Chapter 2
Condition and Cleanliness of Food Contact Surfaces

Introduction

This chapter relates to the design, workmanship, materials, and maintenance of food contact surfaces and the routine, scheduled cleaning and sanitizing of those surfaces, including gloves and outer garments.

2-1. **Key Sanitation Condition No. 2:**

Condition and cleanliness of food contact surfaces

Food contact surfaces in food processing can include all equipment, utensils and facilities used during processing; as well as, worker clothing and hands, and packaging materials. This is a very comprehensive concern because potential food contamination can come from numerous direct or indirect routes that are not always obvious during the processing operation.

2-2. **Food Contact Surface:**

"Those surfaces that contact human food and those surfaces from which drainage onto the food or onto surfaces that contact the food ordinarily occurs during the normal course of operations" (GMP, 21 CFR 110.3). Typical food contact surfaces include utensils, knives, tables, cutting boards, conveyor belts, ice makers, ice storage bins, gloves, aprons, etc.”
Monitoring

2-3. **Goal:**
Monitoring should provide assurance that food contact surfaces including gloves and outer garments are properly designed, constructed and maintained to facilitate sanitation, and that they are adequately and routinely cleaned and sanitized.

A complete SSOP plan will account for all food contact surfaces that could lead to direct or indirect contamination of foods during processing. A monitoring program should ensure that, 1) processing equipment and utensils (food contact surfaces) are in suitable condition for sanitary processing, 2) equipment and utensils are properly cleaned and sanitized, 3) the type and concentration of sanitizer(s) is acceptable as applied, and 4) that gloves and outer garments which might contact food are clean and in good condition.

2-4. **What to Monitor:**
- Condition of the food contact surfaces;
- Cleanliness and sanitation of food contact surfaces;
- Type and concentration of sanitizer(s) used; and
- Gloves and outer garments which might contact food are clean and in good condition.

At its simplest, the monitoring of food contact surfaces typically involves a combination of visual checks and chemical testing of sanitizers. Visual inspection includes confirmation that surfaces are in good condition so that they can be properly cleaned and sanitized. Also, gloves and outer garments must be clean and in good repair. Monitoring includes visual checks for the construction and condition of surfaces. Proper lighting and polished or light-colored surfaces allow for easier detection of residues on surfaces. Some pieces of equipment may require disassembly to identify areas which trap food particles. The monitoring process looks for recesses, poorly bonded joints, corroded parts, exposed bolts or screw heads or other areas which trap water or soils which could hinder the effectiveness of cleaning and sanitation procedures.

Chemical testing is very simple for most commonly used sanitizers, such as chlorine, iodine, and quaternary ammonium compounds. Special test strips change color in the presence of a specific sanitizer, and the intensity of color indicates chemical concentration. The strips quickly provide results that are sufficient for most tests. Instructions accompanying the strips explain the proper use since some instantly change color while others must be soaked for a certain period of time. Although accurate, most test strips allow for determining a concentration range, not a precise concentration. Also, test strips are not available for all sanitizers. Colorimetric test kits requiring simple chemical mixing are available for many sanitizers. Most are precise, relatively rapid and require little training. Chemical or laboratory suppliers to the food industry can usually furnish test strips and kits.
Periodic verification checks for sanitation, such as microbiological testing of surfaces, is recommended but is not required. These methods are described later in this chapter.

2-5. How to Monitor:

◆ Visual Inspection --
  • Surfaces in good condition;
  • Surfaces cleaned and sanitized; and
  • Gloves and outer garments clean and in good repair.

◆ Chemical Testing --
  • Sanitizer concentration (test strips or kits).

◆ Verification Checks --
  • Microbial tests of surfaces (optional).

Monitoring frequency depends on what is monitored. Inspection of equipment for proper design (ensuring adequate drainage, for example) and evidence of corrosion may be sufficiently performed on a monthly schedule. Sanitizer concentrations are usually determined at the time they are applied as part of plant clean-up procedures. Where sanitizers are prepared over the course of the day, they should be checked periodically during the day. The frequency of the checks should be determined by the conditions of use. Certain sanitizers degrade more quickly than others and require more frequent monitoring before application to surfaces. Typical monitoring schedules are shown in the example monitoring record 2-8 and later in the Sanitation Control Guides. In addition, the adequacy of equipment cleaning should be verified after each cleaning and sanitizing operation.

Corrections

Problems discovered during monitoring must be corrected in a timely manner. If a piece of equipment is corroded, the correction may involve refinishing or replacement of the equipment. If a work surface is not cleaned it should be properly cleaned and sanitized before beginning work. If a sanitizer concentration is too weak, it should be replaced or adjusted to the proper strength. This implies that targets (criteria) must be established to identify whether conditions are acceptable or unacceptable. For example, chlorine sanitizers are usually applied to food contact surfaces at approximately 100-200 ppm available chlorine. If monitoring indicates a concentration outside of this range, the concentration must be corrected and documented. The background section of this chapter provides details that should help in establishing acceptable ‘targets.’
Typical Corrections:

- Observation: Sanitizer concentration from dispenser varies day to day.
  Correction: Repair or replace chemical proportioning equipment and train cleaning crew in its proper use.

- Observation: Juncture of two table tops traps food debris.
  Correction: Separate tables to allow access for cleaning.

- Observation: Table work surfaces show signs of corrosion.
  Correction: Refinish or replace damaged equipment and switch to less corrosive cleaning compound.

Records

Sanitation control records provide evidence that the company’s sanitation program is adequate, that it is followed and problems are identified and corrected. The actual records or recording forms will differ to suit a particular processing operation. The example records (2-7 and 2-8) identify monthly and daily check points in one of numerous possible formats for recording observations. Notice some of the approaches used in the various types of records.

- The Monthly Sanitation Control Record (2-7) allows for a more comprehensive check of the conditions and workmanship of all food contact surfaces and equipment in the plant, while the corresponding Daily Sanitation Control Record (2-8) can allow for more detailed checks for the cleanliness of the food contact surfaces.

- Observations (S/U in 2-8) are recorded more frequently for those food contact surfaces associated with ready-to-eat products than those associated with the raw, to-be-cooked seafood processing line.

- A pre-operational monitoring (Pre-Op) check (2-8) is recommended for all processing operations. It discovers any problems and makes necessary corrections before any processing begins.

- Pre-Op and “Start” conditions can differ. For example, in 2-8, a Pre-Op check monitors cleanliness of the equipment, while another check at “Start” is necessary to assure that the workers have clean gloves and aprons, something that can not be checked during pre-op.

- Actual values are recorded where a value is available such as sanitizer concentrations, etc. The type and strength of the sanitizer being used is listed as a useful reminder of the target value.
Ample space is available to mark corrections. An “Unsatisfactory” (U), observation is always followed by a recorded correction.

The times for all observations, including corrections, are recorded.

2-7.

**Monthly Sanitation Control Record**

**Report Date:** 1/21/99

**Firm Name:** Any Seafood Co., Inc

**Firm Address:** Anywhere. USA

<table>
<thead>
<tr>
<th>Sanitation Area</th>
<th>Decision</th>
<th>Comments/ Corrections</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1) Safety of Water</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safe and sanitary source (S/U)</td>
<td></td>
<td>Municipal water bill and analysis on file (1/10/99)</td>
</tr>
<tr>
<td>annual</td>
<td></td>
<td>Requested installation of air gap in water line used</td>
</tr>
<tr>
<td>No cross-connections in hard plumbing</td>
<td></td>
<td>to fill new thaw tank</td>
</tr>
<tr>
<td>(S/U)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2) Condition and Cleanliness of Food</strong></td>
<td></td>
<td>Replaced cracked cutting</td>
</tr>
<tr>
<td>Contact Surfaces</td>
<td></td>
<td>board at station no. 2</td>
</tr>
<tr>
<td>Processing equipment and utensils in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>suitable condition (S/U)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3) Prevention of Cross-contamination</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical conditions of plant and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>layout equipment (S/U)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

S = Satisfactory / U = Unsatisfactory

**Additional Comments:**

Air gap installed 1/22/99

Need plan to phase out all wooden cutting boards

Signature or initials BSJ
# Daily Sanitation Control Record

**Report Date:** 10/22/99  
**Firm Name:** Any Seafood Co., Inc.  
**Firm Address:** Anywhere, USA

<table>
<thead>
<tr>
<th>Sanitation Area and Goal</th>
<th>Pre-Op Time:</th>
<th>Start Time:</th>
<th>4 Hour Time:</th>
<th>8 Hour Time:</th>
<th>Post-Op Time:</th>
<th>Comments and Corrections</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Safety of Water</td>
<td></td>
<td>7:35A</td>
<td>8:10A</td>
<td>12:15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(See Monthly Sanitation Control Record)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Back Siphon-Hoses (S/U)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>U</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) Condition and Cleanliness of Food Contact surfaces (See Monthly Sanitation Control Record)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Equipment cleaned and sanitized</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Line 1: (S/U)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Line 2: (S/U)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>S</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Adjusted to 100 ppm before use (4:40P)</td>
</tr>
<tr>
<td>- Sanitizer Strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sanitizer Type: Chlorine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strength: 100-200 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Line 1: (ppm)</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Line 2: (ppm)</td>
<td>100</td>
<td>100</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Gloves and aprons clean and in good repair</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Line 1: (S/U)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Line 2: (S/U)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>U</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Replaced 10 pairs of gloves (8:30A)</td>
</tr>
<tr>
<td>3) Prevention of Cross-Contamination (See Monthly Sanitation Control Record)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Hands, gloves, equipment, and utensils washed/sanitized after contact with unsanitary objects (S/U)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Employees working on raw products, wash and sanitize hands/gloves/outerwear before working with cooked products (S/U)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Unpackaged cooked products separated from raw products (S/U)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>U</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**S** = Satisfactory / **U** = Unsatisfactory
Background

Materials for Food Contact Surfaces

Proper selection of materials and design of food contact surfaces can help prevent potential food contamination. Features for durability and function are important, but they cannot compromise concerns for food safety. In simple terms, surfaces should be safe, non-corrosive and easily cleaned and sanitized.

2-9. General Requirements for Food Contact Surface

◆ Safe Material --
  • Non-toxic (no leaching of chemicals);
  • Non-absorbent (can be drained and/or dried);
  • Resist corrosion; and
  • Inert to cleaning and sanitizing chemicals.

◆ Fabrication --
  • Can be adequately cleaned and sanitized; and
  • Smooth surfaces including seams, corners, and edges.

A complete discussion of all the various food contact materials is beyond the scope of this chapter, but the following points should be considered.

Most metal surfaces are prone to corrosion directly from the foods (e.g., pickled seafood, brines or marinades) or from chemicals used in cleaning and sanitizing. Selection of metal surfaces must consider the process and food type. The corrosion process occurs due to acidity (pH), salinity, temperature, and time of exposure. Joining two or more dissimilar metals will often greatly accelerate corrosion due to the generation of a small but destructive electric voltage between the pieces.

Stainless steel is often the preferred food contact surface because it can be fabricated with a smooth cleanable finish and it is durable. Although the initial investment can be relatively high, the cost can be recovered through reduced maintenance and prolonged use. Stainless-steel materials in the 300 series (grades) are typically used in food processing. Grained stainless steel can be very attractive, but these surfaces contain thousands of tiny grooves in the surface, making cleaning difficult. These should not be used.
2-10. General characteristics of some food contact surfaces

<table>
<thead>
<tr>
<th>Surface Materials</th>
<th>Concerns</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Iron or Cast Iron</td>
<td>Acids or chlorinated detergents. Can cause rust. Lacks strength.</td>
<td>Not recommended in food processing.</td>
</tr>
<tr>
<td>Concrete</td>
<td>Often etched by acidic seafoods and cleaning compounds. Can crack.</td>
<td>Concrete should be dense and acid resistant. Materials should not loosen from surface. Use alkaline cleaners.</td>
</tr>
<tr>
<td>Glass</td>
<td>Strong caustic cleaning compounds can etch.</td>
<td>Clean with moderately alkaline or neutral detergents.</td>
</tr>
<tr>
<td>Plastics</td>
<td>Some stain easily. Currently available materials cannot be used at very low or high processing temperatures.</td>
<td>Best to color coordinate items for intended use (i.e., raw vs. cooked) and select plastics that will not deform or crack when exposed to processing temperatures.</td>
</tr>
<tr>
<td>Rubber</td>
<td>Damaged by certain solvents. Trimming boards can warp and their surface can dull knife blades.</td>
<td>Avoid porous or spongy types that hold water or food debris.</td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>Expensive, certain grades are pitted by chlorine or other oxidizers.</td>
<td>Best metal surfaces for food processing. Consider 300 level series.</td>
</tr>
<tr>
<td>Lead</td>
<td>Solder and flux containing lead in excess of 0.2% may not be used as a food contact surface</td>
<td>Try to eliminate use in food processing plant.</td>
</tr>
<tr>
<td>Wood</td>
<td>Pervious to moisture and oils/fats. Softened by alkali and other caustics. Often difficult to clean.</td>
<td>Treated woods must meet criteria for wood preservatives as defined in 21 CFR 178.380. Limit use as food contact surface.</td>
</tr>
<tr>
<td>Galvanized metals</td>
<td>Tend to rust leaving a white powder by-product due to zinc corrosion that could cause product adulteration.</td>
<td>Avoid use as food contact surface. Should not be used with acidic foods.</td>
</tr>
<tr>
<td>Paint and sealants</td>
<td>Chemical leaching, flaking, and peeling.</td>
<td>Generally not recommended for direct contact surfaces, especially those subject to abrasion. Use only approved substances.</td>
</tr>
</tbody>
</table>
### Food conditions that can influence choice of appropriate food contact surfaces

<table>
<thead>
<tr>
<th>Item</th>
<th>Corrosion Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pickled fish (e.g., herring, mackerel)</td>
<td>Strongly corrosive; High acidity and salts</td>
</tr>
<tr>
<td>Salt cured fish products (e.g., smoked fish, brined shrimp)</td>
<td>Moderately corrosive; Medium acidity and salts</td>
</tr>
<tr>
<td>Fresh and refrigerated fish (e.g., peeled shrimp, fillets, shucked oysters, picked crab meat, surimi)</td>
<td>Weakly corrosive, Low acidity</td>
</tr>
<tr>
<td>Fish powders, Dried fish (e.g., freeze dried shrimp, fish protein concentrate)</td>
<td>Non-corrosive</td>
</tr>
<tr>
<td>Frozen Fish (e.g., IQF frozen shrimp)</td>
<td>Non-corrosive</td>
</tr>
</tbody>
</table>

**Aluminum** is used primarily for construction of utensils because of its low density as well as low fabrication costs. Aluminum has low mechanical strength and corrodes rapidly in an acidic environment (e.g., pitted table surface). The use of aluminum is declining due to concerns for corrosion from cleaning and sanitizing solutions.

**Brass** (copper-zinc alloy) and **copper** have been used historically for construction of food contact surfaces. However, their use has diminished because of molecular reactions with food ingredients and corrosion resistance. Likewise, brass and copper can produce off-colors. They accelerate oxidation of ascorbic acid (vitamin C) and facilitate the onset of rancidity of seafood high in unsaturated fatty acids.

**Other metals**, like cast iron and black iron were first used for constructing of food contact surfaces during the Iron Age. Known as ferrous metals, this group corrodes following contact with water, hence, they may not be used in construction of food contact surfaces. Corrosion creates cavities that reduce the effectiveness of cleaning and sanitizing programs. However, cast iron may be used as a surface for cooking (U.S. Food Code 4-101.12).

Historically, **wood** was the premier natural material of choice for constructing food contact surfaces (e.g., wooden baskets for seafood) as well as for floor construction. Advancements in development of other materials replaced wood. In most seafood processing plants, wooden floors are being replaced with concrete. However, wood continues to be used in design and construction of fermentation vats (or tanks) for low pH (inert to acidic environmental conditions) and high salt foods (corrosion resistant properties). In some instances, wooden boards or cutting boards are still used for trimming seafoods, but this generally is not recommended because normal usage leads to a rough surface contain-
ing places for food and microbial entrapment as well as making it difficult to clean and sanitize. The suitability of wood depends on its quality and application. If a fine-grained hardwood is selected and properly maintained, it may be acceptable for some food contact uses. However, as a matter of policy, many health agencies do not consider wood to be impervious and strongly discourage its use in knife handles or other implements used directly for processing seafood.

2-12. **Food contact surface materials which normally should be avoidable if feasible:**

- Wood (microbial concerns);
- Ferrous metals (corrosion concerns);
- Brass (variable corrosion resistance and product quality concerns); and
- Galvanized metal (corrosion and chemical leaching concerns).

Note: Certain state regulations may prohibit use of these materials as food contact surfaces in processing operations.

Plastic surfaces come in a variety of types approved for food processing. They offer a wide range of properties associated with temperature tolerance, machinability, hardness and flexibility. The decision to replace metal with plastics as a food contact surface is based on its mechanical strength and compatibility with processing requirements. The numerous merits of plastic often outweigh its few detriments.

Concrete is a common food contact surface made from a mixture of sand, limestone and stone. Concrete has been used for construction of water holding tanks, benchwork surfaces and flooring. The suitability of the surface depends on how it is finished. A smooth concrete surface is cleanable and repairable. Concrete surfaces can withstand corrosive action but may be weakened by caustic solutions. Select concrete formulations that are designed for the intended use. Because concrete is porous, certain concrete sealants are available for use in food plants. Tiles are also used in some processing plants, with grout forming the matrix between the tiles. As with concrete, grouts should be selected and applied to be as smooth as possible and, if necessary, sealed to prevent penetration of liquids and soil.

Outer garments, particularly aprons and gloves are considered food contact surfaces. In fact, any garment that routinely comes into contact with food must be considered. Frequent washing of gloves, aprons and other garments that may contact food, either directly or indirectly, is very important to ensuring a safe and high quality food product.

When not in use, gloves and garments should be stored in clean, dry areas separate from soiled clothing. Company policies should be established for buying, cleaning and storing clothing and gloves. These articles must be stored so that air circulates around them to facilitate drying. If folded or stacked in a pile while damp, large numbers of bacteria may grow on surfaces during storage.
Gloves, aprons and other garments should be properly designed for their intended use and be constructed of durable materials. For example, gloves made of non-absorbent materials (plastic or rubber) should be used. Cloth gloves should not be used with ready-to-eat products. Small, pre-existing holes in the glove material can result in bacteria being transferred from unwashed hands to the outside surface of the gloves contaminating the food product.

2-13. Storage of Clothing and Gloves:

- Store clothing and gloves in clean and dry locations;
- Ensure that clothing and gloves are not exposed to splash, dust or other contaminants; and
- Store clean garments separately from soiled garments and gloves.

Food processing companies should have a written policy (SSOP) for the replacement and reuse of clothing and gloves. Many companies issue gloves, aprons and boots to their employees to maintain control. They may require that issued items remain at the plant, and periodically inspect them for condition and replacement.

Equipment Design, Fabrication, and Location

2-14. Design and Install Food Contact Equipment to:

- Drain and not entrap soils;
- Provide access for cleaning and inspection; and
- Withstand plant environment.

Food contact surfaces should be constructed and designed so they can be readily cleaned and sanitized. Any seams or joints should be smoothly bonded. Equipment should be designed to avoid sharp angles or structures that hinder proper cleaning and sanitation. Surfaces should drain and not entrap soils. Although state and local regulations may have specific requirements, fixed equipment should be located far enough away from the processing walls and above floors to permit access for cleaning. Ensure that the supporting members are welded and do not provide places for insects to hide. Determine that food machinery is installed or relocated above floor level to facilitate maintenance, cleaning and sanitizing. If a solid floor-mounted base is required, the floor-machinery junction should be coved and tightly sealed. A recommended action would be to fill hollow floor bases with concrete. Stand supports utilizing a single pedestal with a round coved base sealed to the floor are preferred to the H-support often observed in food plants. Equipment should be designed with the fewest possible supports needed to meet safety and weight supporting requirements.
When purchasing machinery, observe positioning of electrical motors and control panels. Motors should be mounted on the equipment rather than on the processing floor, and never over production lines. Further, the electrical connections to motors should be waterproof and electrical conduits should be sealed to eliminate entrances for insects. The electrical wires should be grouped and protected within conduits to facilitate cleaning. Switch boxes should be positioned away from the processing equipment to allow for cleaning without electrical hazards. Floor-mounted units should have sloped upper surfaces for drainage, and conduit risers should enter the cabinet through the floor or from suspended grouped overhead wireways.

Conveyor belts should be made of non-absorbent and corrosive-resistant materials (e.g., nylon or stainless steel) that are easy to clean. Temperature considerations are important when selecting conveyor belts, as many plastic materials cannot withstand cryogenic temperatures used in freeze tunnels or the high heat of fryers. Motors and oiled bearings should be placed where oil and grease will not adulterate food product.

Water and steam should be supplied to food process machinery in pipes and tubes that are insulated if their surface temperature is hazardously high or sufficiently low to condense water vapor from the atmosphere resulting in a sanitation problem. Filters should be inspected monthly or more frequently if production necessitates.

During renovation, piping should be installed or relocated at least three inches from the walls and floors to facilitate thorough cleaning and sanitizing. Pipe hanger suspension rods should be round and suspended from braces.

Cleaning and Sanitizing Food Contact Surfaces

Clean, sanitary food contact surfaces are fundamental to the control of pathogenic microorganisms. The contamination of seafood through either direct or indirect contact with insanitary surfaces potentially compromises the safety of that product for consumption. The sanitary condition of food contact surfaces must be demonstrated for compliance with the sanitation control procedures. Effective sanitation standard operating procedures will outline the basic cleaning and sanitizing schedule (example, 2-28). Cleaning and sanitizing typically involves five steps: dry clean, pre-rinse (brief), detergent application (may include scrubbing), post-rinse and sanitizer application.

2-15. Five Steps of Cleaning and Sanitizing

1. Dry-clean;
2. Pre-rinse;
3. Detergent application, then;
4. Post-rinse; and
5. Sanitizing.

5 Steps!
Cleaning

The importance of cleaning cannot be overemphasized. The effectiveness of a company’s sanitation program more often relates to the implementation of proper cleaning procedures than to the type of sanitizer used. Simply rinsing equipment and processing surfaces with a chlorine solution, at any concentration, will not sanitize surfaces unless they are first cleaned with an appropriate detergent. The selection of detergents and sanitizers, their concentrations, and method of application will depend on several factors including:

1) nature of the soil;
2) degree of cleaning and sanitation required;
3) type of surface to be cleaned; and
4) type of equipment used for cleaning and sanitizing.

Sanitizers alone cannot be depended upon to remove microorganisms. Soil includes fish tissue, scales, process wastes, grease, bacterial films, dirt, etc. It is not always apparent. Certain bacteria, including some pathogens, may adapt to harsh conditions by forming a biofilm. They physically change, sending out tendrils that attach to the surface and to each other. They soon release a slime layer (a polysaccharide) which further protects them. Bacteria in a biofilm are not effectively removed with common soap and water cleaning procedures, and are up to 1,000 times more resistant to common sanitizers than when in a free state. A systematic cleaning routine should be followed to remove these biofilms and other soils.

Dry cleaning is simply using a broom, brush or squeegee to sweep up food particles and soil from surfaces. Too often processors use a water spray as a broom to push particulates. This practice significantly increases water consumption, contributes to water pollution or high water treatment costs, and creates problems associated with clogged drains and handling of wet solid wastes. It also tends to disperse dirt and bacteria to other areas of the plant (i.e., walls, equipment, and tables).

Pre-rinsing uses water to remove small particles missed in the dry cleaning step and prepares (wets) surfaces for detergent application. However, scrupulous removal of particulates is not necessary prior to application of detergent.

Detergents assist with particle removal and reduce cleaning time and water consumption. Each detergent is different and product directions must be followed. Many household cleaners and those intended for extensive hand contact are referred to as general purpose, or GP cleaners. They are quite mild and safe for use on painted or corrodbible surfaces. They are rarely adequate for whole-plant use in commercial processing environments. However, they can be effective for lightly soiled surfaces or when given sufficient contact time and agitation (scrubbing).

Alkaline or chlorinated detergents are recommended for most processing plant applications and are more effective than general purpose cleaners against food soils. Alkaline detergents range from moderately to highly alkaline (caustic). Chlorinated products are usually more aggressive in loosening stubborn protein-based soils or for surfaces that are difficult to clean due to their shape or size, such as perforated storage crates (totes) and waste containers. They are also alkaline and many are very corrosive. They should not be used on corrodbible materials, such as aluminum. Although chlorinated to assist with the chemical disruption of soils, they are detergents, not sanitizers.
A common strategy for operations currently using GP cleaners is to switch to an aggressive chlorinated detergent for a week or two, then maintain cleanliness with a somewhat milder alkaline detergent. Although most seafood processing soils contain mostly protein which is best removed with alkaline and chlorinated detergents, occasional cleaning with an acid detergent will remove inorganic mineral deposits (scale) and stains such as those associated with hard water.

In situations where exposure to excess alkaline or acid conditions are a problem, such as with wastewater discharge restrictions or equipment susceptible to corrosion, enzyme detergents may be an acceptable alternative. Because enzymes are specific to a given soil type, these detergents may not be as effective as other detergents for general plant use. Enzyme detergents are tailored for protein, oil or carbohydrate-based soils. Carbohydrate soils mostly occur where braidings, batters or starches are used. Moderately alkaline detergents are also generally effective for removing these materials. Smokehouse and cooker surfaces may be especially difficult to clean, requiring specialized highly-caustic cleaning chemicals and application methods.

<table>
<thead>
<tr>
<th>2-16.</th>
<th>Types of Detergents:</th>
</tr>
</thead>
<tbody>
<tr>
<td>♦ General Purpose (GP);</td>
<td></td>
</tr>
<tr>
<td>♦ Alkaline;</td>
<td></td>
</tr>
<tr>
<td>♦ Chlorinated (chlorinated alkaline);</td>
<td></td>
</tr>
<tr>
<td>♦ Acid; and</td>
<td></td>
</tr>
<tr>
<td>♦ Enzyme.</td>
<td></td>
</tr>
</tbody>
</table>

For any given detergent and soil, cleaning effectiveness will depend upon several basic factors: contact time, temperature, physical disruption of the soil (scrubbing), and water chemistry.

<table>
<thead>
<tr>
<th>2-17.</th>
<th>A detergent’s effectiveness varies with:</th>
</tr>
</thead>
<tbody>
<tr>
<td>♦ Contact time;</td>
<td></td>
</tr>
<tr>
<td>♦ Temperature;</td>
<td></td>
</tr>
<tr>
<td>♦ Physical disruption (scrubbing); and</td>
<td></td>
</tr>
<tr>
<td>♦ Water chemistry.</td>
<td></td>
</tr>
</tbody>
</table>

**Contact Time**

Detergents do not work instantly but require time to penetrate the soil and release it from the surface. A simple strategy for increasing contact time is to set up soak tanks or sinks. Utensils, pans and other small pieces of equipment can be placed in tanks or sinks throughout the day. This often significantly reduces the need for scrubbing by hand later with a pad or brush. When larger pieces of equipment are dismantled for end of day cleaning, these too can be placed in designated soak tanks while
permanent, fixed pieces are cleaned in place. To avoid pitting or other damage, select an appropriate detergent when using extended soak times.

Obviously, large pieces of equipment or permanent fixtures cannot be submerged in a detergent solution. An effective method for increasing contact time on these surfaces is to apply the detergent as a foam, or less commonly, a gel. Air is incorporated with a high foaming detergent during application to produce a foam possessing the consistency of thin shaving cream. This clings to surfaces to be cleaned, even vertical surfaces which otherwise tend to dry prior to scrubbing or rinsing. Like other soils, dried detergent must be fully removed with fresh detergent prior to rinsing.

Foam applications serve other purposes as well. Detergent, water and air are mixed by the application equipment, producing consistent detergent concentration. It is also highly visible when applied, facilitating uniform coverage, optimal chemical usage and management oversight. Many types of foam applicators are available. They generally fall into three groups: 1) in-line systems; 2) precharged portable units; and 3) hose-end applicators. In-line foammers are connected to the plant water supply and draw detergent from a bulk container. Compressed air is injected into the line to create foam. The portable foamers consist of a tank, which is partially filled with measured detergent and water, then pressurized with compressed air. They are wheeled where needed and the contents delivered through a hose and nozzle similar to those used with the in-line models.

**Hose-end foam applicators** are similar in appearance to applicators sold at garden centers for home use with pesticides and fertilizers. Detergent is poured into a bottle, attached to a hose and delivered by opening a water valve. Air needed for foaming is drawn into the solution by venturi action. This method usually produces a wetter foam possessing poorer cling properties than the first two methods. It is the least expensive option but can be a significant improvement over applying detergent from pails or basins. Coverage is more uniform and some contact time extension is expected. When working with alkaline or chlorinated detergents, employees should wear appropriate clothing such as goggles, tall boots and aprons or full protective suits.

All cleaning methods, including foams and soaks require sufficient contact time to fully loosen and suspend soil. A moderately alkaline detergent will typically require 10-15 minutes to fully loosen most seafood processing soils. An extended time period (more than approximately 20 minutes) may allow detergents to dry and redeposit their soil load, or shorten equipment life. Therefore, contact time must be considered when selecting a detergent for any given application.

Washing methods are sometimes classified according to the design of the processing equipment to be cleaned. Some processing lines contain flumes or piping which can be cleaned without disassembling each section. This is known as clean-in-place or CIP. Closed processing systems are cleaned and sanitized by pumping one or more detergent solutions through the lines and associated equipment (such as any heat exchangers or valves) for prescribed intervals. The dairy industry uses this approach for cleaning fluid milk lines. Specially designed, low foaming detergents are usually required for CIP applications. When equipment must be disassembled for cleaning, it is referred to as clean-out-of-place, or COP.
2-18. Detergent application methods:

- Soak tanks;
- Foam;
- Automated systems;
  - CIP (clean-in-place); and
  - parts washers.
- Manual (pails).

Temperature

Most chemical activities increase with increasing temperature. This generally holds true with detergent efficiency, but with some important exceptions. Many styles of steam cleaners are available for heating detergent solutions and rinse water. Although, these can facilitate penetration and suspension of some food soils, hotter is not always better. Most raw seafood residues contain proteins which are readily denatured or cooked by hot water. This can occur even at solution temperatures near the cool end of commercial hot water cleaning (approximately 140°F). These cooked-on soils are especially stubborn and may require substantially more time and scrubbing effort to remove, or the use of a more aggressive detergent than otherwise would be necessary.

One strategy is to use water for initial wetting and detergent cleaning, then rinse at 140-160°F. This improves effectiveness with less risk of cooking seafood residues onto plant surfaces. For certain applications, such as cookers and smokehouses, highly caustic detergent or alkali (caustic soda) is heated to 180°F or hotter. These conditions chemically alter and disperse soils such that denatured food residues are not likely to develop.

Disruption (scrubbing)

The selection of proper detergents and application methods will minimize the need for manual scrubbing, however physical disruption of soils is frequently required to assist with soil removal. To be effective, cleaning aids must be carefully selected. Appropriate methods include brushes, pads and pressure spray depending on the application. In many cases, manual cleaning is only needed occasionally.

2-19. Example Cleaning Procedure:

A processor applies an alkaline foam detergent to equipment every day. The detergent is allowed to stand and then is rinsed without scrubbing. Actual scrubbing with brushes or pads takes place only once each week.
2-20. Physically removing soils:
- Brushes — proper stiffness;
- Pads — proper cutting properties; and
- Pressure spray — moderate pressure.

Brushes and pads can be highly effective but only if properly selected. If additional pressure is needed to remove difficult soils, bristles may splay, resulting in significantly reduced efficiency. In these cases, a stiffer brush is needed. However, excessively stiff bristles may not conform to surfaces or may require excessive pressure and effort. A stiff brush on a long handle can quickly fatigue the user. Brushes and brooms should be color coded and only be used in specified areas. Brushes, brooms, or pads used in raw areas should never be used in processing areas for ready-to-eat products.

Pads have become very popular as manual cleaning aids. They readily conform to surfaces and usually require only light pressure to be effective. They may improve the feel of the user as compared to a brush. For example, fingers on a pad can be run under the lip of a processing table with improved contact. Pads are also appropriate for cleaning knives and other small implements. Pads are synthetic materials designed for a specific cleaning application. Two pads similar in appearance may differ greatly in performance. They should have sufficient cutting properties to loosen soils without scratching plant surfaces. They are often specified according to the material or hardness of surfaces to be cleaned. Steel wool should not be used because it's too abrasive and can cause rusting. When hand detailing equipment, employees should wear protective gloves to prevent contact with harsh chemicals.

Pads, brushes and brooms should be dedicated to tasks for which they are designed. Not only is cleaning effectiveness optimized, but cross contamination between areas of the plant can be minimized. A system of color coding can be very helpful for training and management oversight. Color coded pads are available to facilitate proper selection. For example, red cleaning aids could be selected for use in the raw materials area, white aids in the finished product area, and black aids with drains. The colors in each area designate some predetermined use, such as scrubbing relatively hard or soft surfaces.

2-21. Pads, brushes and brooms should be dedicated to tasks for which they are designed:
- Optimizes cleaning effectiveness; and
- Minimizes cross-contamination between areas of the plant.

Cleaning aids which retain water, such as sponges, wiping cloths and mops should not be used for routine cleaning in processing plants. After just one use, they may harbor large numbers of bacteria, including species known to cause disease. They are very difficult to clean and sanitize, and frequently contaminate the very surfaces you wish to sanitize. Although they are convenient for picking up excess
water or sanitizer solution, a better option is to use a sanitized squeegee to strip surfaces of liquids, or select equipment that drains by design.

### 2-22.

**Cleaning aids which retain water**, such as sponges, wiping cloths and mops should **not** be used for routine cleaning in processing plants.

After use, cleaning aids should be thoroughly cleaned, rinsed, sanitized and stored so that they dry. Hang brooms off of the floor to store. Brushes and squeegees can be hung on a wall or board to dry. Alternatively, they can be stored in a fresh sanitizer solution. Store pads in fresh sanitizer unless they can be stored so that air circulates freely around them and they dry between uses.

Removing detergent with high pressure spray is another method for physically disrupting loosened soils. **Pressure washers** are widely available and are popular, especially for difficult to reach surfaces such as metal mesh belts. Like steam cleaners however, they are inappropriate for general use. Pressure spray kicks up water and associated soil, creating an aerosol or mist, which can carry onto previously cleaned surfaces. Generally, plants are cleaned from the top down, starting just above the splash zone on walls and finishing with the floors. If a high pressure spray hits the floor, recontamination of cleaned food contact surfaces is highly likely. One disease-causing bacteria, *Listeria monocytogenes*, thrives in damp environments such as floor drains. This microorganism is not permitted in ready-to-eat seafoods at any level. Therefore, never direct pressurized spray into floor drains. This practice creates a mist that spreads the pathogens over a large area.

Spray systems can be characterized as:
1) high pressure, high volume;
2) high pressure, low volume;
3) low pressure, high volume; and
4) low pressure, low volume.

The first of these, high pressure (may exceed 1,000 psi) combined with high water flow, can damage equipment (for example, may cut through grease seals) and be dangerous to employees. Excessive water usage is usually to be avoided since it contributes to high operating costs, and does not significantly assist with soil removal. This mostly limits food processing spray systems to low volume delivery at water pressures generally not exceeding approximately 200 psi.

Some processors may find they require nearly continuous cleaning throughout the day. Processing line belts or product totes that are cycled frequently for reuse may be most efficiently cleaned with **automated equipment**. These range from fixed spray heads, scrapers and rotary brushes used to minimize soil build-up during operation to fully automated cleaning cabinets and container washers. Fully automated equipment is often designed for a particular function, such as washers that position, wash, rinse, sanitize and drain product totes (lugs). Small parts washers are available for automated cleaning of utensils and disassembled equipment parts.
Cleaning and Water Chemistry

Water is seldom pure. It commonly contains various impurities, which may alter the effectiveness of cleaning (and sanitizing) chemicals. **Hard water** contains calcium and magnesium salts, which react with cleaners and diminish their effectiveness. The reacted constituents drop out of solution forming a mineral-complex residue that may trap food soils and become increasingly difficult to remove. Most modern industrial detergents contain conditioners to minimize these problems, but in some locations, water chemistry may be a factor in the proper selection of cleaning agents. At a minimum, greater detergent concentrations are likely to be needed when used with hard water. Certain other **minerals**, such as iron or manganese may stain plant fixtures and equipment. Water chemistry is especially important when selecting sanitizers. Major suppliers of cleaning and sanitizing chemicals are usually the best source for specifying products appropriate for given water conditions. Various treatment systems are commercially available for control of water hardness and other water impurities. Often, such pretreatment of plant water will significantly improve the performance of cleaning and sanitizing chemicals.

Post-rinsing

During post-rinsing, water is used to remove detergent and loosen soil from food contact surfaces. This process prepares the cleaned surfaces for sanitizing. All the detergent must be removed in order for the sanitizing agent to be effective.

Sanitizing

After food contact surfaces are cleaned, they must be sanitized to eliminate or at least suppress potentially harmful bacteria. Many types of chemical sanitizers are commercially available. They may or may not require rinsing before the start of processing, depending upon the sanitizer and its concentration (see table 2-26). All sanitizers must be approved for use in food establishments and be prepared and applied as labeled. The U.S. Environmental Protection Agency and the U.S. Food and Drug Administration regulate sanitizers used in food processing facilities (21 CFR 178.1010). The regulatory reference can be confusing. Questionable chemicals should be checked against local authorities.

2-23. **Sanitizing follows proper cleaning:**

1. Dry-clean;
2. Pre-rinse;
3. Detergent application;
4. Post-rinse;
5. Sanitizing.

Application Methods

Sanitizing is a relatively simple process involving the application of an approved sanitizer to equipment and other plant surfaces that have already been cleaned. Recommended methods for applying sanitizers include **proportioners and applicators**, low pressure **tank sprayers**, and **dips**. The proportioners and applicators can be installed in-line or at separate stations. A range of procedures can be used, from manual mixing to fully automated systems that draw from bulk containers. Some sanitizers,
such as quaternary ammonium compounds (quats or QACs), may be applied as a foam with the same equipment used for detergent foam application. This increases contact time (important for these sanitizers) and visually confirms coverage. Complete coverage is required with any sanitizer, but excessive spraying only wastes chemical.

2-24. Sanitizer Mixing and Application:

- In-line proportioners/applicators;
- Station proportioners/applicators;
  - Hand and footbath sanitizers;
- Foamers;
- Tank sprayers (low pressure); and
- Dips.

Sufficient contact time and coverage is sometimes best assured by the use of sanitizer dip tanks for utensils and equipment parts. As with corrosive detergents, care is needed with many sanitizers to avoid damaging equipment. For control of common soil microorganisms, such as *Listeria* and *E. coli*, footbaths are frequently part of a plant sanitation program. Most often, they are simply trays containing sanitizer solution positioned at room entrances, which coat the soles of footwear and the wheels of carts. Some systems continually replenish the solution or direct the overflow from hand sanitation dips into a footbath. Footbaths must be level to be effective.

Sinks and cleaning stations can be supplied with proportioning devices that mix and deliver sanitizer in the proper concentration. Many designs draw from a bulk container or reservoir, which minimizes maintenance, controls chemical usage and may reduce monitoring. Systems are commercially available which allow the user to select detergent, sanitizer or fresh water when filling a basin or spraying processing room surfaces. Proportioning devices need to be monitored to be sure that they are working properly and delivering the expected concentration of sanitizer. Sanitizers must be used at concentrations that are effective without violating regulatory limits (2-25). Certain sanitizers are commonly applied at higher concentrations when used on floors, cooler walls and other non-food contact surfaces.

Types of sanitizers

Unfortunately no ideal sanitizer exists for every requirement. Some common sanitizers and their advantages and disadvantages are listed in overhead 2-26. Chlorine and products that produce chlorine comprise the largest and most common group of food plant sanitizing agents. Chlorine sanitizers are effective against many types of bacteria and molds. They work well at cool temperatures and tolerate hard water. They are also relatively inexpensive. Household bleach is a solution of sodium hypochlorite; a common form of chlorine, although use of common bleach is prohibited in certain states. Look for labeled instructions since not all sources are approved for use in food processing.

Chlorine exists in more than one chemical state when dissolved in water. The effectiveness of chlorine sanitizers is proportional to the percentage of hypochlorous acid in solution; the most effective
chemical form of chlorine. The percentage of hypochlorous acid increases as alkalinity (pH) is decreased. The pH of some water supplies is artificially elevated, which reduces the effectiveness of chlorine. However, chlorine is very unstable at low pH and may dissipate prematurely without killing bacteria. Also, at a pH below 4.0, chlorine gas (i.e., World War I mustard gas) is formed which is highly toxic and corrosive. For these reasons, chlorine sanitizers are usually applied at alkaline pH or in a formulated form to maintain a near neutral pH. Also, never mix chlorine and ammonia. The mixture could be hazardous.

Chlorine sanitizers have certain disadvantages however. They can be corrosive to equipment, and may form organochlorine by-products of environmental concern in effluent. Chlorine is inherently unstable in solution, requiring frequent monitoring and replenishing to maintain adequate concentration. A common misconception is that the chlorine content of a sanitizer can be confirmed by its odor. Chlorine is chemically tied up in the presence of most soils, hence the need to thoroughly clean and rinse prior to applying sanitizer. A used solution that still smells like chlorine may have little or no active chlorine available for killing microbes.

Of the total chlorine applied, the amount of free chlorine available for killing microorganisms is the amount in excess of that combined (bound) with soils and other compounds. This background level of inactivated, bound chlorine is known as chlorine demand. As chlorine is added to a system, the point at which the chlorine demand is satisfied and free and measurable levels of chlorine persist, is known as the breakpoint. Breakpoint chlorination is the process of using just enough chlorine to achieve a persistent level of measurable chlorine in solution. At times, it may be necessary to add more chlorine to meet chlorine demand. Test strips must be used to determine if proper chlorine levels have been achieved.

### 2-25. Sanitizer Concentrations Commonly Used in Food Plants

<table>
<thead>
<tr>
<th>Sanitizer</th>
<th>Food Contact Surfaces</th>
<th>Non-food Contact Surfaces</th>
<th>Plant Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine</td>
<td>100-200* ppm</td>
<td>400 ppm</td>
<td>3-10 ppm</td>
</tr>
<tr>
<td>Iodine</td>
<td>25* ppm</td>
<td>25 ppm</td>
<td></td>
</tr>
<tr>
<td>Quats</td>
<td>200* ppm</td>
<td>400-800 ppm</td>
<td></td>
</tr>
<tr>
<td>Chlorine dioxide</td>
<td>100-200* †ppm</td>
<td>100-200†ppm</td>
<td>1-3‡ppm</td>
</tr>
<tr>
<td>Peroxyacetic acid</td>
<td>200-315* ppm</td>
<td>200-315</td>
<td></td>
</tr>
</tbody>
</table>

* The higher end of the listed range indicates the maximum concentration permitted without a required rinse (surfaces must drain)
† Includes mix of oxychloro compounds
Source: 21 CFR 178.1010
The hypochlorites are the most common chlorine sanitizers. They are available as liquid concentrates or in dry/granular form. The granular or powdered chlorine products are sometimes referred to as bleaching powders. Do not confuse these with scouring powders, which generally should not be used in food processing facilities. Chlorine also can be injected as a gas directly into designated water lines. This is a low cost option for large operations but is potentially hazardous and requires specially designed equipment. Stabilized organic forms of chlorine are also available. Mixing vinegar or another acid with chlorine sanitizers is occasionally proposed for increasing their efficacy but the practice is not recommended. Not only may the chlorine dissipate prior to making contact with microorganisms but dangerous chlorine gas may form if the solution is excessively acidified.

Chlorine dioxide functions differently from other chlorine-based sanitizers. It does not form hypochlorous acid but dissolves in water to produce a solution possessing strong oxidizing properties. It can be more effective than chlorine in terms of ability to kill or reduce bacteria, and it retains some antimicrobial function in the presence of organic soils. For that reason, it is particularly useful for destroying bacteria in bio-films. It is also less corrosive to stainless steel and less pH sensitive than chlorine. Unfortunately, chlorine dioxide is very unstable and must be generated on-site. It is potentially explosive and very toxic if improperly controlled—important considerations when selecting this sanitizer. A relatively safe method for obtaining chlorine dioxide is by mild acidification of an aqueous solution of sodium chlorite commonly known as stabilized chlorine dioxide (21 CFR 173.325).

### Types of Sanitizers

<table>
<thead>
<tr>
<th>Sanitizer</th>
<th>Forms/Description</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine</td>
<td>Hypochlorites, Chlorine gas, Organic chlorine, e.g., Chloramines</td>
<td>-Kills most types of microorganisms</td>
<td>-May corrode metals and weaken rubber</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Less affected by hard water than some</td>
<td>-Irritating to skin, eyes and throat</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Does not form films</td>
<td>-Unstable, dissipates quickly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Effective at low temperatures</td>
<td>-Liquid chlorine loses strength in storage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Relatively inexpensive</td>
<td>-pH sensitive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Concentration determined by test strips</td>
<td></td>
</tr>
<tr>
<td>Iodophors</td>
<td>Iodine dissolved in surfactant and acid</td>
<td>-Kills most types of microorganisms</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Less affected by organic matter than some</td>
<td>-May stain plastics and porous materials</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Less pH sensitive than chlorine</td>
<td>-Inactivated above 120°F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Concentration determined by test strips</td>
<td>-Reduced effectiveness at alkaline pH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Solution color indicates active sanitizer</td>
<td>-More expensive than hypochlorites</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-May be unsuitable for CIP due to foaming</td>
</tr>
<tr>
<td>Quaternary Ammonium Compounds</td>
<td>Benzalkonium chloride and related compounds, sometimes called quats or QACs</td>
<td>-Non corrosive</td>
<td>-Inactivated by most detergents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Less affected by organic matter than some</td>
<td>-May be ineffective against certain organisms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Residual antimicrobial activity if not rinsed</td>
<td>-May be inactivated by hard water</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Can be applied as foam for visual control</td>
<td>-Effectiveness varies with formulation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Effective against Listeria monocytogenes</td>
<td>-Not as effective at low temp. as some</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Effective for odor control</td>
<td>-May be unsuitable for CIP due to foaming</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Concentration determined by test strips</td>
<td></td>
</tr>
<tr>
<td>Acid-Anionic</td>
<td>Combination of certain surfactants and acids</td>
<td>-Sanitize and acid rinse in one step</td>
<td>-Effectiveness varies with microorganism</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Very stable</td>
<td>-More expensive than some pH sensitive (use below pH 3.0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Less affected by organic matter than some</td>
<td>-Corrodes some metals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Can be applied at high temperature</td>
<td>-May be unsuitable for CIP due to foaming</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Not affected by hard water</td>
<td></td>
</tr>
<tr>
<td>Sanitizer</td>
<td>Forms/Description</td>
<td>Advantages</td>
<td>Disadvantages</td>
</tr>
<tr>
<td>-----------</td>
<td>------------------</td>
<td>------------</td>
<td>--------------</td>
</tr>
</tbody>
</table>
| Peroxy Compounds | Acetic acid and hydrogen peroxide combined to form peroxycetic acid | -Best against bacteria in biofilms  
- Kills most types of microorganisms  
- Relatively stable in use  
- Effective at low temperatures  
- Meets most discharge requirements  
- Low foaming; suitable for CIP | - More expensive than some  
- Inactivated by some metals/organics  
- May corrode some metals  
- Not as effective as some against yeasts and molds. |
| Carboxylic Acid | Fatty acids combined with other acids; sometimes called fatty acid sanitizers | - Kills most types of bacteria  
- Sanitize and acid rinse in one step  
- Low foaming, suitable for CIP  
- Stable in presence of organic matter  
- Less affected by hard water than some | - Inactivated by some detergents  
- pH sensitive (use below pH 3.5)  
- Less effective than chlorine at low temp.  
- May damage non-stainless steel materials  
- Less effective against yeasts and molds than some |
| Chlorine Dioxide | A gas formed on-site and dissolved in solution or by acidification of chlorite and chlorate salts | - Kills most type of microorganisms  
- Stronger oxidizer (sanitizer) than chlorine  
- Less affected by organic matter than some  
- Less corrosive than chlorine  
- Less pH sensitive than some | - Unstable and cannot be stored  
- Potentially explosive and toxic  
- Relatively high initial equipment cost |
| Ozone | A gas formed on-site and dissolved in solution | - Kills most type of microorganisms  
- Stronger oxidizer (sanitizer) than chlorine and chlorine dioxide | - Unstable and cannot be stored  
- May corrode metals and weaken rubber  
- Potentially toxic  
- Inactivated by organic matter (similar to chlorine)  
- pH sensitive  
- More expensive than most |
| Hot Water / Heated Solutions | Water at 170 - 190°F | - Kills most types of microorganisms  
- Penetrates irregular surfaces  
- Suitable for CIP  
- Relatively inexpensive | - May form films or scale on equipment  
- Burn hazard  
- Contact time sensitive; inappropriate for general sanitation |

**Quaternary Ammonium Compounds**, sometimes known as quats or QACs have made a comeback in recent years after generally falling out of favor with many microbiologists. They require a relatively long exposure time to achieve significant kill. This is not always a problem however since they are very stable and will continue to kill bacteria long after most sanitizers lose their effectiveness. Because of this residual effect, even in the presence of some soil, they are often selected for footbaths, floors and cooler surfaces. They are quite effective against the pathogen *Listeria monocytogenes* and are commonly used in facilities that produce ready-to-eat products, such as crabmeat, smoked fish and cooked shrimp. Unfortunately, quats also can be selective in the types of microorganisms they kill. Some food processors who have switched to quats have experienced problems with the establishment of coliform or spoilage organisms in the environment, which may then transfer to products. A strategy which is often successful involves alternating with another sanitizer one or two times per week. Detergents must be thoroughly rinsed from surfaces prior to applying quats or the sanitizer will be chemically neutralized.

**Iodine**-based sanitizers, known as iodophors, are formulated with other compounds to enhance their effectiveness. They offer many desirable features in a sanitizer. They kill most types of microorganisms, including yeasts and molds, even at low concentrations. They tolerate moderate contamination
with organic soils, are less corrosive and pH sensitive than chlorine and are more stable during storage and use. They are also less irritating to skin than chlorine and are often selected for hand dips. Iodophors have an amber to light brown color when properly diluted which can be useful for monitoring since color indicates the presence of active iodine. Test strips are also available for more precise monitoring. The principal disadvantage of iodophors is staining, especially of plastics. The problem is minimized by carefully controlling concentrations. Iodophors take longer to kill microorganisms at low temperatures than does chlorine and is rapidly vaporized and inactivated above 120°F. Iodophors must be specially formulated for use with hard water.

**Acid sanitizers** include **acid-anionic** and **carboxylic and peroxycetic acid** types. Their principle advantage is in applications requiring stability at high temperatures or in the presence of organic matter. Being acids, they remove inorganic soils, such as hard water mineral scale, while sanitizing. They are most commonly used in CIP or mechanical cleaning systems. The carboxylic acid sanitizers, commonly known as fatty acid sanitizers, are generally more effective than acid-anionics against a range of microorganism types. The most recent class of acid sanitizers are the peroxy compounds, or **peroxycetic acid**. Produced by combining hydrogen peroxide and acetic acid, peroxycetic acid is highly effective against most microorganisms of concern to seafood processors, especially in biofilms, which would otherwise protect bacteria. They are fast acting even at low temperatures, tolerate some organic soil and degrade to form environmentally safe byproducts. However, water chemistry is important since these sanitizers are inactivated by certain metal ions, such as iron, and become quite corrosive when mixed with water containing high chloride levels, for example wells with salt intrusion problems.

Other sanitizing agents include ozone, ultraviolet light and hot water. **Ozone** is an unstable oxidizing gas that must be generated on-site, contributing to its relatively high cost. It is a more aggressive sanitizer than chlorine but requires careful monitoring to prevent the release of excessive levels of the toxic gas. Ozone, like chlorine, is dissipated when in contact with organic soils. It can be injected into water systems, as an alternative to chlorine gas, to make it safe for processing.

**Ultraviolet (UV) irradiation** is sometimes used for treating water, air or surfaces that can be positioned in close proximity to UV generating lamps. Ultraviolet does not penetrate cloudy liquids or below the surface of films or solids. It has no residual activity and cannot be pumped or applied onto equipment like most chemical sanitizers.

**Confirming Sanitation**

Monitoring to assure a clean and sanitary processing environment is required by the Seafood HACCP Regulation. Each facility must show evidence, such as completed forms, indicating that appropriate cleaning and sanitation procedures are followed. Consistent results are achieved through development of effective methods, thorough training of employees, management oversight and testing. Evaluation methods usually include some combination of daily and periodic activities. Examples of the former include visual confirmation that company SSOP are followed, and the use of test strips or colorimetric kits for measuring sanitizer concentration (Form 2-8).

Test strips are the most popular method for determining sanitizer concentrations. Most are very rapid, low cost, require no laboratory equipment or chemicals, can be performed on-site, and require very little training to use. Typically, the strips are simply dipped or soaked directly in the solution to be tested. A change in strip color indicates the presence of sanitizer; the shade or intensity of which relating
to concentration. This is determined using a color comparator or chart as a reference. Unfortunately, test strips may not be available for all of the sanitizers used in your facility. Also, they generally provide only an estimate of sanitizer concentration or a concentration range. For more precise measurement, a variety of test kits are available. These often involve adding one or more reagents (laboratory chemicals) to a sample of the solution to be tested. Concentration may relate to the color produced or to the quantity of reagent required to produce a visible change in the sample.

Periodically, the effectiveness of cleaning and sanitizing plant surfaces can be evaluated by using contact plates containing bacterial growth media. These test procedures are very simple and require no special equipment and little training. Most contact plates are simply touched to the surface to be tested (e.g., table tops and door handles) then covered with a protective cap, film or sleeve. After the plates are stored for a couple of days, any detected bacteria will appear as small circles. The number of circles appearing on the plates provide a good indicator of the effectiveness of cleaning and sanitizing efforts. An alternative method involves swabbing an area with a sterile applicator, which is transferred into a liquid medium for plating later or swabbed directly onto a solid growth medium. These methods make excellent training tools for employees and assist in the evaluation of cleaning methods and materials. Because high numbers of bacteria are grown on these plates, safe handling and disposal is essential. Store and view them in an area away from processing areas and soak them in strong sanitizer before disposal. Wash and sanitize hands thoroughly after handling plates.

Microbiological testing is relatively slow and does not reveal problems in time to correct them prior to processing. Recent alternatives, such as luminometry, are gaining acceptance in the food processing industry. Luminometry (bioluminescence) is based on the enzymatic reaction responsible for a firefly’s light. In this testing process, the brightness of light is proportional to the amount of bacteria and food debris on the surface. In a typical test, a food contact surface is swabbed following sanitization. Material picked up on the swab is placed inside an instrument that measures light production. The instrument generates a value related to the quantity of cellular material, such as bacteria. In some instances the residual food can provide a high reading when the microbial load on the surface is quite low. Microbiological techniques, are required for more specific testing such as coliform bacteria count.

2-27. Periodic Confirmations for Sanitization:

- Microbiological Enumeration;
  - Contact plates;
  - Swabs; and
- Luminometry.
2-28. Typical Cleaning and Sanitizing Schedule

For table tops (processing tables, packing tables, etc.) and other surfaces that come directly into contact with the product, XYZ Shrimp Company uses 25 ppm iodine, 100 ppm chlorine or 200 ppm quat sanitizer. At these levels, surfaces do not require rinsing the next day. For non-food contact surfaces, such as floors and walls, sanitizer concentration is doubled. Note that quats have detergent-like properties and may be slick when floors are wet. Some newer generation products, such as peroxyacetic acid sanitizers, have been shown to be highly effective against a broad spectrum of bacteria while complying with environmental discharge standards. Peroxyacetic acid may be substituted as directed on the product label declaration for any of the standard sanitizers previously listed. Manufacturers recommendations are followed closely for all sanitizers. When sanitizers are used in footbaths, dips or as an applied sanitizing solution the concentration is confirmed at least every four hours using test strips.

The following program is implemented for each operation:

A. Truck Beds (for raw shrimp):

Daily:
Inside of truck bodies are rinsed, then sprayed daily with 400 ppm quat after all shrimp are unloaded.

Weekly:
Clean using detergent, then sanitize (equivalent to 200 ppm chlorine).

B. Raw Shrimp Receiving (Daily):

1. Workers are restricted from entering processing area directly from truck off-loading area (footbath, hand-washing and appropriate clothing required).

2. Area is cleaned and sanitized at the end of operations using the five part process. The floors are sanitized using low pressure spray of 400 ppm quat or equivalent Peroxyacetic acid.

3. Plastic crates (shrimp totes) are placed in soak tank containing chlorinated detergent or hand scrubbed with detergent, then rinsed and sanitized with 200 ppm quat or equivalent peroxyacetic acid.

C. Processing Room:

Daily:
1. Product pans, totes, knives, deveining tools and similar implements are placed in a detergent soak tank. At the end of clean-up they are rinsed and dipped in sanitizer (100 ppm chlorine or equivalent peroxyacetic acid or iodophor).
2. Processing waste is removed from area, and tables and floors are dry cleaned.

3. Tables, graders, conveyors, wash tank, etc. are thoroughly cleaned and sanitized using the five part system (note item 4 for exception). Since these are food contact surfaces, a sanitizer concentration of 100 ppm chlorine, 25 ppm iodine, 200 ppm quat or equivalent peroxyacetic acid is used. If process intervals exceed six hours, graders and tables are cleared of product and the surfaces sanitized. Excess sanitizer applied during breaks is removed with paper towels or a sanitized squeegee.

4. The tiled processing table is dry cleaned, rinsed then cleaned with a general purpose (GP) detergent and scrubbed with brushes and/or pads. It is rinsed, then sanitized with low pressure spray application of 100 ppm chlorine, 25 ppm iodine, 200 ppm quat or equivalent peroxyacetic acid. If process intervals exceed six hours, it is cleared of product and the surfaces sanitized. Excess sanitizer applied during breaks is removed with paper towels or a sanitized squeegee.

5. Floors, splash zone of walls (four feet above floor), and sinks are cleaned daily using the five part system and sanitized with 400 ppm quat or other double strength sanitizer (e.g. peroxyacetic acid).

6. Footbaths are located at the outside entrances to the processing area. The bath is maintained at 400 ppm quat. The concentration of quat in the bath is checked at the start of the work day before the workers arrive and every two hours during times of use.

7. Hand dips are located at handwashing stations and in the processing area: approximately one for every 15 employees. They are maintained at 25 ppm iodine using a commercial iodophor. The concentration of iodine in the dips is checked at the start of the work day before the workers arrive and every two hours during times of use.

Weekly:
1. Acid detergent is substituted for alkaline or chlorinated detergents on the wash tank, graders, conveyors and stainless steel tables to remove water scale and brighten surfaces.

D. **Product Cooler (refrigerated staging area):**

Twice Weekly:
1. Dry cleaned after area is emptied of product.

2. Floors sprayed with 400 ppm quat.

3. Pallets are cleaned and sanitized.

Weekly:
Thoroughly cleaned and sanitized using the five part system.
Monthly:
The drip pan from the evaporator is sanitized by pouring quat (400ppm) into the pan. The ceiling is wiped with 400ppm quat.

Annually:
The evaporator is thoroughly cleaned using hand brushes etc. It is sanitized with 400ppm quat. **Be sure electricity is turned off and disconnected.**

F. **Pallets, Dollies, Miscellaneous:**

Daily:
1. Cleaned with detergent and sanitized with 400ppm quat or equivalent.

2. Door and water faucet handles are detergent cleaned daily, hand detailed with mild, abrasive pads and sanitized.

3. Doors and walls are cleaned and sanitized daily in splash zone (four feet to floor) and weekly in higher areas.
Sanitation Control Guide

Entry date: Cleaning and Sanitizing FDA Key Condition No. 2

Concern: Food contact surfaces may appear clean but harbor pathogens

Examples:
Bacteria may be present in crevices, overlapping joints or hidden areas difficult to inspect. Clearly visible surfaces may be coated with invisible biofilms containing bacteria. Some surfaces may be stained with minerals or water scale making visual inspection difficult. Chemicals used for cleaning and sanitizing must be appropriate and effective without harming the equipment, utensils or environment of discharge.

Controls and Monitoring:
Visual check of all food contact surfaces for proper cleaning and sanitation. Use a strong flashlight or other shadow-free lighting source when inspecting hidden areas. Disassemble and inspect food contact equipment to identify areas which may trap soils. Frequency: Daily pre-op for raw seafood line, plus after every break for ready-to-eat lines.

Confirm visual checks with bacterial contact plates or luminometer. Frequency: Monthly or more frequently if results indicate. (note: swabs are used in place of contact plates in areas that are difficult to access). Luminometer — weekly or more frequently if results indicate.

Visually confirm that proper procedures, equipment and chemicals are used for cleaning and sanitizing. Use five-step approach. Use test papers to record proper strength for sanitizers. Frequency: Daily pre-op for raw seafood line, plus after every break for ready-to-eat line.

- Pans, knives, and other utensils are placed in a soak tank containing general purpose detergent (concentration controlled by proportioner). After soaking 30 minutes the items are rinsed and dipped in sanitizer (100 ppm chlorine).
- All processing waste removed from work areas, and tables and floors are dry cleaned. Tables are cleaned with general purpose detergents, followed by rinsing, then exposure to 200 ppm chlorine. Floors, splash zone of walls (4 feet above floor), and sinks are cleaned then sanitized with 400 ppm quats or 200 ppm chlorine.
- Periodically (weekly) use an acid detergent to remove stains and scale
- Periodically switch (monthly) to another class of sanitizer to prevent selecting tolerant types of microorganisms.

Recommended Corrections:
If surfaces are inadequately cleaned, fully reclean and resanitize following the five-step procedures. Check sanitizer concentrations. Train employees semi-annually or more frequently if indicated by monitoring.

Records:
Daily Sanitation Control Record
Contact Plate Record (confirmation)
Employee Training Record
### Sanitation Control Guide

<table>
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<tr>
<th>Entry date:</th>
<th>Processing equipment and utensils</th>
<th>FDA Key Condition No. 2</th>
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**Concern:**
Pits, cavities, cracks, scales or breakage on processing equipment or utensils used as food surfaces.

**Examples:**
Food contact surface is collecting debris, shows signs of rusting or is difficult to clean due to rough or worn surfaces. Pits, cuts and cavities on food processing surface (e.g., food cutting boards). Water scale on surface of processing tables after cleaning and sanitizing due to standing water and high mineral content.

**Controls and Monitoring:**
Examine all food contact surfaces (i.e., tables, flumes, knifes, cutting boards, etc.) for condition and ability to clean and sanitize. Observe inclination of processing tables surface to allow proper drainage.

**Frequency:** Daily pre-op and monthly through entire plant.

**Recommended Corrections:**
Replace or repair food processing surfaces (e.g., cutting boards). While replacing ensure that they are made of hard, nonporous, water impervious synthetic materials that can be cleaned and sanitized.

**Records:**
Daily and Monthly Sanitation Control Records