inspected. On the other hand, EHEDG standards utilize performance requirements and design guidelines rather than fabrication specifications. "Also, conformance to 3-A Sanitary Standards is verified by independent third-party verification prior to 3-A symbol authorization. EHEDG has no such third-party verification requirement," adds Miller.

While US standards focus on construction issues, European standards focus on validation tests covering areas such as cleanability, sterilizability and bacteria tightness, along with surface roughness and equipment radii, explains Paul Skudder, chief technologist, SPX Flow Technology. "Therefore, manufacturers need to carefully consider how designs can meet both standards. For example, a nut used on a piece of equipment might have a hex head and be acceptable under EHEDG as it is not in the product

contact area; however, 3-A may require a domed head to eliminate the crevice. Conversely, plug valves, which require manual cleaning, are designed for 3-A approval but do not meet EHEDG requirements."

SPX is a contributing member to several EHEDG and FDA committees responsible for the preparation of guidelines and regulations. Some of these are now looking to rationalize areas of common interest that will benefit both equipment and food manufacturers, according to Skudder.

"The Europeans have done a much better job with hygienic equipment design standards and regulations than we have here in the US," says Bühler's Blackowiak. "Certainly, in some areas such as dairy and meat, guidelines do exist. However, for low-moisture foods, guidelines for hygienic equipment design are not available. Many of our customers refer to existing specifications or guidelines such as 3-A Dairy, BISSC, USDA, etc. They pick and choose the areas that apply to their current needs."

Mike Gangel, Chad Equipment, LLC president, takes design one step at a time. "We do not change our design criteria for US vs. European customers. Obviously, there are some design differences due to overhead rail systems, electrical equipment, etc. But, we address these considerations on a project-by-project basis."

What's driving design—process or regulations?

"Without a doubt, food processors, not regulations, are driving hygienic equipment design," answers Blackowiak. Processors are looking for improved uptime, faster and better cleaning, improved access and minimized microbial risks. Food manufacturers are being proactive and driving food safety initiatives, adds Blackowiak.

"Food safety equipment design is driven primarily by the needs of the process, not by regulations," says Gangel. "We offer continuous design improvement as processes change and upgrade."

"For us, design changes are really driven by what our customers want or need in our belts," says Cambridge's Perdue. "We go to considerable lengths to monitor this and other industry trends. If we've met their need or desires, then we've done our job." Perdue points out as an example the company's Duraflex Edge metal conveyor belt, which was designed in response to customers' desire for a belt that is easy to keep clean and reduces metal fatigue. The belt has a clinched edge, eliminating nearly all the potential for metal hits and decreasing the need to stop production for product contamination or belt cleaning.

"The production objectives of the processor and the protective objectives of codes and standards need not be mutually exclusive," observes Root. "In fact, it is sanitary design, when properly implemented, that functions as a bridge between the two." It is perfectly viable for production objectives to influence sanitary design, and vice versa. But, if one is sacrificed to enhance the other, process performance and regulatory compliance will be compromised to the detriment of both the equipment manufacturer and the processor. The sanitary design bridge is essential, according to Root.

"Equipment manufacturers should always remember they are part of the triangle that connects food safety [and quality] to the equipment supplier and the chemical supplier," says Thomas Krueger, president, Summit Laboratory, LLC. "They must recognize the importance of providing equipment that assists food processors in producing safe, quality food, and is compatible with the cleaners and sanitizers used in today's food industry. The value to the buyer is realized as a cost saving when it purchases quality equipment that is safer to use, takes less time to clean, requires less training, reduces recall risk, reduces

chemical costs and is durable enough to last for a very long time."

"The design improvements are driven both by regulatory pressures and production time," says Miller. Designing the equipment in advance for CIP cleaning provides documented, repeatable verification of cleaning, while reducing downtime during changeovers and sanitation. Thus, proper design for cleaning and sanitation provides the benefits of regulatory compliance and maximizing production time, according to Miller.

The need for consistency and efficacy in cleaning and the minimizing of production downtime led JMP Engineering's automation group to take a novel approach in designing a robotic pick-and-place cell that is also capable of a completely automated washdown after two shifts of sorting and handling meat products. The robotic cell consists of four pick-and-place robots stationed over a conveyor belt. While it would be possible for people to wash down the entire cell in a clean-out-of-place (COP) scenario, the engineers thought it would be far too time-consuming to move the entire cell off line for manual cleaning. Then, there was the issue of how to assure people would clean all the equipment consistently and effectively every time.

Since the meat product is picked up with a vacuum system, it made perfect sense to use the existing lines in reverse to force cleaning fluids through them and flush them out, says Bell. "We did that, and then we thought we could take it a step further. We have four robots, and each robot is close enough to the neighboring one that we can actually park robots two and four and have robots one and three clean them. Then, we switch it so they're all clean." (To see this cell in action, visit http://youtu.be/eQZQ-R62Q9g.)

Solving the low-moisture foods design dilemma

At last year's PACK EXPO, a presentation described the One Voice Initiative. Led by the Engineering Solutions Group in PMMI's Alliance for Innovation & Operational Excellence (AIOE), the initiative provides some "must have" requirements that both CPGs and OEMs agree on regarding equipment design for low moisture foods.

"The One Voice Initiative is an excellent, industry-led alliance of two vital influence groups: the processing and packaging community and its equipment suppliers," says NBE's Root. "Establishing a unified, shared set of guidelines for equipment design will be great. Two important factors, that I believe are essential to the broad and deep adoption of the initiative, are: [1] clarification and implementation of enforcement and [2] a very wide cross-section of experts from design and manufacturing to logistics, installation, operations and sanitation."

"I represent Bühler Aeroglide in this effort and contribute actively to this working group of food processors and equipment manufacturers," says Blackowiak. "Together, we are developing a hygienic equipment design guideline. The objective is to have one guideline accepted by the low-moisture food industry, providing a uniform approach to equipment supply and hygienic requirements. From an equipment supplier's viewpoint, the guideline accomplishes several things," continues Blackowiak. "First, it defines equipment to an industry standard, which translates to standard equipment offerings versus custom solutions per customer. In turn, this allows us to supply cost-effective hygienic equipment. Second, it levels the playing field because all suppliers are bidding on the same supply, apples to apples. And third, my customer and I are on the same page. We understand each other and the requirements of the equipment."

According to the presentation, "One Voice in Sanitary Equipment Design for Low-Moisture Foods,"[1] presented at PACK EXPO on September 24, 2013, One Voice is a uniform approach to the most common, non-proprietary equipment designs that meets a base food safety requirement for the manufacture of low-moisture foods. It includes:

• A common understanding among CPG companies, OEMs and other key stakeholders of the basic needs and requirements for food safe design

• A broad agreement on and application of a set of existing general principles and guidelines for CPGs and OEMs (for example, GMA for dry clean, and AMI and DMI for wet clean)

• A recognized set of industry standards that are current and aligned with the above design principles

• A strong adherence to and common interpretation and implementation of these general principles, guidelines and standards

• A robust educational outreach to ensure broad industry acceptance and adoption of One Voice in sanitary equipment design

• A focused, repeatable solution that reduces one-off solutions, improves cost management, expedites contracting, enhances compliance and improves results for all stakeholders

• A strong commitment to continuous improvement based on lessons learned and FSMA regulatory requirements.

A webinar reviewing the status of One Voice and explaining the purposes of the initiative will be available on FE's website until October 24, 2014. [2]

Faster, safer and easier to clean

The components and materials used in food processing equipment haven't changed a great deal in recent times, says Ole Poulsen, senior global R&D technology, SPX Flow Technology. Elastomers require certification, but SS already meets the requirements detailed within the standards. However, bigger changes have been made in overall equipment design, such as the avoidance of edges, dead legs, metal-to-metal contacts, etc. There is also ongoing investigation into new welding techniques to eliminate crevices and close any gaps that currently exist. Mix-proof valves are an example of a redesign to meet USDA/PMO regulations. In this case, the valve seat and leakage areas were changed to meet the more stringent requirements.

While materials may not have changed that much, accessibility to some of the materials is improving, says JMP Engineering's Bell. This is especially true of some of the more exotic food-grade plastics. SS, of course, has always been available, but more shapes and profiles are now readily available from stock. As far as OEM parts are concerned, Bell reports that suppliers are finally beginning to understand that a 90 percent SS/10 percent bronze and aluminum alloy doesn't make a component like a cylinder a food-grade component. It has to be 100 percent SS, and it has to have surfaces that don't harbor bacteria. In addition, AMI's 10 sanitary design principles must be rigorously followed. [3]

Some machine builders have been practicing good design principles for some time. "We implemented the

concept of minimal-bacteria harboring areas many years ago," says Chad Equipment's Gangel. "We use all SS construction with no hollow components, continuous welds and minimal fasteners." For equipment that can't be cleaned in place, he recommends the use of sanitary tubing and clamping systems.

While closed-profile tubing (round or rectangular) has been the norm for some time, the trend is to move away from closed profiles in machine frames to completely open profiles, e.g., L-angle or C-channel, according to Bell. With these, there are no closed geometries where something can get into the frame without being easily rinsed or cleaned out.

Closed-profile tubing on machine frames has been problematic, according to Blackowiak. "Hollow shapes are a bacteria risk. Traditionally, a dryer frame is constructed of square and rectangular tubing, but even with end caps and welding, tubes continue to be a bacteria risk. After installation, we have seen contractors and maintenance personnel drill holes into these tubes to mount various items. Once a hole is drilled, water can enter and become a harboring place for bacteria."

Another important consideration is the design and fabrication of tool-less equipment whenever it has to be taken apart for cleaning or repair, according to Walker's Monaweck. "The majority of our conveyors are tool-less. No tools are needed to remove chutes, conveyor belts, motor, drives, pulleys and bearings." With the implementation of FSMA, Monaweck expects to see other suppliers implement tool-less technology, if they haven't already.

A dryer might seem to be one item that couldn't be cleaned in place. But when processors asked Bühler Aeroglide for a CIP dryer, the supplier listened. "One of our objectives was to dramatically reduce the amount of time to clean the dryer," says Blackowiak. "In the past, addressing how a piece of equipment was cleaned was an afterthought. Applying solutions to existing equipment was a patchwork of solutions. The design of the new Ceres dryer provides ease of cleaning from day one and influenced every component within our new system."

These kinds of improvements make new equipment faster and easier to clean while improving food safety and adhering to the latest regulations—attributes you might not get when buying used goods. "Do not buy used equipment that is more than a few years old and does not incorporate the latest food safety design criteria," advises Chad Equipment's Gangel. "Work with reputable suppliers, and understand and implement proper food safety features."

Finally, work with suppliers that have the in-house ability to undertake tests and completely validate a process prior to supplying a full-scale processing plant, advises SPX's Poulsen. "You also need to consider the level of automation and condition monitoring within a plant. Higher throughputs and a need to reduce downtime make predictive and preventative maintenance a critical aspect of system requirements." (For more on maintenance systems, see "CMMS provides enhanced functionality," page 93 in this issue).

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2 "The One Voice Vision: Sanitary Machine Design Requirements for Low Moisture Food Manufacturing," Oct. 24, 2013, FE Webinar. (Accessible until Oct. 24, 2014).

3 "American Meat Institute Foundation releases updated Sanitary Equipment Design Principles," FE online, Feb. 14, 2014.

Wayne Labs has more than 20 years of editorial experience in industrial automation. Before joining Food Engineering, *he served as a senior technical editor for Omega Engineering Inc. In addition to feature articles, Wayne covers FE's Manufacturing News, Dry Processing and Field Reports (case histories) sections and writes FE's twice monthly TechFlash e-newsletter. Email:* labsw@bnpmedia.com