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DAIRY, FOOD AND ENVIRONMENTAL

Sanitation

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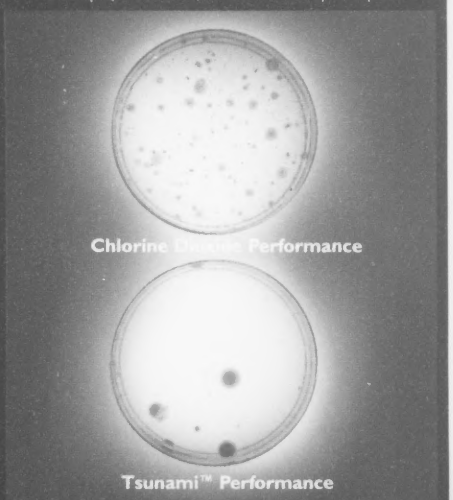

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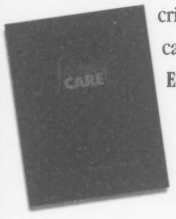

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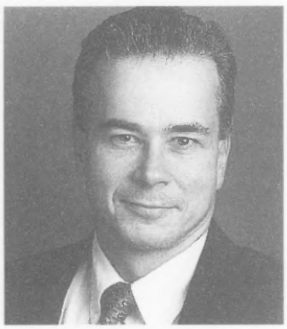


By ROBERT E. BRACKETT
IAMFES President

"Don't be shy, BECOME INVOLVED!"

Last month I wrote about the need for growth in IAMFES. In that column, I stressed the necessity for growth of both attendance at the Annual Meeting as well as in Membership. I also predicted that the 1998 IAMFES Annual Meeting in Nashville would be a resounding success. I am happy to report not only was the Annual Meeting a success, but it was a huge success that exceeded our optimistic expectations in several ways. First, our attendance of 1,152 smashed our previous record of 1,029. Secondly, the Annual Meeting also resulted in 168 new IAMFES Members. This is great news, but there is more to our success than these statistics.

Although the increase in attendees and new members is noteworthy, a less obvious measure of success was increased participation in our Committees and Professional Development Groups (PDGs). It is the Committees and PDGs that are the lifeblood of our Association. They carve out the topics for the following year's program, debate policy for our journals and the Association, and serve as a repository for expertise in food safety and sanitation. Moreover, they have been the traditional training grounds for new leadership in the Association. Without strong Committees and PDGs, IAMFES would be nothing more than a subscription list for the *Journal of Food Protection* and *Dairy, Food and Environmental Sanitation*. If you have not previously been involved in Committees and PDGs, perhaps now is the time for you to begin thinking about doing so.

It may seem odd that I choose to write about Committees and PDGs after a meeting in which participation in these groups actually increased. However, it was comments and questions from attendees who were NOT involved in Committees and PDGs that prompted my addressing this issue. I want to provide an open response to their comments and questions while the Annual Meeting is still a fresh memory. I want to stimulate even greater participation in next year's Meeting.

There are several primary reasons for Members not becoming involved with Committees and PDGs. One reason is that they simply don't understand exactly what the various Committees and PDGs are, how they differ, how they function, and the responsibilities of members and participants. A thorough explanation of these questions is beyond the scope of this column and will be addressed in detail in future *DFES* articles. However, a second and more common reason why some IAMFES Members do not become involved in Committees and PDGs is that they have the mistaken impression they are not "allowed" to attend the Committee or PDG meetings. This couldn't be further from the truth because IAMFES maintains an "open door" policy on participation and involvement in all Committee and PDG meetings.

Some Committees, such as the Standing or Special Committees, are appointed or approved by your

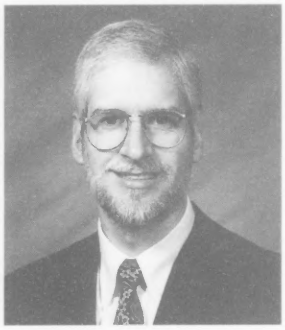
Executive Board for a specific purpose. Members are appointed based on their interest, experience, and willingness to serve. Although actual membership or representation on these Committees is limited to appointees, Committee meetings are completely open and any IAMFES Member is welcome to attend and contribute as non-voting guests if they choose.

In contrast to Committees, PDGs are "special interest" groups whose specific goals or purposes are dictated by the wishes of the PDG members. The good news is that membership is completely open to any IAMFES Member. In other words, one need only attend and participate to be a member. Individuals are encouraged to become members of any and all PDGs in which they believe they can contribute or derive benefit. The only constraint to membership is time! IAMFES provides so many interesting and stimulating PDGs that members sometimes have difficulty making choices as to which PDG meeting to attend. Moreover, the IAMFES staff and Executive Board are working to solve scheduling conflicts that would help minimize this difficulty.

So, if you have been holding back from becoming involved in Committees and PDGs because you felt you didn't "belong," hold back no longer. I want to reemphasize what I've already stated. All IAMFES sponsored meetings are completely open to everyone who wishes to attend. IAMFES needs your ideas, your talent, your energy and your involvement. If you are interested in serving on specific committees, share your interest with committee chairs and any Executive Board member. Get involved and make IAMFES the best Association it can be!

COMMENTARY

FROM THE EXECUTIVE DIRECTOR



By DAVID W. THARP
IAMFES Executive Director

"Through your efforts, the Foundation Fund is much stronger"

Ask and you shall receive. That sounds like an easy concept, but does it really ring true? Well, in the case of the Foundation's 1st Silent Auction, it is very true. In the July President's column, Gale Prince encouraged industry, Affiliates and all IAMFES Members to bring items to the Annual Meeting to be "auctioned" as a fundraiser for the Foundation. We are pleased to report that we had over 40 items donated and excellent participation from attendees at the Meeting. The Foundation raised over $2,000 from the donated items and this will help push the fundraising towards the goal of $100,000 in the year 2000!

As a direct result of the Silent Auction, the Foundation received a $500 contribution. This was in addition to the $2,000 from Auction items. That is the second time in recent history we received a sizeable contribution. May I take a moment to plead with you? Please, please consider sending your contribution to the IAMFES Foundation. The Foundation provides much needed services to IAMFES Members and helps to raise the awareness of our Association. Your contribution, no matter what size, will ensure the continued efforts of the IAMFES Foundation. You may include a contribution with your Membership renewal, or send a separate check to our office. We need your help to reach $100,000!

That being said, let me thank those of you who have helped the Foundation over the years. So far this year, we received more than $3,000 in contributions from Members. Terrific! When I look back three years ago, we received very little in direct Member contributions to the Foundation. Through the vision of Harry Haverland and with the assistance of Board Members, Foundation Fund Members and the IAMFES staff, we have helped the Foundation Fund grow by leaps and bounds. Thanks to those of you who have helped. Through your efforts, the Foundation Fund is much stronger than just a few years ago. You can be proud of the results of your work.

If you are not aware of the projects the Foundation supports, let me help you learn. The Foundation supports 100% of the expense related to our Lending Library of training and educational videotapes. There are over 75 titles on our Lending Library listing and we have more than 300 tapes available for Member use, free of charge! Also supported by the Foundation Fund are travel funds for our speakers' presentations at the Annual Meeting. This program is used where an urgent need is demonstrated and is monitored by our Program Committee and Executive Board. Also at the Annual Meeting, our Ivan Parkin Lecturer is supported by the Foundation and we have been fortunate to attract many well-known leaders in the arena of food safety and protection. The Foundation's support of this Opening Lecture adds a professional touch to our Annual Meeting.

Other programs supported by the Foundation Fund include the Developing Scientist Competition for food science students, shipment of excess Journals to developing countries, and support of the Crumbine Award, which is presented to a local health unit, demonstrating excellence in food protection.

I hope that this helps you become more aware of the IAMFES Foundation and its activities. The Foundation truly helps the Association carry out the mission of "Providing food safety professionals worldwide with a forum to exchange information on protecting the food supply." Again, I encourage you to make a contribution to the Foundation in whatever amount is comfortable for you. Your contribution will be put to good use, I assure you!

In conclusion, we want to thank each of the sponsors who contributed items to the Foundation Fund Silent Auction. Thanks also to everyone who participated in the bidding process and to the highest bidder for each item. We hope that you enjoyed the Auction and we look forward to next year for an even larger selection of unique items!

IAMFES FOUNDATION FUND SILENT AUCTION RESULTS

ITEM	SPONSOR	HIGHEST BIDDER
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1999 Annual Meeting Registration	IAMFES	Dave Henning
33 lb Hickory Smoked Country Ham	Tennessee Affiliate	John Bruhn
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85th Annual Meeting Logo Glass Mug	Qualicon	Henry Atherton
Afghan	Alice Haverland	Dennis Westhoff
Celebrate Tennessee Cookbook	Ruth Fuqua	Janell Percy
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IAMFES Logo Shirt	IAMFES	Donna Christensen
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Imported Cigars	U.S. Tobacco	Chuck Papa
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Italian Lithographs (colored)	John Lupien	Carole Peet
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Ohio Breakfast Kit	Kathy Jones	Carol Deibel
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Wine – Duck Walk Vineyards 1994	California Affiliate	Albert Espinoza
Wine – Geyser Peak 1995	California Affiliate	Bert Bartleson
Wine – Glen Ellen 1996 Chardonnay	California Affiliate	Joe Hinriches
Wine – Guenoc	California Affiliate	Karen Bewig
Wine – Merlot	California Affiliate	Bert Bartleson
Wine – Sterling Vineyards 1994	California Affiliate	Bert Bartleson
Wine – Ventana	California Affiliate	Chuck Lattuada

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Attachment of *Aeromonas hydrophila* to Stainless Steel Surfaces

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SUMMARY

This study evaluated the ability of *Aeromonas hydrophila* to attach to and form biofilms on stainless steel surfaces at different temperatures and incubation times. Following a 3 min exposure, *A. hydrophila* adhered to stainless steel surfaces and was not removed by a 10 s vortex wash regardless of temperature. Biofilm complexity and extracellular material increased at 28°C as incubation time was extended. At 4°C no complex structure was observed. *A. hydrophila* failed to attach to stainless steel at 42°C. Scanning electron microscopy provided information on structure and morphology of cells but was not appropriate for cell quantitation. Glass bead removal of attached cells was rapid and quantitative but provided no information on biofilm structure. Biofilm cell population on stainless steel chips reached 10^5 CFU/chip following 8 days incubation at 28°C. Results show that *A. hydrophila* can easily attach to and colonize stainless steel surfaces, which may impact food quality and safety should control measures fail.

INTRODUCTION

Bacteria present in aquatic environments adhere to various types of biotic or abiotic surfaces. Bacterial attachments range from simple reversible adherences to elaborate bindings involving extracellular anchoring structures *(3, 7, 26)*. Biofilms are of concern in the food processing environment because microorganisms may adhere to and proliferate on poorly cleaned and sanitized food processing surfaces *(13)*. During processing, cells may dislodge from biofilm surfaces *(19)* and contribute to product contamination, which may shorten product shelf-life and increase the potential of transmitting foodborne diseases *(4, 9)*.

Biofilm formation has been studied on many types of materials, including: glass, rubber, polypropylene, stainless steel *(17, 18, 25, 32, 36)* and many plastics *(13)*. Such studies have led to a better understanding of: (1) differences that exist between planktonic and sessile bacterial cells *(27)*, (2) factors influencing attachment of bacterial cells to different surfaces *(12, 17, 31)*, (3) differences between organisms *(34)*, and (4) effects of nutrient and environmental conditions on biofilm formation *(22)*.

A. hydrophila is recognized as an opportunistic pathogen for immunocompetent as well as immunocompromised individuals *(16)*. In humans, this bacterium is known to adhere to and invade intestinal cells, producing in the process enterotoxins and cytotoxins *(33)*. *A. hydrophila* also has been established as a pathogen of cold blooded animals such as amphibians and fish *(11, 14)*. Important sources of *A. hydrophila* in human infections include contaminated water, foods, and nosocomial or hospital-acquired infections *(29)*. Diseases caused by this organism include septicemia *(21)*, fresh water wound infection *(14, 15)*, skin infection *(14)*, gastroenteritis *(1, 2, 35)* corneal ulcer *(10)*, acute and chronic diarrhea *(20)*, and pneumonia *(29)*.

Because we have previously isolated *A. hydrophila* on catfish processing plant equipment *(8)*, the goal of the present study was to evaluate the ability of selected *A. hydrophila* strains to establish biofilms on stainless steel under various incubation durations and temperatures.

MATERIALS AND METHODS

Stainless steel chip preparation

Stainless steel chips (hard cold rolled SAE 1010 steel, Rockwell B-90 No. 2 finish, Small Parts Inc. Miami Lakes, FL) were cut into I × I cm squares and ultrasonically cleaned in 2% enzymatic detergent solution (Terg-A-Zime, Alconox, Inc. New York, NY) for 15 min. Cleaning was done by immersing 100 chips in 200 ml of cleaning solution inside a sonicator for 15 min (Banson, Smith Line Co., Shelton, NC). Chips were then removed, rinsed six times with 500 ml deionized water in a 1000 ml beaker, dried on tissue paper, and sterilized at 121°C for 15 min before use.

Culture preparation

Two strains of *A. hydrophila* were used in this study: a clinical strain (K 144) obtained from Dr. Samuel A. Palumbo (Eastern Regional Research Center, U.S. Department of Agriculture, Philadelphia, PA) and a catfish plant environmental strain (Env) isolated by us in a previous study *(8)*. Stock cultures were maintained on tryptic soy agar (TSA; Difco Laboratories, Detroit, MI). Slants were held at 4°C and subcultured monthly. Prior to use, strains were grown in tryptic soy broth (TSB; Difco) for 24 h at 28°C. Working cultures were obtained by diluting overnight cultures 1:10,000 in TSB, from which 1 ml was transferred to 9 ml TSB to obtain approximately 10^4 CFU/ml.

Preparation of attached cells

Individual chips were added to test tubes (16 × 150 mm; Pyrex, Corning Glassware, Corning, NY) containing 10^4 CFU/ml bacteria in 10 ml TSB. In a preliminary experiment, submerged chips were incubated for 3 and 15 min at 22°C. In additional experiments, chips were incubated at *A. hydrophilla* growth minima (4°C), optima (28°C), and maxima (42°C) temperatures for 4, 8, 12, 24, and 72 h. At designated times, chips were aseptically removed from culture tubes, placed in 10 ml of 0.1 M phosphate buffered saline (PBS; pH 7.2) and mixed with a vortex mixer (Thermolyne, Dubuque, IA) for 10 s. The vortexed chip was held with a sterile forceps and washed with 50 ml of sterile PBS, which was gradually poured over the chip surfaces.

Electron microscopy

Sample preparation for scanning electron microscopy (SEM) involved overnight fixation of chips in 2.5% glutaraldehyde – 0.1 M potassium phosphate buffer solution (pH 7.2 at 4°C) followed by three 15-min rinses, with 5 ml buffer at 20°C used per rinse. Chips were dehydrated in a series of 5 ml graded ethanol concentrations (35, 50, 70, and 95%) for 10 min at each grade. Dehydration was completed with three 15-min rinses in 5 ml 100% ethanol. Chips were then immersed in 5 ml hexamethyldisilazane, which was changed twice at 10 min intervals. Chips were attached to specimen stubs with double sided tape and sputter coated with a layer of gold/palladium under vacuum evaporation for 3 min. Samples were viewed on a JEOL SEM (Joel, Japan) at 20 kV.

The numbers of bacterial cells on chips were estimated by counting ten randomly chosen fields at a magnification of 3200×. Coordinates of fields were computer generated using a random number generator written in Quick Basic (Microsoft Corporation, Bothell, WA). By scaling 1 µm over the length and width of the viewing screen, it was found that each field of view at 3200 × magnification covered an area of 972 µm². Accordingly, the number of cells counted in the ten randomly chosen fields were extrapolated to the total area of the chip (10^8 µm²) using the following equation.

$$N = \frac{T \times A_c}{10\ A_f}$$

N = Total number of cells per chip
T = Total number of cells in 10 fields
A_c = Total chip area (10^8 µm²)
A_f = Viewing field area (972 µm²)

Viable count by cell removal

Attached cells on chips were removed by full-speed vortexing of chips with 0.5 g sterilized microscopic glass beads (0.1 mm; Biospec Products, Inc., Bartlesville, OK) in 10 ml PBS for 45 s *(13, 24, 27)*. Cell enumeration was done by plating 1 ml of diluted wash PBS on aerobic plate count petrifilm (3M, St. Paul, MN) using sterile 0.1% peptone water as diluent. Plates were incubated at 28°C for 2 days prior to colony counting. Generation times of study strains on chips were determined over time intervals during which growth was exponential *(26)*.

Statistical analysis

To study the rate of attachment, a split-split plot design was used. Analysis of variance (ANOVA) was done using mean $\log_{10}$CFU/chip microbial population data at a confidence interval $P<0.05$ using the Statistical Analysis System (SAS Institute, Inc., Cary, NC). Mean values of three replicate experiments were compared using the least significant difference procedure.

RESULTS AND DISCUSSION

SEM analysis

SEM analysis of stainless steel chips exposed for short durations (3 and 15 min) to stationary phase cultures (10^4 CFU/ml) of *A. hydrophila* revealed that attachment occurred following short exposure times (Fig. 1). Observed attachment was randomly dispersed and "irreversible" in that the adopted washing protocol did not dislodge these cells. Control chips dipped in sterile TSB revealed no cells on chip surfaces (result not

Figure 1. *A. hydrophila* strain Env (a) and K 144 (b) attached after 3 min exposure to stainless steel chips at 22°C.

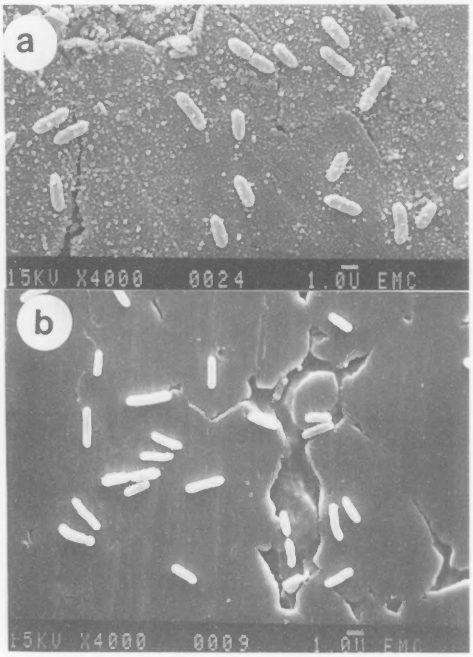
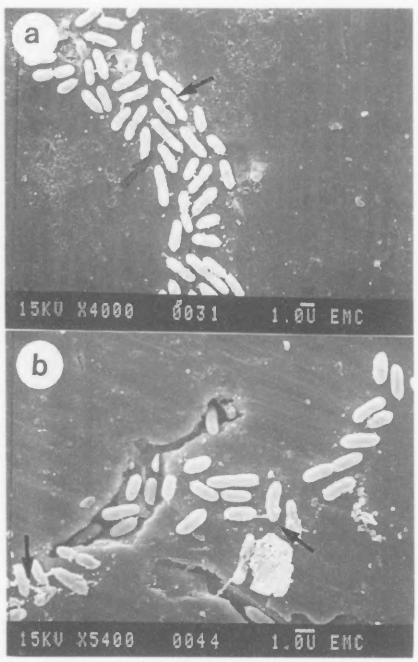


Figure 2. *A. hydraphila* strains Env (a) and K 144 (b) attached after 15 min exposure to stainless steel chips at 22°C. Extracellular materials were produced (see arrow).



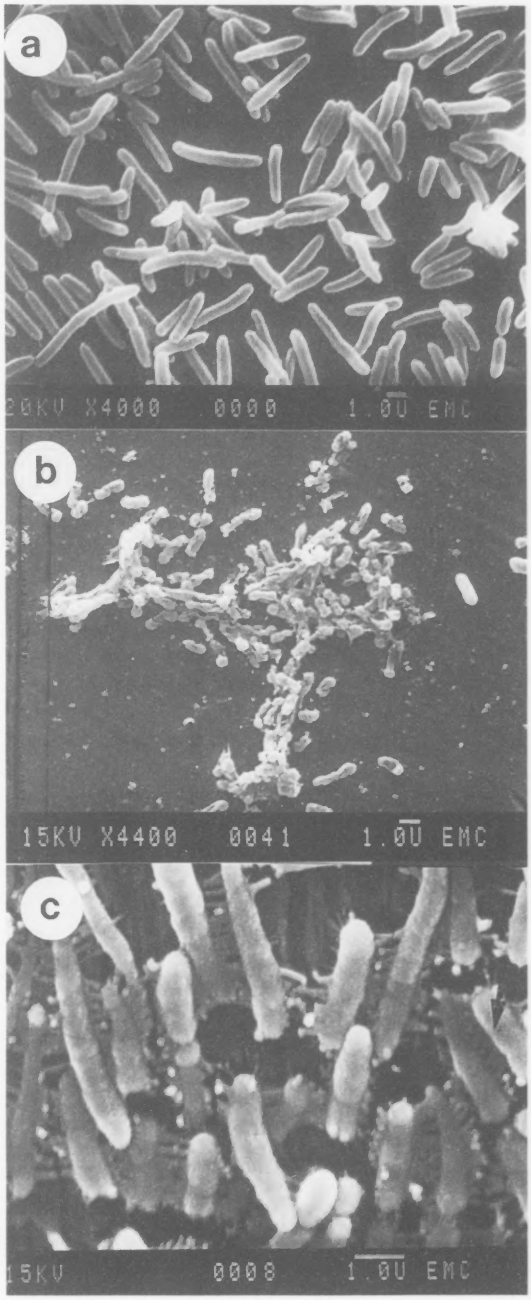
shown); however, crevices and grooves of varying depth and texture were observed on all chips used in this study. Cell attachment occurred in a random fashion that was independent of surface crevices (Fig. 1). This finding was reported earlier for *Listeria monocytogenes* by Mafu et al. *(25)*.

That *A. hydrophila* could strongly and rapidly attach to stainless steel surfaces after short exposure is of importance to food processing facilities at which seafoods and aquaculture products naturally harboring *A. hydrophila* are processed *(1, 5, 8, 23)*. Rapid attachment is an early stage of establishing a microniche for the bacterium to potentially proliferate on surfaces. Although no relationship was observed between attachment and surface texture of stainless steel, surface roughness would render cleaning and sanitation more difficult, because organisms might be imbedded in crevices.

Initial rapid attachment of *A. hydrophila* to stainless steel surfaces under present study conditions may be attributed to several factors, including Van der Waals forces, surface charge, ionic strength, and surface tension *(22)*. Early involvement of extracellular material in anchoring *A. hydrophila* cells cannot be overlooked. Close examination of short exposure micrographs revealed that extracellular attachment structures were observed on preparations that underwent exposures as short as 15 min (Fig. 2). Costerton and Lappin-Scott *(6)* suggested that bacteria become attached to surfaces via cellular appendages such as pili and exopolysaccharides. That extracellular structures were observed after short exposures suggests that *A. hydrophila* surface associations are important precurser events in biofilm development.

In the present experimental design, attachment occurred under favorable nutrient conditions without surface conditioning, which is absorption of macromolecules onto surfaces before bacterial attachment *(3)*. Some investigators suggest that attachment occurs when nutrient supply is adequate, while others sug-

Figure 3. *A. hydrophila* K 144 attached ta stainless steel chips after 8 days at 4°C (a) and at 28°C (b) and (c). Extracellular materials were produced (see arraw).



gest that attachment occurs predominantly when cells are starved *(19)*. It would be interesting in future studies to evaluate attachment of *A. hydrophila* to surfaces under conditions of starvation and surface conditioning.

Extended incubation at 28°C affected the spatial arrangement and structure of attached cells. At 8 days, occasionally complex multi-layer structures were observed (Fig. 3b and 4b) at 28°C while they were not found at incubation periods of 72 h or shorter (Fig. 5). No multilayer structures were observed on chips incubated at 4°C for 8 days (Fig. 3a and 4a). Characklis and Marshall *(3)* explained previously that biofilms were not uniform in time and space. Biofilms can consist of less than a monolayer of cells or can be as thick as 300 to 400 mm *(3)*. Another notable difference that could be detected at long incubation time (8 days) was that more extracellular material was found at 28°C (Fig. 3c and 4c) than at 4°C (3a and 4a).

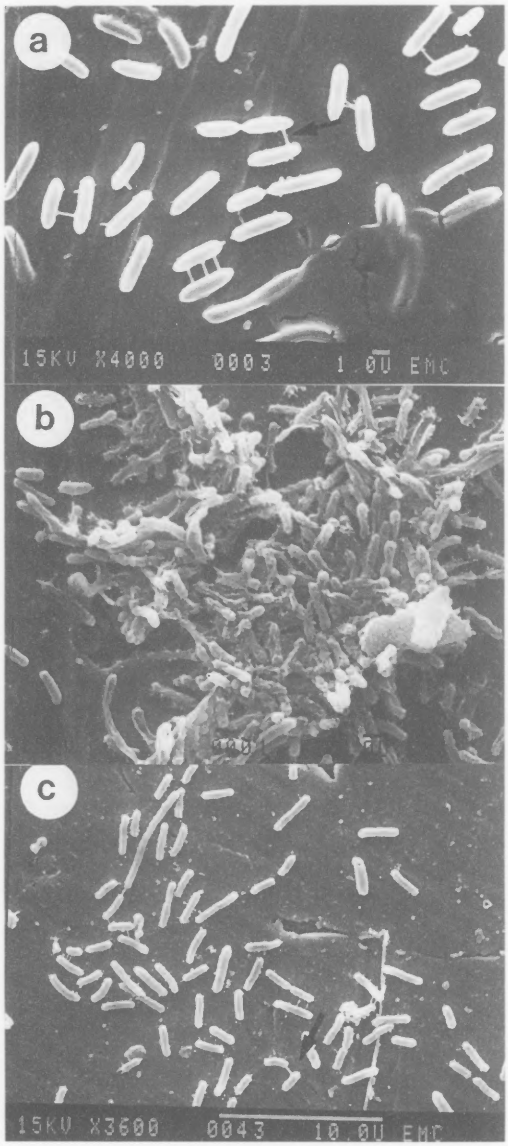
At 42°C, *A. hydrophila* cells were not found on chips, irrespective of the exposure time studied. Occasionally, a few (2 to 3) cells were found on the whole chip, as determined by complete microscopic chip surface scanning. No data was obtained on *A. hydrophila* survival at 42°C.

At optimal growth temperature (28°C), extracellular materials and structure complexity of *A. hydrophila* biofilm increased as incubation time was extended. Results suggested that prolonged exposure on food processing surfaces may result in formation of complex multilayered structures. Based on these results, *A. hydrophila* should be considered a biofilm-forming bacterium because it attached, produced extracellular materials, and developed multilayer structures on stainless steel chips *(3, 6)*. The absence of complex biofilms at 4°C and their presence at 28°C suggest that refrigeration hindered complex biofilm formation.

Cellular morphology

Attached *A. hydrophila* cells appeared rod-like with rounded ends. Measurement of cell size at 22°C revealed that attached K144 cells (length 2.6 μm ± 0.4, width 0.75 μm ± 0.0) were slightly longer and thinner than cells of the Env strain (length 2.2 μm ± 0.5, width 1.0 μm ± 0.0). Observed morphology of *A. hydrophila* was in agreement with earlier observations *(28, 30, 35)*. Cells in pairs were observed, but no particular importance of this morphology was noted compared with single cells. Accordingly, both cell types were involved in early attachment to stainless steel surfaces.

Figure 4. *A. hydrophila* strain Env attached ta stainless steel chips after 8 days at 4°C (a) and at 28°C (b) and (c). Extracellular materials were produced (see arraw).



Extending exposure time of stainless steel chips to *A. hydrophila* culture at different incubation temperatures had no impact on observed cellular morphology, with cells maintaining rod-like shapes. However, differences in cell size were observed. Cells incubated for 8 days at 4°C (Fig. 3a and 4a) were consistently longer than cells incubated at 28°C (Fig. 3b and 4b). This cell elongation may reflect stressed cells at this lower incubation temperature. Attached cells of strain K144 were 4.0 ± 0.76 µm in length and 0.73 ± 0.1 µm in width, while cells of strain Env were 3.7 ± 0.6 µm in length and 0.9 ± 0.1 µm in width at 4°C. At 28°C, K144 cells were 1.8 ± 0.5 µm in length and 0.5 ± 0.04 µm in width, while Env cells were 1.9 ± 0.4 µm in length and 0.75 ± 0.0 µm in width.

Counting with SEM

Attempts to enumerate attached cells using SEM were labor intensive and expensive. Several obstacles were encountered that called into question the reliability of this approach. Accuracy of cell counts obtained using SEM was compromised by several factors. Cell attachment and subsequent biofilm development was not uniformly distributed on stainless steel chips (Fig. 6a). High magnification (3200 ×) was required to count cells reliably; however, the 10 randomly selected sampling areas represented only 1:10,900 of the total area of a chip, which may suggest sampling inadequacy. Finally, at lower magnification, counting cells reliably was not possible due to multiple cell layers (Fig. 6b). Nevertheless, SEM analysis was a valuable tool in studying the structure of *A. hydrophila* attached cells.

Proliferation of attached cells

Enumeration of *A. hydrophila* on stainless steel chips was accomplished by removing attached cells with microscopic glass beads, followed by plate counting *(25, 27)*. Using this approach, population development of attached cells was studied at 4, 28, and 42°C. No cell attachment occurred at 42°C (results not shown); therefore, data presentation will be limited to temperatures of 4 and 28°C.

Stainless steel chips exposed for the same duration to the same inoculum of 10^4 CFU/ml resulted in 100 fold more cells adhering ($P<0.05$) at 28°C than at 4°C (Fig. 7). The number of attached cells continued to increase significantly ($P<0.05$) during the first 12 h of incubation at 28°C, but did not increase thereafter ($P>0.05$) for up to 72 h. Krysinski et al. *(24)* found that numbers of *Listeria monocytogenes* attached on stainless steel chips did not significantly change over a 24 to 72 h period at 25°C.

Figure 5. *A. hydraphila* attached ta stainless steel chips at 28°C strain K 144 after 72 h (a) and strain Env after 24 h (b).

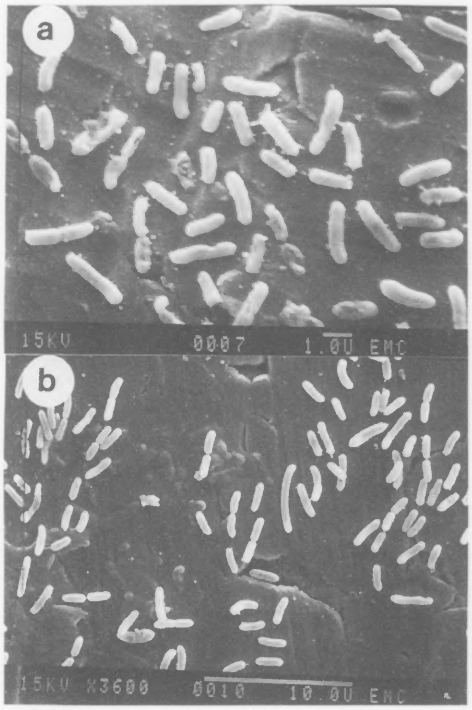
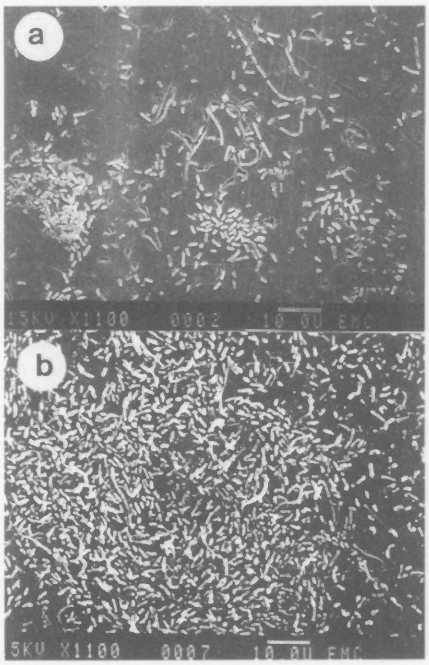


Figure 6. *A. hydraphila* K 144 biafilm cells attached ta stainless steel chips after 8 days at 28°C (a) nan unifarmity af cell attachment, (b) multilayer biafilm cells.



Rates of attached cell population increases observed on chips for both strains were diphasic (Fig. 7). An initial rapid population increase (4 to 12 h, phase 1) was followed by slower development (24 to 72 h, phase 2). At 4°C, the doubling time of attached *A. hydrophila* was 5.0 h in phase 1 and 12.3 h in phase 2. At 28°C, the doubling time was 2.2 h in phase 1 and 39.4 h in phase 2. The observed increase in generation time during the latter part of the incubation period may be attributed to nutrient depletion by planktonic cells that compete with biofilm cells. The shorter generation time of planktonic cells in TSB (1.0 h at 28°C and 7.0 h at 4°C) supports this interpretation (Fig. 8). The observed difference in numbers of attached cells on chips at the two study temperatures could be attributed to a lower cell attachment rate at the lower incubation temperature. Also, the shorter generation time at 28°C could increase the number of cells available for attachment during the 4 h incubation time prior to enumeration. It was difficult to attribute the increase in cell numbers observed on the chips during incubation as being due solely to cell division or to continued attachment of planktonic cells to the chip surface.

The test system utilized in this study revealed rapid attachment of *A. hydrophila* to stainless steel chips, so that a maximal population density of approximately 10^5 CFU/chip was achieved at 8 days at 28°C, with both *A. hydrophila* test strains behaving similarly. Krysinski et al. *(24)* found 10^4 *Listeria monocytogenes* per cm^2 attached on stainless steel chips after 72 h at 25°C.

CONCLUSION

In conclusion, *A. hydrophila* rapidly adhered to stainless steel surfaces and had the potential to form biofilms. At optimal growth temperature (28°C), extracellular structures were involved in the formation of complex and multilayered biofilms. At 4°C, complex biofilms were not

Figure 7. *A. hydrophila* stroins K 144 ond Env biofilm cell populotion development on stoinless steel chips in tryptic soy broth ot 4 ond 28°C.

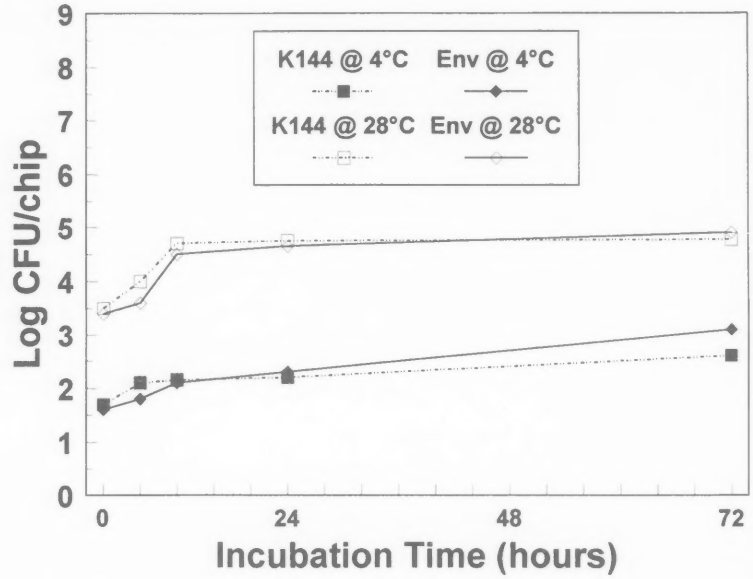
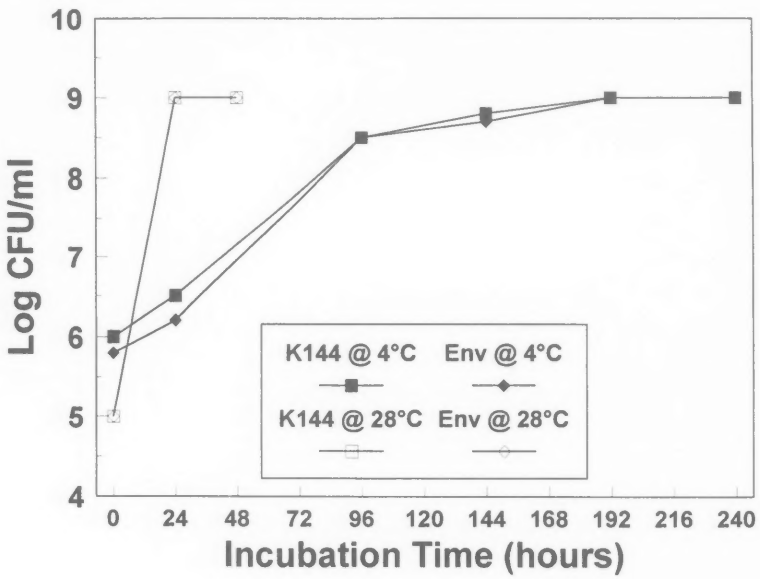


Figure 8. *A. hydrophilo* stroins K 144 ond Env plonktonic populotion development in tryptic soy broth ot 4 ond 28°C.



formed and the observed attached cells consisted totally of single cells. At 42°C, *A. hydrophila* cells failed to adhere to stainless steel surfaces.

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Predominant Microflora on Catfish Processing Equipment

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SUMMARY

Eighty-eight gram negative and nine gram positive bacterial isolates from swab samples of equipment surfaces taken from two catfish processing plants over two replications were identified with the Vitek Identification System and commercially available rapid biochemical kits. Of the identified gram negative isolates, *Aeromonas* spp. represented 37.5%, *Pseudomonas* spp. represented 37.5%, and enteric species (Family Enterobacteriaceae) represented 18.2%. *Aeromonas* spp. were predominant in samples of deheaders, conveyors, and cutting boards but were not isolated from surfaces of automated filleting machines. Predominant microflora on automated filleting machines and a chill tank were *Pseudomonas* spp., followed by enteric species. *Pseudomonas* spp. were isolated from contact surfaces of every processing unit operation sampled in this study. Samples taken from conveyors yielded the greatest microbial diversity. Plants differed in terms of predominant bacterial types, with identified isolates from the larger, automated plant being mostly pseudomonads (47.6%), whereas 56.5% of the identified gram negative isolates from the smaller, manually operated plant were aeromonads. These differences may be related to the difference in frequency of chlorination between the two plants.

INTRODUCTION

Consumption of aquacultured channel catfish (*Ictalurus punctatus*) has increased, as reflected by consumer demands on processing and farming operations *(2)*. As consumption increases, more emphasis will be placed on quality and safety of various products resulting from catfish processing. Human pathogens of concern in aquacultured foods include *Salmonella* spp., *Edwardsiella tarda*, *Clostridium botulinum*, *Listeria monocytogenes*, *Aeromonas hydrophila*, and *Vibrio* spp. *(16)*.

The environment can influence resulting microflora of fish *(16)*. Leung et al. *(11)* sampled surfaces and viscera of catfish as well as water and sediment from ponds for fecal streptococci, fecal coliforms, *Aeromonas hydrophila*, and *Pseudomonas aeruginosa*. No differences between water, sediment, and fish viscera were reported for fecal streptococcal and coliform counts; however, significantly higher counts of aeromonads and pseudomonads were recovered from visceral samples compared with water and sediment *(11)*. Based on a study characterizing the microflora of aquacultured striped bass, Nedoluha and Westhoff *(12)* concluded that the surrounding environment may exert a greater influence on pond microflora than is exerted by the pond environment on fish microflora.

Bacteriological surveys of catfish have involved processed samples, such as fillets. Andrews et al. *(1)* sampled 335 fresh and 342 frozen samples of catfish collected by FDA inspectors from processors in the Southeastern U.S.A. *Salmonella* spp. was isolated from 4.5% of fresh samples and 1.5% of frozen samples. *E. tarda* was isolated from 0.6% of fresh samples. Catfish harvested between July and September had higher incidence of *Salmonella* spp. than those harvested between January and March, indicating seasonal variation in incidence. *Shigella* spp. and *Arizona* spp. were not detected. Fernandes et al. *(6)* also reported seasonal differences in numbers of *E. coli* and *Staphylococcus aureus* from aquacultured channel catfish fillets. Hannah and McCaskey *(7)* surveyed 60 retail catfish fillets from 5 markets in Alabama. *L. monocytogenes* was isolated from 5% of fillets and *Salmonella* spp. from 1.6%. *Escherichia coli* O157:H7 was not detected.

Surveys of processing plant environments can help identify areas likely to contribute to cross-contamination due to high numbers of surface-associated spoilage or pathogenic microorganisms. Núñez *(13)* investigated microbial loads on surfaces at different points in catfish processing plants and reported that the highest aerobic, psychrotrophic, and total coliform counts were from evisceration equipment. Fernandes et al. *(6)* reported differences in counts of *E. coli*, *S. aureus*, and total aerobic, psychrotrophic, and coliform bacteria of catfish fillets collected from catfish processing plants varying in size and process flow.

The objectives of the present study were (1) to characterize bacteria isolated from surfaces of different processing unit operations in catfish plants, (2) to identify areas likely to harbor bacterial spoilers or pathogens, and (3) to identify the predominant microflora associated with food contact surfaces on catfish processing equipment.

MATERIALS AND METHODS

Sampling location

Two commercial catfish processing plants were surveyed twice. The first replication was conducted during late winter and early spring and the second during late spring and early summer. Plant 1 was small and manual, whereas Plant 2 was large and automated. At the first plant, a total of 20 samples were taken: 9 from the deheader/evisceration station, 7 from conveyors following evisceration, 2 from evisceration tubes, and 2 from cutting boards used for hand-trimming/filleting. At the second plant, 19 samples were taken: 4 from the deheader/evisceration station, 6 from conveyors downstream from evisceration, 2 from automated filleting machines, 2 from cutting boards, and 5 from the inside surface of a chill tank.

Isolation of bacteria

Samples were obtained by swabbing equipment surfaces (5.1 cm^2) with 2 perpendicular passes of sterile, cotton swabs (Baxter Healthcare Corporation, McGaw Park, IL). Inoculated swabs were placed in sterile, ten-ml volumes of trypticase soy broth (TSB; Difco, Detroit, MI) contained in plastic test tubes. Tubes were placed in a portable cooler (ca. 5°C) and transported to the laboratory for analysis. Upon arrival, test tubes were placed at 25°C for 24 h for enrichment. Following incubation, isolation streaks of samples were done on selective media and trypticase soy agar (TSA; Difco) and incubated at 32°C for 24 h. Predominant colony types on each medium were described and subcultured following incubation. Selective media used for Plant 1 were Hektoen-Enteric agar (HEA; Difco) and Starch Ampicillin agar (SAA) *(15)* that was made by adding 10 g of starch (Sigma, St. Louis, MO) to 1 liter of rehydrated phenol red agar base (Difco). Ten mg of ampicillin (Sigma) was dissolved in 5 ml of sterile, distilled water, the solution was filter-sterilized with a 0.2 μm sterile filter (Alltech Associates, Inc., Deerfield, IL), and added to the sterile medium. Media for Plant 2 were HEA, SAA, Phenylethanol agar (PEA; Difco), and Mannitol-egg yolk-Polymyxin B agar (MYPA; Difco). Selective media for gram positive bacteria (PEA and MYPA) were added to the isolation protocol for Plant 2 because predominant colony types on TSA from Plant 1 were gram negative bacteria; therefore, to characterize gram positive bacteria from surfaces of catfish processing equipment, isolation streaks of enriched samples were done on PEA and MYPA and incubated at 32°C for 24 h. The second replication of Plant 2 focused on gram negative bacteria only, because the first replication suggested their predominance. Therefore, selective media described above for Plant 1 were used.

Identification of bacteria

Predominant colony types from each medium were subcultured on TSA slants incubated at 32°C for 24 h. Gram, oxidase, and catalase reactions of isolates were determined. Identification was accomplished by use of Gram Negative Identification (GNI) cards and Gram Positive Identification (GPI) cards for the Vitek Jr. Identification System (bioMérieux Vitek, Inc., Hazelwood, MO). For this procedure, isolates were streaked onto 5% sheep blood agar plates (Becton Dickinson and Company, Cockeysville, MA) and incubated at 35°C for less than 24 h prior to testing on the Vitek system. Appropriate McFarland turbidity standards (No. 0.5 – No. 1 for gram positive and No. 1 – No. 2 for gram negative bacteria) were made by use of sterile cotton-tipped swabs (Baxter Healthcare Corporation) and phosphate buffer (bioMérieux Vitek, Inc.). GNI and GPI cards were inoculated according to manufacturer's instructions and loaded into the reader/incubator tray of the Vitek system. Results were obtained within 24 h. Gram negative isolates also were identified using Oxi/Ferm tubes (Becton Dickinson and Company) and Enterotubes (Becton Dickinson and Company). In addition, some gram

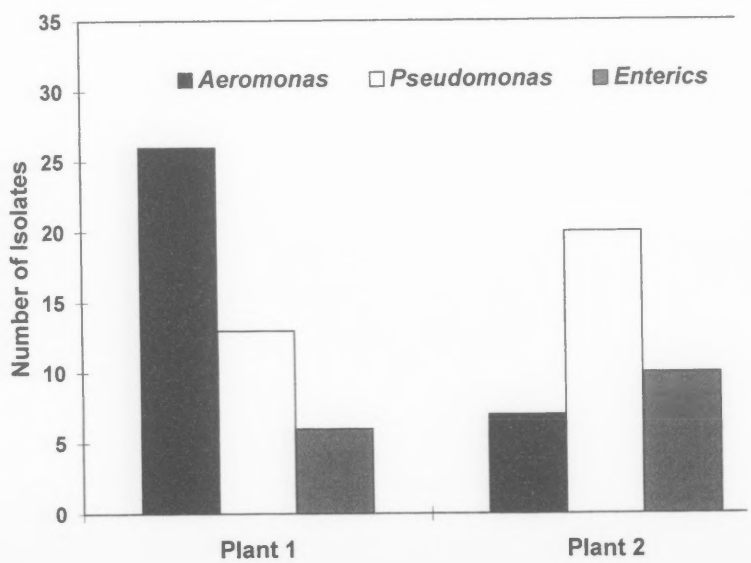
TABLE 1. Site descriptions and incidence of bacterial isolates from plant 1 (manual)

	Isolates				
Site description	*Aeromonas*	*Pseudomonas*	*Enterobacteriaceae*	*Plesiomonas*	Total
Deheader	12 (60%)	6 (30%)	1 (5%)	1 (5%)	20
Conveyor	8 (50%)	5 (31%)	3 (19%)	0	16
Cutting Board	3 (60%)	1 (20%)	1 (20%)	0	5
Eviscerator Tube	3 (60%)	1 (20%)	1 (20%)	0	5

TABLE 2. Site descriptions and incidence of bacterial isolates from plant 2 (automated)

	Isolates				
Site description	*Aeromonas*	*Pseudomonas*	*Enterobacteriaceae*	*Acinetobacter*	Total
Deheader	2 (20%)	5 (50%)	2 (20%)	1 (10%)	10
Conveyor	2 (20%)	3 (30%)	3 (30%)	2 (20%)	10
Chill Tank	2 (13%)	9 (56%)	4 (25%)	1 (6%)	16
Filleter	0	2 (67%)	1 (33%)	0	3
Cutting Board	1 (33%)	1 (33%)	0	1 (33%)	3

Figure 1. Numbers of *Aeromonas* spp. *Pseudomonas* spp., ond enterics (Enterobocterioceae) for two cotfish processing plonts.



positive isolates were identified using Staph-Ident, API 20 Strep, and API Listeria kits (bioMérieux Vitek, Inc.). Gram negative isolates from the second replication of the study were identified at least to genus using Oxi/Ferm tubes and Enterotubes. Biochemical identification analyses were performed as recommended by manufacturers.

RESULTS

A total of 50 gram negative isolates were obtained from equipment samples taken at Plant 1, and 56 gram negative and 16 gram positive isolates were obtained from samples taken at Plant 2. Of the isolates from Plant 1, 8.0% remained unidentified. From Plant 2, 25.0% of gram negative isolates and 43.8% of gram positive isolates remained unidentified. The following genera or species were identified: *Aeromonas* spp. (including *A. hydrophila*), *Pseudomonas* spp., *Acinetobacter* spp., *Providencia alcaligenes*, *Citrobacter freundii*, *Hafnia alvei*, *Plesiomonas shigelloides*, *Edwardsiella tarda*, *Morganella (Proteus) morganii*, *Enterobacter* spp., *Enterococcus* spp., *Staphylococcus* spp., *Streptococcus* spp., and *Bacillus* spp.

The isolates that were identified differed between processing plants (Fig. 1). Gram negative isolates from samples taken at Plant 1 were largely aeromonads (56.5%), whereas pseudomonads represented 28.3% of the isolates. In contrast, gram negative isolates from Plant 2 were predominantly pseudomonads (47.6%), with *Aeromonas* spp. representing 16.7%. Differing predominant microflora between Plants 1 and 2 were present for both replications.

Tables 1 and 2 list numbers of identified gram negative isolates and corresponding percentages based on the number of identified gram negative isolates from each site sampled at Plants 1 and 2. Gram positive microflora characterization, which was done at Plant 2 during the first replication, showed that most isolates were cocci and located on conveyors. One gram positive isolate from a

deheader sample was identified as *Enterococcus* sp., as was one isolated from a sample taken from a conveyor. Two isolates from conveyor samples were identified as staphylococci. Two isolates from conveyor samples were identified as *Bacillus* spp., and one isolate obtained from a conveyor sample was identified as *Streptococcus* sp. One *Staphylococcus* sp. isolate also was obtained from a sample taken from a cutting board, and one gram positive isolate from a filleting machine was identified as *Streptococcus* sp.

Overall, for both plants combined, the largest percentages of the eighty-eight identified gram negative isolates were *Pseudomonas* spp. (37.5%) and *Aeromonas* spp. (37.5%), followed by species of Enterobacteriaceae (18.2%). Aeromonads represented 46.7% and 38.5% of the identified gram negative isolates recovered from swab samples taken from deheaders and conveyors, respectively. Pseudomonads represented 36.7% and 30.8% of the identified isolates from samples obtained from deheaders and conveyors, respectively. Coliforms and gram positive bacteria comprised a minor portion of the identified isolates. Importantly, *L. monocytogenes*, *Salmonella* spp., and other enteric pathogens were not isolated in this study.

DISCUSSION

Results of this study demonstrate the difficulty of identifying environmental isolates with the use of commercially available methods developed primarily for identification of clinical, pathogenic isolates. This was particularly true for the Vitek Jr. Identification System. Kleiss et al. *(10)* compared this automatic system with manual biochemical kits available through bioMérieux and found that staphylococci identifications matched on only 24% of the environmental samples taken from food processing plants, whereas 80% of the samples matched for coliforms.

Another problematic aspect of automatic systems is identifying isolates to species. For example, 9 *Aeromonas* spp. isolates were obtained from the deheader at Plant 1 during the first replication of this study. Four of these were identified by the Vitek system as *A. sobria* and the remaining five as *A. hydrophila/caviae*. Vitek system confidence levels were 98% for *A. sobria* and 72% for *A. hydrophila/caviae*. Voges-Proskauer reactions were required to separate *A. caviae* and *A. hydrophila*. The difficulty in identifying *Aeromonas* spp. based on phenotypic tests was addressed by Kaznowski *(9)*, who determined useful phenotypic biochemical tests for distinguishing *Aeromonas* spp. and concluded that identification of certain strains required molecular approaches.

A study of retail catfish fillets reported a low incidence of *L. monocytogenes* and *Salmonella* spp. *(7)*, which is consistent with present results. Recognized human pathogens, *A. hydrophila* and *E. tarda*, were isolated in the present study, but *E. tarda* represented only 1.1% of the identified gram negative isolates. Wyatt et al. *(18)* reported that 79% of fresh catfish carcasses tested by means of selective enrichment with medium containing high concentrations of bile salts were positive for *E. tarda*. The non-selective enrichment used in the present study may have allowed predominant microorganisms to out-compete *E. tarda*.

Aeromonas spp. has been recovered from numerous natural aquatic environments *(8)* and drinking water *(4)*. The observed isolation frequency for *Aeromonas* spp. in catfish processing plants reflects the influence that microbes originating in aquatic environments (freshwater ponds in the case of catfish) possibly can have on types of microorganisms in fish or seafood processing plant environments. Also, studies of other food processing environments have reported high incidences of *A. hydrophila*. Okrend et al. *(14)* reported that the majority of retail pork, beef, and poultry sampled were positive for aeromonads. Barnhart et al. *(5)* surveyed a poultry processing plant for *A. hydrophila* and found this bacterium in over 90% of carcass and chill water samples. Further, the presence and level of *A. hydrophila* was not correlated with results of common microbiological tests *(5)*.

Seasonal variation with respect to predominant microflora of catfish processing equipment surfaces was not observed. Seasonal variation has been reported for the incidence of *Salmonella* spp. *(1)* and numbers of *E. coli* and *S. aureus (6)* recovered from channel catfish fillets.

Núñez *(13)* reported that larger, automated plants manufactured catfish fillets with lower microbial numbers than smaller, manually operated plants, possibly because of superior sanitization. However, Fernandes et al. *(6)* reported lower microbial numbers in channel catfish fillets collected from a small processing plant. Microbial quality did not differ for catfish fillets collected from medium and large processing plants *(6)*. Differences in predominant environmental microflora between plants reported in the present study may be due to differences in frequency of sanitizer application to processing equipment surfaces. Both plants surveyed in this study sanitized equipment surfaces with industrial sodium hypochlorite solutions. Employees in Plant 1 (manual) cleaned and sanitized equipment at the end of a processing day, while those in Plant 2 (automated) sprayed sanitizer on equipment surfaces using tank sprayers during employee break periods in addition to cleaning and sanitizing after processing.

In a study comparing species of multiple antibiotic resistant in bacteria isolated from raw and chlorinated distribution waters, Armstrong et al. *(4)* reported that the incidence of gram negative, nonfermentative rods (including *Pseudomonas/Alcaligenes* group) increased from 38.1% of the total number of isolates from raw water to 55.7% in drinking water supplies. On the other hand, the percentage of gram negative, fermentative rods (including *Aeromonas* spp.) decreased from 57.1% in untreated water to 3.8% in treated water *(4)*. Similar results also were reported from a different study by

Armstrong et al. *(3)*, with the percentage of *Pseudomonas/Alcaligenes* group increasing from 6.9% to 35.7% of the total number of isolates from river water and treated water from the same river system, respectively. They also reported a decrease from 2.0% to 0% in percentage of *Aeromonas* spp. in treated river water samples. These results suggest that *Pseudomonas* spp. may be more resistant to chlorine than *Aeromonas* spp.; therefore, frequent sanitizing with chlorinated agents may select for predominance of pseudomonads in the processing environment. If so, the presence of *Aeromonas* spp. may indicate less frequent sanitation of catfish processing equipment.

Three critical control points in catfish processing have been identified: receiving, weighing-packing-labeling, and iced storage of finished product *(13)*. These processing points were not sampled in our study. Cross-contamination is a concern at deheading/evisceration, skinning, and/or filleting steps; however, conveyors also can provide sites that may be difficult or even overlooked in cleaning and sanitation procedures. Process flow has been reported to influence microflora of channel catfish fillets *(6, 17)*. Importantly, the plants surveyed in the present study differed in process flow; however, this fact would not explain differences between Plants 1 and 2 in predominating microflora of deheaders, since this station was first in both process flows.

In conclusion, bacteria identified from catfish processing equipment surfaces would not likely constitute a food safety concern, with the possible exceptions of *A. hydrophila* and *E. tarda*. Effective systems to identify plant environments likely to harbor potential human pathogens and to ensure proper cleaning and sanitizing practices are necessary for the manufacture of safe products. The results of this study supply important information regarding processing microflora that may affect aquacultured catfish quality and safety.

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Sixth in a series of articles related to *"Spoilage of Acid and Acidified Foods by Sporeforming Microorganisms"* presented at the Institute of Food Technologists 1997 Annual Meeting held in Orlando, FL

Spoilage of Acidic Products by *Bacillus* Species

John H. Hanlin

SUMMARY

A number of sporeforming microorganisms of the genus *Bacillus* show considerable resistance to acidic conditions and are able to grow at pH values below 4.6. These organisms are of particular concern in the production of both acid and acidified food products because of (a) their ubiquity in soil and on vegetables, fruit and spice, (b) their ability to grow at low pH values, (c) the heat resistance of their spores, and (d) their degree of thermophily. *Bacillus coagulans* is probably the most studied member of the acid tolerant bacilli (ATB) group; however, other species such as *Bacillus licheniformis* and *Bacillus polymyxa* are frequently encountered. Members of the ATB group are resistant to acid and can grow at pH values close to 3.8. Reported spore $D_{100°C}$ -values, for *Bacillus coagulans* range from 0.7 to 7 minutes.

This review will describe the growth of ATB at low pH values, i.e., below 4.6, and the heat resistance of their spores. The impact of multiple hurdles or barriers (including organic acids and food grade preservatives) on the minimum pH for growth and on spore D-value will be addressed. While ATB are generally considered to cause economic spoilage, a condition known as metabiosis can arise, which may present an opportunity for microorganisms of public health significance to grow. The metabiotic effect ascribed to both *B. coagulans* and *B. licheniformis* is reviewed.

INTRODUCTION

The acid tolerant bacilli (ATB) are an important group of microorganisms in the food industry. Although they exhibit considerable diversity from a phylogenetic perspective, they share two important traits of significance to the food industry:

(a) they have the ability to grow in foods with pH values be low 4.6, and
(b) they produce heat-resistant endospores.

It is these characteristics and their ubiquity in the environment (soil, fresh produce and spices) that confer upon ATB the ability to cause economic spoilage in acid and acidified foods.

The degree of thermal processing delivered to low-acid foods in hermetically sealed containers is generally sufficient to inactivate all but the most heat-resistant thermophilic sporeformers. Acidic foods in hermetically sealed containers may receive a thermal process less extreme than that delivered to low-acid foods; thus growth of ATB is often associated with economic spoilage in foods or food ingredients with pH values below 4.6. Other characteristics of ATB include:

(a) growth under aerobic or facultative anaerobic conditions, and
(b) growth at mesophilic or facultative thermophilic temperatures.

TABLE 1. Degree of undissociation of acetic acid and lactic acid at pH 4.0

Organic Acid	pK	% undissoc. at pH 4.0
Acetic	4.76	84.5
Lactic	3.08	39.2

Although the archetypal ATB is *Bacillus coagulans*, other bacilli are capable of growing in acidic foods. They include *Bacillus licheniformis*, *Bacillus polymyxa*, *Bacillus macerans*, *Bacillus pumilis*, and *Bacillus subtilis*.

GROWTH OF ATB AT LOW PH VALUES

Foods may be classified according to their pH value. Those foods with a pH value above 4.6 are termed low-acid, whereas those with a pH of 4.6 or below are termed acid or acidified foods. The U.S. Code of Federal Regulations defines acid foods as "foods that have a natural pH of 4.6 or below." Acidified foods are defined as "low acid foods to which acid(s) or acid food(s) are added" that have a water activity > 0.85 and a finished equilibrium pH of 4.6 or below *(3)*.

Members of the *Bacillus* genus can grow over a wide pH range. Although strains of ATB also grow over a wide pH range, including pH values below 4.6, they are perhaps best known for being able to grow in acidic conditions. Rarely does a situation exist in which ATB are exposed solely to a low concentration of H^+ ions in a food product; therefore, identifying a minimum pH for growth of ATB is an arduous task. Foods comprise a complex series of microoenvironments, and factors such as buffering capacity, titratable acidity, percent moisture, A_w, the presence of organic acids for flavor and taste, and nutritional makeup significantly impact microbial growth. In addition to these factors, the condition of the microorganism or culture is equally important. The state of the culture can be defined in terms of culture history, the concentration of microorganisms in the sample under study, their physiological state (vegetative cell or spore) and any previous injury the cells or spores may have received. Nevertheless, studies show that the minimum pH for growth of ATB is between 3.8 and 3.9 *(17, 22)*.

Two studies in particular underscore the importance of inoculum size in determining the minimum pH for growth. Rice and Pedersen *(16)* showed that the minimum pH for growth for spores of *B. coagulans* strain 713 was 4.2 at a high inoculum level (10^6 CFU/ml) but increased to pH 4.5 when the inoculum level was 10^2 CFU/ml. Similarly, Rodrigo et al. *(17)* reported the minimum pH for growth for about 10^6 CFU/ml as 3.93 whereas 4.5 was the lowest pH at which growth occurred for about 10^2 CFU/ml.

OTHER ANTIMICROBIAL HURDLES IN ACIDIC FOODS

Product pH is seldom the sole antimicrobial hurdle in an acidic food. Acidic foods often contain one or more organic acids, and these acids possess important antimicrobial properties. Organic acids such as acetic or citric acid exist in either an undissociated (R-COOH) or dissociated ($R\text{-}COO^- + H^+$) state, and these forms exhibit different antimicrobial properties. The ratio of the undissociated to the dissociated form is a function of the pH of their environment. The pH at which the ratio is 50:50 is defined as the pK *(8)*. As the pH is decreased below the pK, more of the organic acid exists in the undisocciated form. This form is able to cross the cell membrane where, in the higher pH environment within a cell, it will dissociate and release free H^+ ions. The H^+ ions cause cell acidosis, which leads to impairment of enzymatic reactions, protein synthesis and the proton motive force *(6)*.

Acetic acid is often considered to be the most antimicrobial organic acid in widespread use. It achieves this, in part, because of its pK value of 4.76. At pH values below 4.76, more than 50% of the acid is in the undissociated form. Table 1 illustrates why acetic acid exhibits a greater degree of antimicrobial activity compared with lactic acid.

Studies at the Campden & Chorleywood Food and Drink Association illustrate the impact of common organic acids on the minimum pH for growth of a mixed culture of ATB. Banks et al. *(4)* evaluated the antimicrobial impact of acetic acid compared to citric acid at the same pH values. They showed that the minimum pH for growth in trypticase soy broth, (TSB) was pH 4.5 when the TSB was acidified with 0.5% citric acid. In the presence of 0.5% acetic acid, the minimum pH for growth was 5.1. Their data support the hypothesis that acetic acid generally displays greater antagonism toward ATB than citric acid or lactic acid *(4)*.

The incorporation of a third hurdle adds an additional level of complexity. This is shown by an increase in the minimum pH at which growth can be sustained. The minimum pH at which spores of ATB would germinate and outgrow in 0.5% citric acid plus 1 mg/ml potassium sorbate was 5.4, but this increased to 5.7 in the presence of 2 mg/ml potassium sorbate *(4)*. Similarly, in the presence of 0.5% acetic acid, the pH minima with 1 or 2 mg/ml potassium sorbate were reported as pH 5.7 and 6.0, respectively. The addition of a fourth hurdle further impairs the ability of ATB to grow at low pH values and was quantified in

TABLE 2. Impact of cumulative hurdles or barriers on the minimum pH for growth of acid tolerant bacilli in trypticase soy broth inoculated with 10^6 spores/ml and incubated at 30°C (data from 4)

Hurdle*	Hurdle Description	Minimum pH for Growth (# of days)
pH	Impact of free H^+ ions	<4.2 (4 days)
+ 10^2 spores/ml	Reduction in inoculum level	4.5 (1 day)
+ 0.5% acetic acid	Addition of organic acid	4.5 (29 days)
+ 1 mg/ml K sorbate	Addition of a preservative	5.4 (42 days)
+ 12°C	Reduction in temperature	> 6.0

*Cumulative impact of new hurdle on top of previous hurdle(s), e.g. hurdle of K sorbate addition on top of pH, reduced spore load and acetic acid.

Banks' observation that the minimum pH for growth continued to climb as additional hurdles were presented to the microorganism. Table 2 shows the impact of incremental hurdles on the minimum pH for growth.

HEAT RESISTANCE OF ATB SPORES

Bacterial spores, including those of ATB, are several orders of magnitude more heat-resistant than their progenitor vegetative cells. Their level of heat resistance has traditionally been characterized in terms of D-value and *z*-value. The D-value of a population of spores describes the time (minutes) required at a specified temperature to inactivate 1 $\log_{10}$ (90%) of the spore population, while the *z*-value connotes the temperature change needed to increase or decrease the D-value tenfold *(5)*. For example, if the D-value is 1 minute at 100°C and the *z*-value is 10°C, the same population of spores would be expected to exhibit a $D_{90°C}$ of 10 min and a $D_{110°C}$ of 0.1 min.

The ability of a sporeformer to survive a heat treatment depends on many factors, including choice of strain, temperature of sporulation, nutritional environment of the sporulation medium, and the methodology used to measure spore heat resistance. A number of methods are generally used to quantify spore D and *z*-values. The methods most frequently used are:

(a) heating spores in a defined medium and plating for recovery on agar,
(b) heating spores in a food product and plating for recovery on agar, and
(c) heating and recovering spores in a food product.

The pH of the heating and recovery menstruum, the temperature and nutritional profile of the recovery medium, and the presence or absence of inhibitors such as salt or organic acids are all factors that significantly impact spore heat resistance *(7, 18)*. Differences in methodology between laboratories make it difficult to compare spore D-values from different studies. Nevertheless, spores of ATB are extremely heat resistant with $D_{100°C}$-values sometimes in excess of 1 minute *(9)*.

A maxim of spore heat resistance theory is that a spore's D-value is decreased in lower pH environments. The D-value for *B. coagulans* at pH 4.3 was about 20 to 25% lower than at pH 4.5 at both 85°C and 95°F *(17)*. Mallidis et al. *(10)* also showed the effect of heating menstruum pH on the D-value of *B. coagulans* spores. At 100°C, spore D-values in media with pH values of 7.0, 4.5, and 4.2 were 21.0, 4.9, and 4.15 minutes, respectively. In double concentrated tomato paste, the D-value of *B. coagulans* at 90°C was reported to be 3.2 min *(19)*. In this study, spores were heated in concentrated tomato paste at a pH of 3.98 and recovered on agar. Figure 1 represents a compilation of thermal inactivation data from several sources for spores of *B. coagulans*. It is immediately evident that there may be as much as a 10-fold difference from one study to another in D-value at a given temperature. These differences are due to strain variation, sporulation conditions, and conditions of the assay (pH, salt etc.).

EFFECT OF ORGANIC ACIDS ON SPORE HEAT RESISTANCE

Organic acids not only affect the growth of ATB, they also significantly alter their D-values. Two different studies clearly demonstrate the effects of this phenomenon on spores of ATB. Lynch and Potter *(9)* studied the effects of common acidulants on thermal inactivation of *B. coagulans* spores. Spores were heated in a frankfurter emulsion slurry (acidified to pH 4.2 or 4.5 with one of several organic acids) and recovered on thermoacidurans agar supplemented with 0.1% soluble starch. In a similar study, Palop et al. *(15)* evaluated the effect of the same organic acids on the D-value of *B. coagulans* spores. Spores were heated in homogenized asparagus acidified to pH 4.0 with either acetic, citric, malic or lactic acid or HCl and recovered in nutrient agar with dextrose. Results of both studies are shown in Table 3. It is of interest to note that in both studies, lactic and acetic acids sensitized *B. coagulans* spores to heat. Furthermore, the rank order of effectiveness was the same in both studies: Acetic acid was the most active and was able to reduce spore D-value by 46 to 81%.

The level of heat resistance exhibited by spores of other ATB species is similar to that of *B. coagulans*.

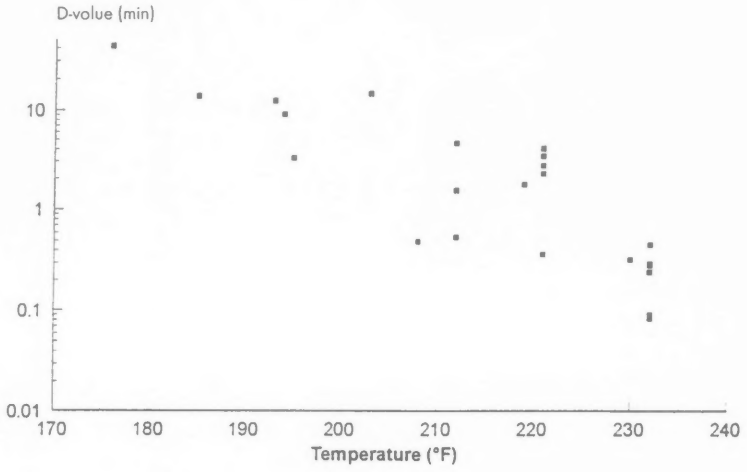
TABLE 3. Impact of acids on the D-value of spores of *B. coagulans*

Acidulant	D-value of *B. coagulans* spores (105°C)*	(111°C)**
Citric Acid	4.09	0.45
HCl	3.92	0.28
Malic Acid	3.35	0.24
Lactic Acid	2.68	0.09
Acetic Acid	2.22	0.08

* ref. 9

** ref. 15

Figure 1. Thermol inoctivotion curve for *B. coogulans* compiled from published studies (odopted from *9; 10; 17; 19; 21; 23; 24).*



Montville and Sapers *(13)* reported D-values in tomato of about 2 min at 100°C and 4 min at 95°C for spores of *B. licheniformis*. D-values at 90, 95 and 100°C for the same spore-former were 23.9, 11.8 and 5.8 min respectively when spores were heated in tomato juice at pH 4.4 and recovered on nutrient agar *(18)*. In comparison, spores of *B. subtilis* had reported D-values at 90, 95 and 100°C of 29.5, 15.8 and 5.7 min, respectively, under similar heating and recovery conditions *(18)*.

THE METABIOTIC EFFECT

The growth of ATB in foods or ingredients has not generally been associated with foodborne disease, primarily because of the acidic nature of foods associated with ATB spoilage and the depression of pH usually ascribed to ATB growth. Acid production, however, is not always a distinguishing characteristic of ATB growth. Several reports in the literature describe the ability of ATB to elevate the pH of an acidic food above pH 4.6, producing a low-acid environment. This phenomenon, in which one microorganism can alter the environmental conditions to the extent where another microorganism can grow, is known as "metabiosis" *(12, 14)*.

Several studies in the literature have reported that ATB have elevated the pH of acidic foods above 4.6 to the point that growth of *C. botulinum* is a concern. As early as 1941, Slocum and coworkers isolated aerobic bacilli from home canned tomatoes implicated in an outbreak of botulism *(20)*. Montville demonstrated that *B. licheniformis* could raise the pH of a model system from 4.4 to values close to and above neutrality *(12)*. He also showed that, when *B. licheniformis* and *C. botulinum* were co-inoculated at low levels, toxin production was evident *(12)*.

Actively growing vegetative cells of *B. coagulans* have also been reported to raise the pH of an acidic substrate *(2)*. This strain failed to grow at pH 4.2 but grew robustly at pH 4.5 and elevated the pH of tomato juice to 5.4 within 21 days. Rodriguez et al. *(18)* reported the metabiotic effect for *B. licheniformis* as well as for *B. subtilis*. In both instances the pH of the tomato juice was elevated to at least pH 8.0.

The exact mechanism by which some ATB strains can raise the pH of a substrate is unclear; however, the production of 2,3-butandiol and glycerol may be involved. Al Dujaili and Anderson *(1)* reported that 23% of their ATB isolates were able to elevate the pH of a substrate. They developed a convenient screening tool in which bromocresol purple was incorporated into *Bacillus* Tomato Juice Agar. The colonies that were able to elevate pH produced purple zones in the yellow acidified medium.

The heat resistance of spores of ATB species capable of eliciting a metabiotic effect appears to be similar to that of *B. coagulans*. D-values at 100°C of 1.5 to 5.8 minutes have been reported and are similar to those reported for non-metabiotic strains in the literature *(13, 18)*. Spore D-values at 85, 90, 95°C of

18.3, 7.5, 5.1 respectively have been reported for *B. licheniformis (13)*.

CONCLUSION

ATB and their spores are an important group of microorganisms, especially in acidic products that are shelf stable. Some of these ATB can grow at pH values as low 3.8; however, the minimum pH for growth depends on a number of factors, e.g., other antimicrobial hurdles and levels of inoculum. The ATB do not appear to grow at the low pH values at which *Alicyclobacillus* spp. are reported to grow; however, spores of ATB strains appear to be considerably more heat resistant *(11)*.

Although ATB are generally associated with product spoilage, some strains of ATB can induce a metabiotic effect and raise the pH from the high-acid zone to the low-acid zone. At these higher pH values, microorganisms of public health significance, including *C. botulinum*, are of concern.

The food industry has an excellent record in controlling the growth of ATB in shelf stable acid and acidified foods. The development of an appropriate thermal treatment by a process authority is a requirement. The quality of incoming fruits and vegetables as well as the removal of soil, debris, and decay will reduce spore load. Plant and line sanitation, as well as specifications for work-in-process and cooling and storing of finished product, must be considered in the safe manufacture of acid and acidified foods.

ABOUT THE AUTHOR

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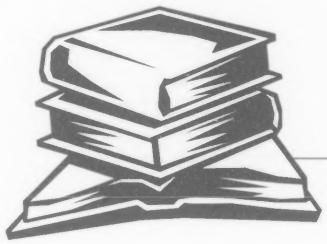
Book reviewed by: Julie A. Albrecht, Ph.D., Extension Food Specialist, University of Nebraska, Lincoln, NE 68583-0808

Book Review



Essentials of Food Safety & Sanitation

David McSwane, Nancy Rue, and Richard Linton

The *Essentials of Food Safety & Sanitation* is an eleven chapter textbook designed for foodservice managers and workers to obtain up-to-date practical food safety education. This text could also be used by instructors in foodservice management programs in community college and universities. Faculty or Extension Specialists with a background in food safety will find this textbook easy to use. A teachers guide could be helpful, especially if overhead transparency masters would be included.

The first four chapters thoroughly cover food safety and sanitation management, food safety hazards, foodborne illness, and food product flow for foodservice managers and workers to understand the importance of food safety. The chapter on HACCP is well done and provides numerous examples for a foodservice manager to grasp how HACCP can be implemented into a foodservice operation. Facilities, equipment and utensils are discussed in relationship to food safety issues. Cleaning and sanitizing and environmental sanitation are covered in two chapters. An overview of other safety concerns are included in the chapter on accident prevention and crisis management. One chapter provides the foodservice manager basic information on adult education and how to train employees. The local food code and/or an inspector would be additional resources to use with the chapter on food safety regulations.

Each chapter begins with a story or situation which illustrates the importance of the subject to be covered. Next are listed the objectives for the chapter and a list of essential terms covered in the chapter. The text is easy to read with numerous pictures, diagrams, charts, and bulleted sections to help the reader learn the material. Each chapter ends with a summary and activities which may include a case study, discussion questions and multiple choice or true/false questions. References/suggested readings are included at the end of each chapter for further information. The answers to the case studies and quizzes are given in the Appendix. A glossary of terms is provided.

A postcard in the front of the textbook provides the student or teacher with a means to take a Certified Food Safety Manager Examination. Information is provided at the end of the book on taking the test. No information on the cost of testing is provided.

The *Essentials of Food Safety & Sanitation* is a textbook designed for use in classes and workshops. It would make an excellent resource for a self-study course with additional instructions and learning aids.

For copies of *Essentials of Food Safety & Sanitation*–

Mail requests to: Prentice Hall, Upper Saddle River, NJ 07484

Call for Nominations
1999 IAMFES Secretary

Nominations are now being accepted by the Nominating Committee for the office of IAMFES Secretary. A representative from the regulatory sector will be elected in the spring of 1999 to begin serving at the conclusion of the 1999 IAMFES Annual Meeting for the year 1999-2000.

Letters of nomination, including a photograph and biographical sketch are to be submitted to the Committee Chairperson **no later than November 1, 1998**. After the close of nominations, the Committee will review the nominees and select two (or more) persons to be presented to the Membership for voting.

The Secretary-Elect is determined by a majority of votes cast through a mail vote taken in the spring of 1999. Official Secretary duties begin at the conclusion of the 1999 IAMFES Annual Meeting. The elected Secretary serves as a Member of the Executive Board of IAMFES for a total of five years succeeding to President, then serving as Past President. Board meetings are scheduled at least three times a year and other commitments may be necessary.

For more information regarding duties and requirements of the position, please contact David Tharp, Executive Director at 800.369.6337 or 515.276.3344; Fax: 515.276.8655; E-mail: dtharp@iamfes.org.

Send a letter of nomination for Secretary of IAMFES, along with a photograph and biographical sketch of nominee, to the Nominations Chairperson:

F. Ann Draughon
University of Tennessee
Food Tech Department
P.O. Box 1071
Knoxville, Tennessee 37901-1071
Phone: 423.974.7425; Fax: 423.974.7450
E-mail: draughon@utk.edu

Nomination deadline is November 1, 1998.

Awards Nominations

The International Association of Milk, Food and Environmental Sanitarians welcomes your nominations for our Association Awards. Nominate your colleagues for one of the Awards listed below. Only IAMFES Members are eligible to be nominated. You do not have to be an IAMFES Member to nominate a deserving professional.

To request nomination criteria, contact:

IAMFES
6200 Aurora Avenue, Suite 200W
Des Moines, Iowa 50322-2863

By telephone: 800.369.6337; 515.276.3344;
Fax: 515.276.8655 or E-mail: iamfes@iamfes.org.

Nominations deadline is February 19, 1999. You may make multiple nominations. All nominations must be received at the IAMFES office by February 19, 1999.

* Persons nominated for individual awards must be current IAMFES Members. Black Pearl Award nominees must be a company employing current IAMFES Members. NFPA Food Safety Award nominees do not have to be IAMFES Members.
* Previous award winners are not eligible for the same award.
* Executive Board Members and Awards Committee Members are not eligible for nomination.

Presentation of awards will be during the Awards Banquet at the IAMFES Annual Meeting in Dearborn, Michigan on August 4, 1999.

Nominations will be accepted for the following Awards:

Black Pearl Award — Award with Black Pearl

Presented in recognition of a company's outstanding achievement in corporate excellence in food safety and quality. Sponsored by Wilbur Feagan and F&H Food Equipment Company.

Honorary Life Membership Award — Plaque and Lifetime Membership in IAMFES

Presented to Member(s) for their devotion to the high ideals and objectives of IAMFES and for their service to the Association.

Harry Haverland Citation Award — Plaque and $1,000 Honorarium

Presented to an individual for years of devotion to the ideals and objectives of IAMFES. Sponsored by DiverseyLever U.S. Food Group.

Harold Barnum Industry Award — Plaque and $1,000 Honorarium

Presented to an individual for outstanding service to the public, IAMFES and the food industry. Sponsored by NASCO International, Inc.

Educator Award — Plaque and $1,000 Honorarium

Presented to an individual for outstanding service to the public, IAMFES and the arena of education in food safety and food protection. Sponsored by Nelson-Jameson, Inc.

Sanitarian Award — Plaque and $1,000 Honorarium

Presented to an individual for outstanding service to the public, IAMFES and the profession of the Sanitarian. Sponsored by Ecolab, Inc., Food and Beverage Division.

NFPA Food Safety Award — Plaque and $3,000 Honorarium

Presented to an individual, group, or organization in recognition of a long history of outstanding contribution to food safety research and education. Sponsored by National Food Processors Association.

CALL FOR ABSTRACTS

IAMFES
86th Annual Meeting — August 1-4, 1999
Dearborn, Michigan

Instructions for Preparing Abstracts

Procedure

- Type abstract in space provided on the abstract form. Abstracts must be double-spaced in a font size no smaller than 12 point. No more than 200 words.
- Type in the title, CAPITALIZE the first letter of the first word and proper nouns.
- List the names of authors and institution(s). Capitalize first letters and initials.
- Give the full name, title, mailing address and the office telephone number of the author who will present the paper.
- If the paper is to be presented by a student entered in the Developing Scientist Awards Competitions, check the box to indicate this and have the form signed by your Major Professor or Department Head. **(For more information on the Developing Scientist Awards Competitions, see the following pages.)**
- Mail four (4) printed copies and one (1) electronic version on a 3½ inch disk (saved as text export or ASCII file or rich text format) of the abstract to be received by January 8, 1999 to:

  Carol Mouchka
  IAMFES
  6200 Aurora Avenue, Suite 200W
  Des Moines, IA 50322-2863

Enclose one (1) self-addressed postcard for each abstract that is submitted to acknowledge receipt of the abstract. Authors will be notified by mail of acceptance or rejection of their abstract.

***NOTE: Your abstract must be received by the IAMFES office no later than January 8, 1999. Photocopies of the abstract form may be used.**

Abstract General Information

Content of the Abstract

The abstract should describe briefly:

(a) the purpose of research/objectives;
(b) methodology;
(c) essential results;
(d) conclusions/significance/ implications.

Presentation Format

Papers may be presented orally or by poster format at the discretion of the IAMFES Program Committee. Oral presentations will be scheduled so a speaker has a maximum of 15 minutes, including a 2 to 4 minute discussion. Carousel projectors for 35-mm slides will be available. Other equipment may be used at speaker's expense. Prior authorization must be obtained.

OVERHEAD PROJECTORS ARE NOT TO BE USED.

Subject Matter for Papers

Papers should report the results of applied research on: food, dairy and environmental sanitation; foodborne pathogens; food and dairy microbiology; food and dairy engineering; food and dairy chemistry; food additives and residues; food and dairy technology; food service and food administration; quality assurance/control; mastitis; environmental health; waste management and water quality. Papers may also report subject matter of an educational and/or nontechnical nature.

Criteria for *Acceptance* of Abstracts

1. Abstract must accurately describe briefly:
   (a) the problem studied/objectives;
   (b) methodology;
   (c) essential results;
   (d) conclusions/significance/ implications.

   Results should be summarized. **Do not use tables or graphs.**
2. Abstract must report the results of original research pertinent to the subject matter described above in subject matter for papers section.
3. Research must be based on accepted scientific practices.
4. Research should not have been previously presented nor intended for presentation at another scientific meeting; paper should not have appeared in print prior to the Annual Meeting.

Typical Reasons for *Rejection* of Abstracts

1. Abstract was not prepared according to "Instructions for Preparing Abstracts." (page 663)
2. Abstract does not contain essential elements described above in #1, "Criteria for Acceptance."
3. Abstract reports inappropriate or unacceptable subject matter, is not based on accepted scientific practices, or the quality of the research or scientific approach is inadequate.
4. Work reported appears to be incomplete.
5. The abstract was poorly written or prepared including spelling and grammatical errors.
6. Results have been presented/published previously.
7. The abstract was received after the deadline for submission.
8. Abstract contains information that is in violation of the IAMFES Policy on Commercialism.

Additional Abstract Forms

Photocopies of the abstract form may be used.

Membership in IAMFES

Membership in IAMFES is NOT a requirement for presenting a paper at the IAMFES Annual Meeting.

IAMFES Abstract Form

DEADLINE: Must be Received by January 8, 1999

Title of Paper _____

_____

Authors _____

_____

Full Name and Title of Presenter _____

_____

Institution and Address of Presenter _____

_____

Phone Number: _____

Fax Number: _____

E-mail: _____

Developing Scientist Awards Competitions ☐ Yes

Major Professor/Department Head approval (signature and date) _____

Selected presentations may be recorded (audio or visual).

Check the format you prefer: ☐ **Oral** ☐ **Poster** ☐ **Video Theater** ☐ **No Preference**

Please TYPE abstract, DOUBLE-SPACED, in the space provided here in a font size no smaller than 12 point. No more than 200 words.

Call for Entrants in the Developing Scientist Awards Competitions

(Supported by the IAMFES Foundation)

IAMFES is pleased to announce continuation of its program to encourage and recognize the work of students and recent graduates in the field of food safety research. Qualified individuals may enter **either** the Developing Scientist Oral Competition **or** the Developing Scientist Poster Competition.

Purpose:

1. To encourage students and recent graduates to present their original research at the IAMFES Annual Meeting.
2. To foster professionalism in students and recent graduates through contact with peers and professional Members of IAMFES.
3. To encourage participation by students and recent graduates in IAMFES and its Annual Meeting.

DEVELOPING SCIENTIST ORAL AWARDS COMPETITION:

The Developing Scientist Oral Awards Competition is open only to **graduate students enrolled in M.S. or Ph.D. programs or recent M.S. or Ph.D. graduates** in programs at accredited universities or colleges where research deals with environmental, food or dairy sanitation, protection or safety. **Competition entrants cannot have graduated more than one year prior to the deadline for submitting abstracts.**

Prior to the Annual Meeting, up to ten finalists will be selected for Competition and awards will be presented at the Annual Meeting to the top three presenters (first, second and third places). Presentations are limited to fifteen minutes which should include two to four minutes for discussion.

Awards: First Place, $500 and an engraved plaque; Second Place, $300 and a framed certificate; Third Place, $100 and a framed certificate. Award winners will also receive a complimentary, one-year IAMFES membership including both *Dairy, Food and Environmental Sanitation* **and** *Journal of Food Protection*.

DEVELOPING SCIENTIST POSTER AWARDS COMPETITION:

The Developing Scientist Poster Awards Competition is open to **enrolled undergraduate and graduate students or recent graduates from undergraduate or graduate programs** at accredited universities or colleges where research deals with environmental, food or dairy sanitation, protection or safety. **Competition entrants cannot have graduated more than one year prior to the deadline for submitting abstracts.**

Prior to the Annual Meeting, up to ten finalists will be selected for Competition and awards will be presented at the Annual Meeting to the top three presenters (first, second and third places). The presentation must be mounted on an eight foot by four foot (8' × 4') display board provided at the Annual Meeting for the duration of the assigned Poster Session. The presenter must be present at his or her poster for the specified time (approximately two hours) during the assigned session.

Awards: First Place, $500 and an engraved plaque; Second Place, $300 and a framed certificate; Third Place, $100 and a framed certificate. Award winners will also receive a complimentary, one-year IAMFES membership including both *Dairy, Food and Environmental Sanitation* **and** *Journal of Food Protection*.

INSTRUCTIONS TO DEVELOPING SCIENTIST AWARDS ORAL AND POSTER COMPETITIONS ENTRANTS:

1. Abstracts must be received by the IAMFES office no later than January 8, 1999.
2. In addition to adhering to the general procedures for abstract preparation and submission required of all individuals submitting abstracts, Competition entrants must submit **two additional** copies of their abstract (i.e., a total of four (4) copies must be submitted). **Competition entrants must also mark the appropriate box on the abstract form to indicate their intention to participate in the Developing Scientist Awards Competition and to designate whether it is "oral" or "poster."**
3. Both the Competition entrant and his or her presentation must be recommended and approved for the Competition by his or her major professor or department head, who must sign the abstract.
4. The work must represent original research done by the Competition entrant and must be presented by the Competition entrant.
5. Competition entrants may enter only one paper in either the Oral or the Poster Competition.

ADDITIONAL INFORMATION:

1. All Competition entrants are required to pay the registration fee (i.e., student member rate, Member rate, or nonmember rate). Nonmembers may join IAMFES and receive the member rate.
2. Acceptance of papers by IAMFES for presentation at the Annual Meeting is independent of acceptance as a Competition finalist. Competition entrants who are chosen as finalists will be notified of their status by the Competition Chairperson by June 1, 1999.
3. All Competition entrants (not just Competition finalists) with abstracts accepted by IAMFES will receive a complimentary, one-year IAMFES membership which includes their choice of *Dairy, Food and Environmental Sanitation* **or** *Journal of Food Protection*.
4. All Competition finalists will receive a complimentary Awards Banquet ticket and are expected to be present at the banquet where the award winners will be announced and recognized.

JUDGING THE DEVELOPING SCIENTIST AWARDS COMPETITIONS:

Abstracts and presentations will be evaluated by an independent panel of judges. Selection of up to ten finalists for the Developing Scientist Oral and Poster Awards Competitions will be based on evaluations of the abstracts and the scientific quality of the work (see judging criteria). All Competition entrants will be advised of the judges' decisions by June 1, 1999.

Only the Competition finalists will be judged at the Annual Meeting and will be eligible for the awards. All other Competition entrants with abstracts accepted by the IAMFES Program Committee will be expected to present their papers/posters as part of the regular Annual Meeting program, but their presentations will not be judged and they will not be eligible for the awards.

JUDGING CRITERIA FOR THE DEVELOPING SCIENTIST AWARDS COMPETITIONS:

ABSTRACT:

Clarity; comprehensiveness; conciseness.

SCIENTIFIC QUALITY:

Adequacy of experimental design; extent to which objectives were met; difficulty and thoroughness of research; validity of conclusions based upon data; technical merit; contribution to science.

ORAL PRESENTATION OR POSTER PRESENTATION:

Organization (clarity of introduction, objectives, methods, results and conclusions); quality of visuals; quality and poise of presentation and in answering questions.

***NOTE: Your abstract must be received by the IAMFES office no later than January 8, 1999. Photocopies of the abstract form may be used.**

IAMFES Policy on Commercialism

1. INTRODUCTION

No printed media, technical sessions, symposia, posters, seminars, short courses, and/or all related type forums and discussions offered under the auspices of IAMFES (hereafter referred to as IAMFES forums) are to be used as platforms for commercial sales or presentations by authors and/or presenters (hereafter referred to as authors) without the expressed permission of the IAMFES staff or Executive Board. IAMFES enforces this policy in order to restrict commercialism in technical manuscripts, graphics, oral presentations, poster presentations, panel discussions, symposia papers, and all other type submissions and presentations (hereafter referred to as submissions and presentations), so that scientific merit is not diluted by proprietary secrecy.

Excessive use of brand names, product names or logos, failure to substantiate performance claims, and failure to objectively discuss alternative methods, processes, and equipment are indicators of sales pitches. Restricting commercialism benefits both the authors and recipients of submissions and presentations.

This policy has been written to serve as the basis for identifying commercialism in submissions and presentations prepared for IAMFES forums.

2. TECHNICAL CONTENT OF SUBMISSIONS AND PRESENTATIONS

2.1 Original Work

The presentation of new technical information is to be encouraged. In addition to the commercialism evaluation, all submissions and presentations will be individually evaluated by the Program Committee (PC) chairperson, technical reviewers selected by the PC chairperson, session convenor, and/or IAMFES staff on the basis of originality before inclusion in the program.

2.2 Substantiating Data

Submissions and presentations should present technical conclusions derived from technical data. If products or services are described, all reported capabilities, features or benefits, and performance parameters must be substantiated by data or by an acceptable explanation as to why the data are unavailable (e.g., incomplete, not collected, etc.) and, if it will become available, when. The explanation for unavailable data will be considered by the PC chairperson and/or technical reviewers selected by the PC chairperson in order to ascertain if the presentation is acceptable without the data. Serious consideration should be given to withholding submissions and presentations until the data are available as only those conclusions that might be reasonably drawn from the data may be presented. Claims of benefit and/or technical conclusions not supported by the presented data are prohibited.

2.3 Trade Names

Excessive use of brand names, product names, trade names, and/or trademarks is forbidden. A general guideline is to use proprietary names once and thereafter to use generic descriptors or neutral designations. Where this would make the submission or presentation significantly more difficult to understand, the PC chairperson, technical reviewers selected by the PC chairperson, session convenor, and/or IAMFES staff will judge whether the use of trade names, etc., is necessary and acceptable.

2.4 "Industry Practice" Statements

It may be useful to report the extent of application of technologies, products, or services, however, such statements should review the extent of application of all generically similar technologies, products, or services in the field. Specific commercial installations may be cited to the extent that their data are discussed in the submission or presentation.

2.5 Ranking

Although general comparisons of products and services are prohibited, specific generic comparisons that are substantiated by the reported data are allowed.

2.6 Proprietary Information (See also 2.2.)

Some information about products or services may be proprietary to the author's agency or company, or to the user and may not be publishable. However, their scientific principles and validation of performance parameters must be described. Conclusions and/or comparisons may only be made on the basis of reported data.

2.7 Capabilities

Discussion of corporate capabilities or experiences are prohibited unless they pertain to the specific presented data.

3. GRAPHICS

3.1 Purpose

Slides, photographs, videos, illustrations, art work, and any other type visual aids appearing with the printed text in submissions or used in presentations (hereafter referred to as graphics) should be included only to clarify technical points. Graphics which primarily promote a product or service will not be allowed. (See also 4.6.)

3.2 Source

Graphics should relate specifically to the technical presentation. General graphics regularly shown in, or intended for, sales presentations cannot be used.

3.3 Company Identification

Names or logos of agencies or companies supplying the goods or services must not appear on the graphics, except on the first slide of the presentation. Slides showing products may not include predominant nameplates. Graphics with commercial names or logos added as background borders or corners are specifically forbidden.

3.4 Copies

Graphics that are not included in the preprint may be shown during the presentation only if they have been reviewed in advance by the PC chairperson, session convenor, and/or IAMFES staff, and have been determined to comply with this policy. Copies of these additional graphics must be available from the author on request by individual attendees. It is the responsibility of the session convenor to verify that all graphics to be shown have been cleared by PC chairperson, session convenor, IAMFES staff, or other reviewers designated by the PC chairperson.

4. INTERPRETATION AND ENFORCEMENT

4.1 Distribution

This policy will be sent to all authors of submissions and presentations in IAMFES forums.

4.2 Assessment Process

Reviewers of submissions and presentations will accept only those that comply with this policy. Drafts of submissions and presentations will be reviewed for commercialism concurrently by both IAMFES staff and technical reviewers selected by the PC chairperson. All reviewer comments shall be sent to and coordinated by either the PC chairperson or the designated IAMFES staff. If any submissions are found to violate this policy, authors will be informed and invited to resubmit their materials in revised form before the designated deadline.

4.3 Author Awareness

In addition to receiving a printed copy of this policy, all authors presenting in an IAMFES forum will be reminded of this policy by the PC chairperson, their session convenor, or the IAMFES staff, whichever is appropriate.

4.4 Monitoring

Session convenors are responsible for ensuring that presentations comply with this policy. If it is determined by the session convenor that a violation or violations have occurred or are occurring, he or she will publicly request that the author immediately discontinue any and all presentations (oral, visual, audio, etc.), and will notify the PC chairperson and IAMFES staff of the action taken.

4.5 Enforcement

While both technical reviewers, session convenors, and/or IAMFES staff may check submissions and presentations for commercialism, ultimately it is the responsibility of the PC chairperson to enforce this policy through the session convenors and IAMFES staff.

4.6 Penalties

If the author of a submission or presentation violates this policy, the PC chairperson will notify the author and the author's agency or company of the violation in writing. If an additional violation or violations occur after a written warning has been issued to an author and his agency or company, IAMFES reserves the right to ban the author and the author's agency or company from making presentations in IAMFES forums for a period of up to two (2) years following the violation or violations.

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UpDates

Osmonics Establishes New Strategic Sales and Marketing Positions

Osmonics announced three promotions to new positions that will strengthen the company's strategic sales and marketing.

Lee Comb has been promoted to Vice President Engineered Products and Systems (EP&S). Comb was formerly Director of Sales for EP&S. He joined Osmonics in 1978, and has spent the last 18 years selling custom-tailored systems into a wide range of applications around the world.

Bjarne Nicolaisen has been promoted to Vice President International. Nicolaisen joined Osmonics with the Desal acquisition in 1996. Formerly, he was responsible for international sales and marketing, and will now have greater responsibility for these same functions in Euro/Africa, Asia/Pacific, and Latin America.

Roger Miller, promoted to Vice President Marketing and Strategy, will develop corporate strategy and oversee the coordination of all marketing efforts. Miller joined Osmonics in 1993 as a Product Manager for Pumps, after holding key management positions with several manufacturing concerns. Most recently he served as Manager of Marketing.

FPM&SA Appoints New Communications Director

Food Processing Machinery & Supplies Association (FPM&SA) recently announced the appointment of Susan J. Higginbotham to the position of Communications Director. In her new position, Higginbotham will manage the association's marketing communications efforts, including advertising and public relations.

As President of Higginbotham & Associates, Inc., she oversaw the day-to-day activities of a multimillion dollar full-service marketing communications firm located in Albany, N.Y., with a subsidiary in New York City. Previously, Higginbotham was Executive Vice President / Client Services at Communication and Design Agency Inc. in Schenectady, N.Y. Her earlier experience included media management, account management and direct experience in radio and television.

Eriez Magnetics Announces Promotions

Eriez Magnetics has announced several key promotions. They include: as the new Product Manager, Metal Detectors, Jeff Kaveny will be responsible for directing the Sales and Marketing efforts for Eriez' line of metal detectors.

In a newly created position, Ed Razanauskas will concentrate on major account potential and developing opportunities with original equipment manufacturers (OEM's) as Manager, Special Projects, Metal Detectors.

Ray Spurgeon will use his technical knowledge of metal detectors in his new position, Technical Sales Representative, Metal Detectors.

In another newly created position, Rich McDowell's new responsibilities will include conducting application testing, supporting product design efforts, and providing sales/service assistance.

Linda Solak has been appointed as Technical Sales Representative, Vibratory/Screening. Solak will be responsible for providing support to sales efforts in the field.

Alfa Laval Flow Inc., Names New Vice President

Alfa Laval Flow Inc. has named Robert Schuck as the new Vice President of Finance and Administration.

Alfa Laval Flow Inc., is a new company resulting from the integration of three Alfa Laval companies: G&H Products Corp., of Pleasant Prairie, WI; Alfa Laval Pumps Inc., of Kenosha, WI, and Alfa Laval Saunders Inc., of Houston, TX. The new company's headquarters will be at the present location of G&H Products.

Schuck joined G&H Products in 1996 as Financial Controller, managing the finance and information systems departments. Prior to G&H, Schuck managed the financial department at another company. He has been with the Alfa Laval Group since 1991.

J&W Scientific Announces New Manager of Custom Column Shoppe

J&W Scientific announces the appointment of Dean Rood to Manager of the Custom Column Shoppe. Dean previously worked in J&W's Technical Support Department as Senior Applications Chemist. He is also known for his published work in the form of technical applications and papers, as Associate Editor for the *Journal of Chromatographic Science* and for the first and second editions of the popular reference work *A Practical Guide to the Care,*

Maintenance and Troubleshooting of Capillary GC Systems. This background will enhance his contribution to J&W's custom manufacturing.

Doug Holt Named Interim Director of MU Value-Added Agriculture Office

Doug Holt has been named Interim Director of the Office of Value- Added Agricultural Outreach at the University of Missouri-Columbia.

Holt, Associate Professor of Food Science and Human Nutrition, replaces Dennis Heldman who retired from the university, said Hildegarde Heymann, Food Science and Engineering Unit Leader.

Before joining MU in 1989, Holt was an Analytical Food Chemist for the Dole Package Food Company in San Jose, CA. He has taught undergraduate and graduate classes in food science and served as Director of the Missouri Center for Agricultural Products Technology. Holt, a native of Corpus Christi, Texas, holds B.S. and M.S. degrees in food science and technology from Texas A&M University and a Ph.D. in food science and technology from the University of Nebraska.

Executive Promotions at A&B

Brian K. Gehrke has been promoted to Senior Vice President of Engineering. Joining A&B in 1980, Mr. Gehrke's career started in A&B's Engineering/ Project Management Group. Gehrke went on to positions in the sales & marketing department where he was promoted to Vice President of Sales & Marketing in 1991.

As Senior Vice President of Engineering, Mr. Gehrke is responsible for the direction and continued development of the corporate engineering group. Overseeing the entire mechanical and process engineering staff, he will administrate engineering practices, new product development as well as provide system design and support.

Jim Banks has been promoted to Vice President of Sales & Marketing. Mr. Banks began his employment with A&B in 1979. He later went on to sales positions with various service and O.E.M. companies serving the Process Industry. Banks returned to A&B in 1997 holding the position of Regional Sales Manager.

As Vice President of Sales & Marketing, Banks is responsible for the leadership and coordination of corporate sales and marketing strategy, as well as new business development.

FIGHT BAC!™

Now available is a new visual tool that brings the four food safety principles to life by presenting them in a simple, graphically interesting manner. IAMFES encourages its members to become involved. Join this effort and you can help close the gap!

For information on joining the FIGHT BAC!™ campaign, contact: The Partnership for Food Safety Education, Phone: 202.429.8273; Fax: 202.429. 4550; Web site: www.fightbac.org.

IAMFES Joins in National Food Safety Education Initiative

Despite continued progress in improving the quality and safety of foods produced in the United States, food-related illness remains a serious public health problem. Each year, as many as 9,000 deaths and between 6.5 million and 33 million illnesses are directly linked to foodborne pathogens.

However, most cases of food-related illness can be prevented if consumers recognize that they play an important role in ensuring the safety of the foods they eat. Accordingly, public health and food safety authorities are stepping up their calls for education about safe food handling with special emphasis on teaching these four key principles: (1) wash hands and surfaces often; (2) prevent cross-contamination; (3) cook foods to proper temperatures: and (4) refrigerate promptly. These four principles address critical points in everyday food handling where improper practices can lead to food-related illness.

To communicate these food safety basics, IAMFES has joined a national coalition of industry government and consumer groups – called the Partnership for Food Safety Education – in one of the most far-reaching and ambitious public education campaigns ever to focus on safe food handling. The campaign is based on the understanding that to capture the public's attention, it will be necessary to make food-related illness personally relevant to people in their everyday lives. As such, IAMFES has been introducing the public to a slimy, green cartoon character called "BAC." This character is to be used to educate the public. IAMFES introduced "BAC" at its Annual Meeting in Nashville, Tennessee and he appeared on the September cover of *DFES*.

NEWS

Because consumer research points to a knowledge gap about the sources and nature of food-related illness, the *Fight BAC!*™ campaign will also help the public understand why foodborne bacteria is everyone's concern. Through this new education effort, consumers will learn that:

- Bacteria are a part of all living things and are found on all raw agricultural products;
- Harmful bacteria can be transferred from food to people, people onto food, or from one food to another;
- Bacteria can grow rapidly at room temperature;
- Growth of harmful bacteria in food can be slowed or stopped by refrigerating or freezing;
- Food-related illness can produce symptoms from mild to very serious. Illness can occur from 30 minutes to two weeks after eating food containing harmful bacteria;
- People who are most likely to become sick from food-related illness are infants and young children, senior citizens and people with weakened imune systems.

It is important for everyone to learn these important facts in order to reduce food-related illness. That's why IAMFES is promoting this new food safety graphic which has the potential to become familiar and meaningful to the general public. This new visual tool, which was extensively tested for consumers, brings the four food safety principles to life by presenting them in a simple, graphically interesting manner. IAMFES encourages its members to become involved in this effort. For additional information, contact The Partnership for Food Safety Education at Phone: 202.429.8273; Fax: 202.429.4550; Web site: www.fightbac.org.

Arborviral Encephalitis Surveillance

There are many different types of arthropod-borne viruses (arborviruses), and they are carried by mosquitoes, sandflies, and midges. The arboviral diseases which have been seen in Mississippi with any regularity are Eastern Equine Encephalitis (EEE) and St. Louis encephalitis (SLE) which are mosquito-borne. Many cases are asymptomatic or mild. Symptoms of severe disease include acute onset of headache, high fever, meningeal signs, stupor, disorientation, coma and seizures. SLE may occur in outbreaks or epidemics and is maintained in an enzootic cycle with birds and mosquitoes. The predominant vector in Mississippi is the southern house mosquito *(Culex quinquefasciatus)*. EEE is transmitted to humans by a variety of mosquitoes.

In Mississippi it is predominantly transmitted by salt marsh mosquitoes *(Culex safinarius)*, and inland by the freshwater marsh mosquito *(Coquillettidia perturbans)*. Horses and humans are dead end hosts for the virus and do not act as sources of the virus for mosquitoes. EEE is not transmitted from person to person or between horses and humans. The MSDH coordinates a hospital-based system of active surveillance for symptomatic arboviral disease. Ten hospitals across the state are contacted weekly to determine whether any cases of encephalitis of unknown etiology have occurred. For any possible cases, specimens are

obtained and sent to CDC for diagnostic testing. Physicians at hospitals outside this system are urged to call the Division of Epidemiology at 601.960.7725 if they have patients in which they suspect arborviral infection, and/or for whom they would like specimens sent to CDC for arboviral testing. This clinical and diagnostic information is used to inform other health care professionals to the presence or risk of disease. Additionally, the information is useful to alert the public to take precautionary measures in the geographic area in which a patient acquired their disease. Treatment of the patient must be based on clinical information, as this confirmatory laboratory information can take an extended period of time to complete.

State Adopts New Rules to Curb Foodborne Illness; Officials Say Lower Refrigeration Temperatures Will Reduce *Salmonella*, Other Diseases

The Texas State Board of Health was cited as adopting new regulations for restaurants, supermarkets, snack bars and other retail food establishments. The new 142-page regulatory food code is the first major revision for Texas since 1977. Most of the details of the revised code were not made public at the board meeting. State officials were cited as saying the regulations, which go into effect in mid-October, are patterned after the nonmandatory 1997 Federal Food and Drug Administration guidelines, already adopted by a dozen other states. They will become the state's minimum standards, which local governments must follow.

Home-rule cities such as Austin can adopt more stringent guidelines if they choose. The biggest and most controversial change under the new regulations requires food establishments to reduce the maximum temperature of their refrigeration units from 45 to 41° (5°C).

According to the FDA, a 41° temperature significantly slows the growth of organisms such as *Salmonella*, *Listeria*, *Yersinia*, the vibrios and others that can cause foodborne illnesses. The 41° regulation also would be in harmony with U.S. Department of Agriculture guidelines as well as Canadian and European requirements, an important consideration as food becomes increasingly global.

Temperature change has been controversial because it could require many food establishments to purchase new equipment. The state is giving these establishments five years, and in some cases longer, to replace various refrigeration units. Another major regulatory change is that prepared foods, potentially hazardous foods and opened packaged foods in restaurants will be required to be date-marked and have specific shelf lives. Glen Garey, general counsel for the Texas Restaurant Association, was quoted as saying at the board meeting that, "We support the rules in the report."

Lisa Wright of San Diego, Regulatory Affairs Manager for Foodmaker Inc., was quoted as saying, "It's in everyone's best interest." Foodmaker is the parent company of Jack in the Box, which has 372 stores in Texas.

Reprinted from *Austin American-Statesman.*

Metro Food Market Embraces Seal of Commitment

Metro Food Market, a division of Richfood Holdings, Inc., the Maryland Council on Food Safety (MCFS) and the Maryland Hospitality Education Foundation (MHEF) have announced that Metro Food Market will be the first-in-state participant in the Grocery Seal of Commitment food safety training program. The announcement was made by John Ryder, President of Metro Food Markets.

According to Progressive Grocer (5/98), only two grocery chains nationally have implemented HACCP-based training. MHEF's new program, introduced state-wide in June, 1998, was, "greeted with open arms by Maryland grocers," said Lisa Wilkinson, MHEF's Executive Director. "We are bringing high-standard, cost-effective, voluntary food safety training to all types of food handlers and vendors in the state of Maryland." According to Ryder, "We have already started training staff. In fact, all of our staff, including me, will be taking this training. At this time, very few chains nationwide have made this commitment to their customers. We wanted to offer this as soon as we learned of the program." Metro, upon completion of training, will receive the Grocery Seal of Commitment. The Seal was offered to grocers after national attention was received by MHEF's sister program for restaurateurs. The Seal of Commitment is a designation that signifies completion of food safety courses by front-of and back-of-house staff and a continued compliance with the Council's mission of thorough, on-going education. The Seal of Commitment is earned after the participant completes a Manager's Sanitation Certification; sponsors a two-hour on-site safety seminar entitled "Smart Staff" during which 75% of the staff is present; and, implements "Smart Start," a workbook-based self test in which new hires must score 100%.

The Council on Food Safety is a program developed and operated by MHEF in partnership with the state and local departments of health. MHEF is a nonprofit organization that serves Maryland's hospitality and tourism industries as the preferred source of education,

training, resources and research. MHEF is known nationally for its training and certification in food safety and alcohol service; School-to-Career, apprenticeship, and internship programs professional development seminars. Major sponsors include McCormick, USF&G and the Restaurant Association of Maryland.

International Food Security and Safety Addressed

The Science Source for Food, Agricultural, and Environmental Issues; Complex relationships among food safety; sufficiency and security of food on a global and United States basis were explored by international speakers at a conference sponsored in November 1997 by the Council for Agricultural Science and Technology (CAST), an international consortium of 36 scientific and professional societies. Speakers included representatives from the United Nations Food and Agriculture Organization, World Food Programme, International Fund for Agricultural Development, and the World Trade Organization.

Food Security: International Dimensions Food security issues differ on each continent. Asia has a much larger fraction of the world's population than of its arable land. Projections suggest crop yields in China might be increased considerably. If India's current economic growth accelerates, diets may change there and India will be placing even greater demand on the world food system. Asia in general is likely to import greater quantities of food.

Africa has experienced rapid population growth and slow economic growth. Its per capita food production has declined for three decades. It will continue to be a net food importer well into the twenty-first century. Western Europe's expected growth in food consumption is limited. Agricultural productivity there is high; however, future agricultural export prospects will be limited.

In Central and Eastern Europe agricultural productivity has been low by international standards relative to its potential. Privatization has begun and eventually this region will play an important role in addressing world food needs.

South America has the largest arable land area available for agricultural exporters, relative to its population without causing deforestation or other environmental damage. The continent likely will supply a much larger volume of agricultural exports in the next century. Australia and new Zealand historically have been strong agricultural exporters, and they are expected to continue in this role, although with limited expansion potential.

North America has a mature, high-income, slowly growing market for agricultural output. Canada will become an even larger exporter of both bulk commodities and higher-valued products. In the United States, 1996 agricultural policy changes increased farmers' planting flexibility and responsiveness to world market demand. A larger fraction of its meats and other animal products likely will be exported in the future.

Hunger and Poverty: The real food crisis today is hunger caused by poverty. Despite a 55% increase in worldwide food production from 1970 to 1995, the number of malnourished people worldwide dropped by only 15%, and 800 million people (an estimated 20% of the world's population) remain hungry. Experts say the supply of food will have to increase by 30 to 50% to meet demand in the year 2020. In Africa, parts of Asia, and in the near East, the absolute number of hungry people will increase, though the proportion of the population that is undernourished will decline.

Four principles must guide thinking about food security. Food security is about people, not about commodities. Chronically hungry people are very poor and usually landless. Women and girls suffer disproportionately. When food is in short supply, women eat last. The food issue is access. Increased food production is not enough.

Today's hunger leads to tomorrow's hunger. Hunger passes from hungry mother to malnourished child. This damage is irreversible; the harm caused by early malnutrition or undernutrition cannot be offset by adequate nutrition later.

Creation of employment and support for education – especially of girls, because it decreases the birth rate-is needed. Women must be supported as agents of social change. More than 80% of the food in Africa is grown by women. Yet they still find it difficult to gain access to basic requirements such as credit, fertilizer, technology, and land.

Potential Solutions: In November 1996, the World Food Summit Declaration and Plan of Action reaffirmed the right of access of everyone to a safe, nutritious, adequate food supply. Their goal is to decrease the number of undernourished by one-half by no later than the year 2015. Local solutions to food insecurity can be identified, provided that (1) the people involved are consulted, (2) the value of their knowledge is recognized, and (3) external knowledge is used to complement local knowledge.

Food Quality and Safety: Challenges and Solutions: Microbial pathogens are likely to dominate food safety concerns in the future; consumers will need information on risks involved.

Food safety regulations should be based on science. Food safety policies must work in concert with an open market philosophy. The Uruguay Round of the General Agreement on Tariffs and Trade

(GATT) addressed rules for agricultural trade, including the need to lower barriers and expand access. The Codex Alimentarius Commission is working to establish food safety standards. The move toward international standards will help avoid trade disputes, thereby providing a safer and more abundant food supply worldwide.

Research in the Twenty-First Century: Technologies must add to rather than deplete the earth's resources, be nonpolluting, apply to farms of all sizes, and be sparing of capital, management, and nonrenewable resources. Stable high-yield production is needed.

General Conclusions: The answer to the challenges of global food security is to get the policies right, thereby unleashing the creativity and inherent entrepreneurship of the private sector in all nations. If that is done on a global basis, the capacity to provide the world with an adequate diet can be achieved. Only with knowledge and commitment can the world be fed, the disease risk in food consumption minimized, and the environment protected.

Obsolete Facilities Can Hinder Dairy Farm Future

The following commentary is from Dave Kjome, Southeast Minnesota Dairy Educator with the University of Minnesota Extension Service. Kjome has been involved in dairy education for 28 years.

"Minnesota has its share of older dairy facilities, and it creates real nightmares when producers look to some type of phased or major expansion. Having been on many dairy farms over the past three decades, I have seen many facilities that have become outdated and inefficient. In the upper Midwest, many dairy buildings are not located so as to fit into a system that reduces labor. There are many facilities that were adaptable to new barn additions of 10 to 20 cows and some upgrading in feed handling and livestock waste. Today, however, their location leaves no room for any additional structure."

"During a visit to a very successful dairy business in Pennsylvania a couple of years ago, I heard the owner remark that every livestock facility should be self destructive in 20 years. Sound wasteful? Well, how many dairy farmers are operating today with the same tractor, corn planter, or pickup as 20 years ago? There comes a time in the life of a dairy farm when the old barn built 60, 70, or 80 years ago no longer is useful. The problem is we can't trade it for a new one or an upgraded model."

How Animal Health Products are Approved

It takes tens of millions of dollars to bring a new [animal health] product to market" points out Dennis Steadman, Merial's Vice President, North American Operations.

A rigorous FDA approval process ensures food safety, which adds cost to research and development. Here's a quick look at how animal health products are approved, as explained by the Animal Health Institute and by using Merial's Ivomec Eprinex as the sample product.

Scientific discovery: Only 1 in 20,006 discovered chemicals make it from the laboratory to the farm. Only 1 in 200 potential drugs make it through preclinical testing and approval.

In 1984, Merck Research Laboratories discovered eprinomectin. By 1988, its properties were identified.

Preliminary trials: These are conducted in test tubes on simple organisms such as bacteria, yeast or molds.

Preclinical trials: These studies involve animals to estimate dosage and check for adverse side effects. If the compound has potential, the research company notifies the appropriate federal agency. FDA approves applications to investigate new animal drugs and feed additives. USDA reviews research plans for vaccines or other animal biologicals.

In March 1990, Merck filed an investigation on New Animal Drug Application for eprinomectin and began the formulation and development process.

Clinical trials: Tests look at safety and effectiveness of product. Government scientists work with the manufacturer and review data. Field trials also are done now to show how the product performs on the field. Manufacturer must prove it can produce a quality, consistent product.

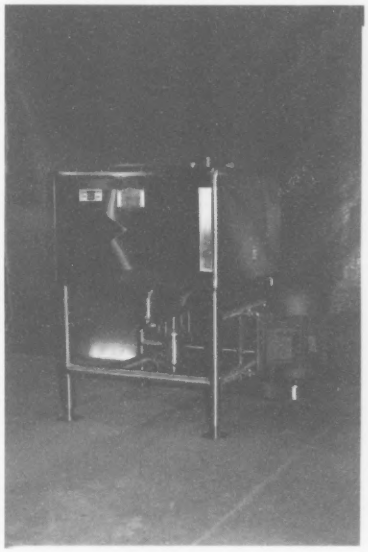
Regulatory review: After clinical trials are done, product is tested by the regulatory agency. If the compound is proven safe and effective, the government gives the manufacturer permission to market product.

In December 1996, Merck submitted its drug application for final approval.

Product approval: The product label now becomes part of the federal record and therefore, a legal document. It can't be changed without government approval and producers must follow label instructions.

In April 1997, FDA approved Merial's Ivomec Eprinex Pour-On for beef and dairy cattle. In June, Merck introduced its new product.

IndustryProducts



Walker Stainless Equipment Co.

Liqui-Mixer™ High Speed Mixer

Walker's high speed Liqui-Mixer™ dissolves solids or semi-solids into complete solution, not, just suspension.

The Liqui-Mixer™ pulls the product from the top center, down to the high-speed impeller, which forces it out to the side of the tank and up top again to repeat the process.

Walker's Liqui-Mixer™ can suit a wide variety of applications with optional impellers and offset mounted motors with adjustable speed. Other options include CIP sprayball, heat transfer surface for heating or cooling with insulation and polished outer shell.

Walker Stainless Equipment Co., New Lisbon, WI

Reader Service No. 331

Innovative 3M Petrifilm Information Management System

3M is introducing its Petrifilm Information Management System, providing food processors with the latest innovation in microbiological testing solutions.

The new system automatically performs colony counts on 3M Petrifilm Aerobic Count plates, streamlining the time-consuming practice of manually counting colonies. After the system quickly counts a colony, it digitizes the data, allowing users to view and analyze current results, retrieve historical data and display trends.

The system consists of a compact, table-top plate scanner, customized software and personal computer. An optional bar code system is available to provide further control over the sampling program.

3M, St. Paul, MN

Reader Service No. 332

GC Product for Chemical Analysis

J&W Scientific offers a new column for the positive identification of Methyl-*tert*-butyl Ether (MTBE) in environmental samples. This important product for gas chromatographers is featured in a new application note published by J&W Scientific.

Amendments to the 1990 Clean Air Act have led environmentalists to examine the existence of the contaminant MTBE in drinking water and underground water systems. This chemical component is a result of oxygenated fuel additives introduced in an effort to combat air pollution. Leaking underground storage tanks and the use of recreational vehicles on lakes and reservoirs have increased the existence and corresponding environmental hazards of MTBE.

J&W's GC column DB-MTBE is designed specifically for chemists to successfully resolve MTBE from the common pollutants 2- and 3-methylpentane. The column is effective for EPA Method 8020 utilizing a photoionization detector (PID) and a flame ionization detector (FID). The GC column is available in a 30 meter length, with two inner diameters of 0.45 nim and 0.53 mm.

J & W Scientific Inc., Folsom, CA

Reader Service No. 333

SystemSURE™ Rapid Hygiene Monitoring System

Becton Dickinson Microbiology Systems, announces that its systemSURE™ Rapid Hygiene Monitoring System has been selected as a "Millennium Product" by the Design Council of the United Kingdom. This honor is awarded to a product which the council deems to be creative, innovative, environmentally responsible, and pioneering in its field, one which opens up new opportunities, demonstrates the application of new or existing technology, challenges conventions,

solves a key problem and shows clear user benefits.

systemSURE™ Rapid Hygiene Monitoring System is designed to be an integral component of the Hazard Analysis Critical Control Point (HACCP) plans of food, dairy, beverage, cosmetic and pharmaceutical product manufacturers. Utilizing bioluminescence technology to detect and measure soiling, the system measures the total amount of adenosine triphosphate (ATP), a molecule that provides the energy source for all living organisms, on surfaces. The systemSURE™ Rapid Hygiene Monitoring System provides a measure of not only microbial contamination but also organic residues that could act as a breeding ground for microorganisms.

In a recent comparative study, the systemSURE™ Rapid Hygiene Monitoring System was shown to be significantly more sensitive than other tests, detecting low levels of contamination, characterized by invisible soils. The system "appeared to be the most sensitive system for detecting residual food residue diluted beyond visibility." The systemSURE™ Rapid Hygiene Monitoring System was also rated "more consistent" in reproducibility; i.e., the ability of a system to allow different users to produce the same results from the same surface/sample consistently.

Becton Dickinson Microbiology Systems, Sparks, MD

Reader Service No. 334

Pall Gelman — Expanded Line of Transfer Membranes

Pall Gelman Laboratory's newly expanded line of membranes for transfer and immobilization features membrane chemistries for sensitive detection and consistent results in all applications and commonly-used detection systems. Nylon, Nitrocellulose, and PVDF membranes are featured.

Biodyne® (Nylon 6,6) membrane provides high sensitivity and low background for enhanced resolution. This membrane does not crack, shrink, or tear when subjected to multiple cycles of hybridization, stripping, and reprobing. It is intrinsically hydrophilic for easy wetting.

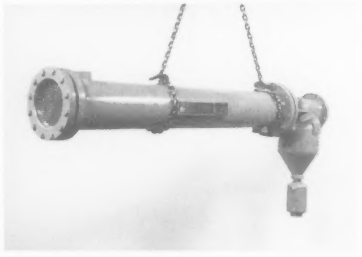
BioTrace™ NT membrane is pure unsupported nitrocellulose that exhibits low burn-through in transfer applications. The membrane is strong and durable, and less likely to crack than competitive nitrocellulose. It is ideal for colony and plaque lifts.

Versatile BioTrace PVDF membrane performs well in protein and nucleic acid transfers. The membrane exhibits low background with chemiluminescent detection systems, and has broad compatibility with commonly used solvents.

For covalent protein immobilization, Pall Gelman Laboratory offers UltraBind™ affinity membrane, a modified polyethersulfone.

Pall Gelman Sciences, Ann Arbor, MI

Reader Service No. 335



R. P. Adams Company, Inc.

Adams' SLB Aftercooler Offers Cooling and Flow

R. P. Adams Company, Inc. has introduced the Adams Model SLB Pipeline Removable Aftercooler with integral cyclone separator. The SLB Aftercooler features a short length bare tube design that provides enhanced cooling performance over other water-cooled units.

The SLB Aftercooler is equipped with a removable tube bundle for easy inspection, maintenance and cleaning. The rear floating tubesheet design fully eliminates stress effects of tube bundle thermal expansion and contraction. In addition, units are designed and certified to meet Section VIII of the ASME Code.

Unlike air-cooled units, the SLB Aftercooler provides a consistent and predictable process control that is independent of ambient temperatures—even during summer months when ambient temperatures are at their highest.

SLB Aftercoolers effectively condense and remove moisture and contaminates from the compressed air stream, eliminating process and control difficulties typically found with aircooled units. The integral cyclone separator removes moisture, rust, pipe scale and other contaminates. More efficient cooling and separating results in less moisture downstream and protects sensitive process equipment, instrumentation and pneumatic devices.

R.P. Adams Company, Inc. Buffalo, NY

Reader Service No. 336

Rapid Results with Culture Confirmation for *Listeria* Testing

Dynabeads® anti-Listeria is designed for rapid, immunomagnetic selective enrichment (IMS) of *Listeria* directly from pre-enrichment broths. The rapid and simple protocol (less than 30 minutes) saves 24 hours of valuable testing time compared to standard culture methods because Dynabeads® anti-Listeria simply replaces the use of Fraser selective enrichment broths. Isolated *Listeria* colonies (or negative results) are achieved in 48 hours from receipt of sample.

Dynabeads® anti-Listeria are uniform, superparamagnetic microspheres (2.8 microns in diameter) with affinity purified antibodies on their surface. When incubated with a sample, Dynabeads® will bind their target bacterium forming a bacterium-magnetic bead complex. This complex is separated from the heterogeneous sample by performing the test in a magnetic test tube rack (Dynal MPC®-M). The isolated and concentrated bacterium:bead complex can then be cultured on any selective culture medium (e.g., Oxford, Palcam).

Dynabeads® IMS method is a rapid culture technique. Colony acquisition means rapid results with culture confirmation. This highly sensitive system will detect as few as 100 organisms/ml of pre-enriched sample. Complete detection is achieved for the genus *Listeria*. The concentration and purification of the sample by immunomagnetic separation (IMS) improves bacterial isolation and thus is useful for cultural confirmation of other presumptive methods. The protocol is simple and reagents are shelf stable. The versatility provided by this methodology will allow testing of many different sample types while enhancing the efficiency of existing manual and automated detection methods.

Dynal, Inc., Success, NY

Reader Service No. 337

RadMan — Six Detector Personal Safety Monitor

Wandel & Goltermann has launched the world's first personal safety monitor capable of measuring both electric and magnetic fields in any direction.

The powerful field monitor RadMan is available as part of the company's Safety Test Solutions product line. It offers safety in

Wandel & Goltermann/Chase Systems

strong electromagnetic fields, for example around radio and telecommunications systems, RF industrial equipment and plastic welders.

RadMan monitors the limit values established by national and international control boards, such as IRPA, VDE, and FCC. Moreover, it gives out both a visual and an acoustic alarm if these levels are exceeded.

A major benefit of RadMan is its ease of use, the operator merely needs to switch it on, as it is already calibrated to the relevant standard. Aside from the personal warning function, RadMan can be used as a monitoring and leak locator unit simply by sliding the absorber cap over the battery compartment. In addition, it is able to distinguish the differences in limit values for different frequencies, showing the correct exposure value as a percentage of the relevant limit value on the LED display.

Wandel & Goltermann/Chase Systems, Flanders, NJ

Reader Service No. 338

UNI-FILTER® 384-Well Filter Bottom Microplates from Whatman

Chemists and life scientists working in combinatorial chemistry or genomics can very easily boost their productivity by 400% with the new UNI-FILTER® 384-well filter bottom microplates for high throughput screening.

These new robotics compatible UNI-FILTER® 384-well filter bottom microplates have the same size footprint as the widely available standard 96-well microplate. This means that each 384-well microplate fits the majority of microplate readers that read 384 wells. In addition to fitting commonly used microplate readers, each accurately and precisely manufactured 384-well UNI-FILTER® filter bottom microplate can be used with any automated liquid handling and reagent dispensing systems built to handle 384-well microplates.

Each well in every Whatman UNI-FILTER® 384-well filter bottom microplates has a capacity of 100 µL. Drip directors are integral parts of the sturdy clear polystyrene device and facilitate collection of filtrate by a 384-well UNIPLATE™ collection plate without crosstalk.

Whatman UNI-FILTER® 384-well filter bottom microplates are versatile and ideal for a wide variety of applications. Whatman UNI-FILTER® 384-well filter bottom microplates are available with GF/C and GF/B glass microfibre filters that have broad chemical compatibility, high flow rates, and nominal pore sizes of 1.2 µm and 1.0 µm, respectively. In addition, UNI-FILTER® 384-well filter bottom microplates are also available with 0.45 µm PVDF (polyvinylidene fluoride) and WCN (Whatman cellulose nitrate) membrane filters. UNI-FILTER® 384-well filter bottom

microplates with the low non-specific protein binding PVDF membrane filters are suitable for work with both aqueous and organic samples and the general purpose WCN membrane is suitable for the filtration of a wide variety of aqueous samples.

Whatman Inc., Clifton, NJ

Reader Service No. 339

Eleven Silliker Labs Receive ISO 25 Accreditation

Silliker Laboratories Group, Inc. has received ISO/IEC Guide 25 (ISO 25) accreditation for 11 labs from the American Association for Laboratory Accreditation (A2LA). ISO 25 defines the criteria for recognition as a competent lab.

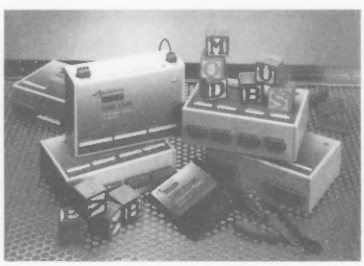
Silliker's labs are the first to be accredited by A2LA, the nation's leading accreditor of laboratories, to the more specific, highly stringent standards developed by the Food Laboratory Accreditation Working Group (FLAWG). These standards are now maintained by AOAC International's Technical Division for Laboratory Management.

A2LA accreditation to ISO 25, which defines critical elements for quality management and technical requirements for proper operation, provides an objective thirdparty assessment of the technical competence of Silliker's laboratory staff. It also attests to the fact that Silliker has been found to be in compliance with an internationally recognized set of standards.

The accredited labs are located in California, Georgia, Illinois, Iowa, Minnesota, New Jersey, Ohio, Pennsylvania, Texas, and Wisconsin. Silliker's Ontario, Canada, and new Modesto labs (formerly DFL Laboratories) will go through the assessment process over the next 12 months.

Silliker Laboratories Group, Inc., Homewood, IL

Reader Service No. 340



Solartron, Inc.

Precision Data Acquisition and Control Pods

Solartron, Inc., has launched a family of compact DIN-rail mounting data acquisition and control units, optimized for highly distributed SCADA and DCS installations. This new set of modules, designated the 3593 Family, is ideal for applications requiring high-accuracy, low channel-count clusters distributed over a wide area. Typical applications range from water treatment plants and cold-storage warehouse monitoring to machinery condition monitoring and building access and climate control. Industry-standard MODBUS/RS485 interfacing ensures immediate integration into most commercially available SCADA/DCS systems, enabling instrumentation engineers to add data acquisition front-ends to pumps, fans, and status monitoring to doors or valves, where it was previously uneconomic.

Solartron's 3593 Family comprises three analog data acquisition modules, a digital 1/0 module, one for proportional analog control, and an RS232 to RS485 converter.

Optional support software includes a simple data logging system built around a DDE server, which additionally allows data to be transferred directly into, for example spreadsheets and a configuration program. All measurement and control electronics are packaged in 150mm × 100mm × 50mm plastic cases and can be DIN-rail mounted within, say, an IP65 mounting case, or free standing for ultimate installation flexibility at or near to the point of measurement. Installation is further simplified by the modules' ability to operate from any 10-30V ac or dc power source and in ambient temperatures up to 70°C.

Precision analog measurement requirements are met by the four channel 3593 134A module with its 16.67 millisecond integration time, 16-bit multislope ADC and better than ±0.025% accuracy, making it one of the most accurate DIN-rail mounting data acquisition units available today. Measurement rate is limited solely by the 38.4 kBaud RS485 communications network and polling by the control computer.

Solartron Inc., Allentown, PA

Reader Service No. 341

Dairy, Food and Environmental Sanitation, Vol. 18, No. 10, Pages 687-696

3-A® Sanitary Standards for Spray Cleaning Devices Intended to Remain in Place, Number 78-00

Formulated By
International Association of Milk, Food and Environmental Sanitarians
United States Public Health Service
The Dairy Industry Committee

The 3-A Sanitary Standards and 3-A Accepted Practices provide hygienic criteria applicable to equipment and systems used to safely produce, process, and package milk, milk products, and both perishable and nonperishable foods or comestible products. It is the purpose of the IAMFES, USPHS, and DIC in connection with the development of the 3-A Sanitary Standards Program to allow and encourage full freedom for inventive genius or new developments. Spray cleaning device specifications heretofore or hereafter developed which so differ in design, materials, and fabrication or otherwise as not to conform to the following standards but which, in the fabricator's opinion, are equivalent or better, may be submitted for the joint consideration of the IAMFES, USPHS, and DIC at any time.

A **SCOPE**

A1 These standards cover the sanitary aspects of spray cleaning devices attached to stainless steel solution supply tubes intended to remain in place during processing operations and used on storage and processing equipment and machinery for milk, milk products, or other comestibles. These standards do not cover spray cleaning devices which are removed prior to processing operations.

A2 In order to conform with these 3-A Sanitary Standards, spray cleaning devices shall comply with the following design, material, and fabrication criteria and the applicable documents referenced herein.

B **DEFINITIONS**

B1 *Product:* Shall mean milk, milk products, and other comestibles.

B2 *Solutions:* Shall mean water and/or those homogeneous mixtures of cleaning agents and/or sanitizers and water used for flushing, cleaning, rinsing, and sanitizing.

B3 **Surfaces**

B3.1 *Product Contact Surfaces:* Shall mean all surfaces which are exposed to the product and surfaces from which liquids may drain, drop, diffuse, or be drawn into the product.

B3.2 *Solution Contact Surfaces:* Shall mean the interior surfaces of the equipment or system which are used exclusively for supply and recirculation of cleaning and/or sanitizing solutions, except those used to supply concentrated cleaning and/or sanitizing materials to the point of use.

B3.3 *Nonproduct Contact Surfaces:* Shall mean all other exposed surfaces.

B4 **Cleaning**

B4.1 *Mechanical Cleaning or Mechanically Cleaned*: Shall mean soil removal by impingement, circulation, or flowing chemical detergent solutions and water rinses onto and over the surfaces to be cleaned by mechanical means in equipment or systems specifically designed for this purpose.

B4.1.1 *Cleaned In Place (CIP):* Shall mean mechanical cleaning of equipment, the cleanability of which has been sufficiently established such that all product or solution contact surfaces do not have to be readily accessible for inspection (for example, silo-type tanks or welded pipelines).

B5 **Surface Modification**[2]

B5.1 *Surface Treatments:* Shall mean a process whereby chemical compositions or mechanical properties of the existing surface are altered. There is no appreciable, typically less than 1 µm build-up of new material; or removal of existing material.

B5.1.1 Surface treatments include:

1. Mechanical (shot peening[3], polishing)
2. Thermal (surface hardening, laser, electron beam)
3. Diffusion (carburizing, nitriding)
4. Chemical (etching, oxidation)
5. Electropolishing

B6 *Sanitizing or Sanitization:* Shall mean a process applied to a cleaned surface which is capable of reducing the numbers of the most resistant human pathogens by at least 5 $\log_{10}$ reductions (99.999%) to 7 $\log_{10}$ reductions (99.99999%) by applying accumulated hot water or steam or by applying an EPA-registered sanitizer according to label directions. Sanitizing may be effected by mechanical or manual methods.

B7 *Sterilization:* Shall mean a process effected by heat, chemicals, or other mechanical means that destroys all vegetative bacteria and inactivates relevant bacterial spores.

B8 *Readily or Easily Removable:* Shall mean quickly separated from the equipment with the use of simple hand tools if necessary.

B9 *Simple Hand Tools:* Shall mean implements normally used by operating and cleaning personnel such as a screwdriver, wrench, or mallet.

B10 *Easily or Readily Accessible:* Shall mean a location which can be safely reached by an employee from the floor, platform, or other permanent work area.

B11 *Inspectable:* Shall mean all product contact surfaces can be made available for close visual observation.

B12 *Dead End:* Shall mean an area or space wherein a product, ingredient, cleaning or sanitizing agent, or other extraneous matter may be trapped, retained, or not completely displaced during operational or cleaning procedures.

B13 *Substantially Flush:* Shall mean mating surfaces or other juxtaposed surfaces shall be within 1/32 in. (0.794 mm).

B14 *Close Coupled:* Shall mean mating surfaces or other juxtaposed surfaces that are less than twice the nominal diameter or cross section of the mating surfaces or a maximum of 5 in. (127 mm).

C **MATERIALS**

C1 **Metals**

C1.1 Product and solution contact surfaces shall be of stainless steel of the American Iron and Steel Institute (AISI) 300 Series[4] or corresponding Alloy Cast Institute (ACI) types[5] (See Appendix, Section E), or metal which under conditions of intended use is at least as corrosion resistant as stainless steel of the foregoing types, and is nontoxic and nonabsorbent.

C2 **Nonmetals**

C2.1 Plastic materials may be used for all spray cleaning devices, seals, O-rings, gaskets, and parts having the same functional purposes.

C2.1.1 Plastic materials, when used for the above specified application(s), shall conform with the applicable provisions of the 3-A Sanitary Standards for Multiple-Use Plastic Materials Used as Product Contact Surfaces for Dairy Equipment Number 20-.

C2.2 Rubber and rubber-like materials may be used for coatings, seals, O-rings, gaskets, and parts having the same functional purposes.

C2.2.1 Rubber and rubber-like materials, when used for the above specified application(s), shall conform with the applicable provisions of the 3-A Sanitary Standards for Multiple-Use Rubber and Rubber-Like Materials Used as Product Contact Surfaces in Dairy Equipment, Number 18-.

C2.3 Rubber and rubber-like materials or plastic materials having product contact surfaces shall be of such composition as to retain their surface and conformational characteristics when exposed to the conditions encountered in the environment of intended use and in cleaning and bactericidal treatment or sterilization.

C2.4 The final bond and residual adhesive, if used, on bonded rubber and rubber-like materials and bonded plastic materials shall be nontoxic[6].

C2.5 Where materials having certain inherent functional purposes are required for specific applications, such as seals and/or bearing components, carbon and/or ceramic materials may be used. Carbon and/or ceramic materials shall be inert, nonporous, nontoxic, nonabsorbent, insoluble, resistant to scratching, scoring, and distortion when exposed to the conditions encountered in the environment of intended use and in cleaning and bactericidal treatment or sterilization.

C3 **Sterilizability**

C3.1 In a processing system to be sterilized by heat and operated at a temperature of 250°F (121°C) or higher, all materials having product contact surface(s) used in the construction of spray cleaning devices and nonmetallic component parts shall be such that they can be (1) sterilized by saturated steam or water under pressure (at least 15.3 psig or 106 kPa) at a temperature of at least 250°F (121°C) and (2) operated at the temperature required for processing.

C4 **Nonproduct Contact Surfaces**

C4.1 All nonproduct contact surfaces shall be of corrosion-resistant material or material that is rendered corrosion resistant. If coated, the coating used shall adhere. All nonproduct contact surfaces shall be relatively nonabsorbent, durable, and cleanable. Parts removable for cleaning having both product contact and nonproduct contact surfaces shall not be painted.

D **FABRICATION**

D1 **Surface Finish**

D1.1 All product and solution contact surfaces shall have a finish at least as smooth as a No. 4 ground finish on stainless steel sheets and be free of imperfections such as pits, folds, and crevices in the final fabricated form, except as provided for in Section D2. (See Appendix, Section F.)

D2 **Permanent Joints**

D2.1 All permanent joints in metallic product and solution contact surfaces shall be continuously welded. Welded areas on product contact surfaces shall be at least as smooth as a No. 4 ground finish on stainless steel sheets, and be free of imperfections such as pits, folds, and crevices when in the final fabricated form, except that where welds are not accessible for grinding and polishing, the following welding requirements shall be followed.

D2.1.1 All welds shall be made by the TIG method or an equally satisfactory method. The following precautions shall be taken:

D2.1.1.1 Inert back-up gas shall be used to protect and control the interior of the weld.

D2.1.1.2 The welding surface (interior, face, and exterior) shall be cleaned and freed of all foreign matter and surface oxide before welding. Iron-free abrasive shall be used when cleaning surfaces.

D2.1.1.3 All tube and fitting ends shall be square cut and deburred.

D2.1.1.4 Welding procedures shall assure uniform and complete penetration of the weld at all times.

D2.1.1.5 All welds having pits, craters, ridges, or imbedded foreign materials shall be removed and the joints shall be properly re-welded.

D2.1.1.6 Internal and external grinding and/or polishing of pipeline or device assembly welds is not required. However, welds performed from the outside of a pipeline or device cannot create imperfections such as pits, folds, and crevices on the interior of the pipeline or device.

D2.1.1.7 A boroscope or other acceptable inspection device shall be available to use to inspect representative welds.

D3 **Bonded Materials**

D3.1 Bonded rubber and rubber-like materials and bonded plastic materials having product contact surfaces shall be bonded in a manner that the bond is continuous and mechanically sound, so that when exposed to the conditions encountered in the environment of intended use and in cleaning and bactericidal treatment or sterilization, the rubber and rubber-like material or the plastic material does not separate from the base material to which it is bonded.

D4 **Cleaning and Inspectability**

D4.1 Spray cleaning devices shall be designed so that the product and solution contact surfaces of the spray cleaning devices and all nonremoved appurtenances thereto can be mechanically cleaned and shall be installed to be accessible and readily removable for inspection or readily inspectable in place.

D5 **Inlet Connections**

D5.1 When provided, sanitary inlet fittings, connections, and valves shall conform with those applicable provisions of 3-A Sanitary Standards for Polished Metal Tubing for Dairy Products, Number 33-,3-A Sanitary Standards for Fittings for Milk and Milk Products, Number 63- and the applicable 3-A Sanitary Standard for the valve in use.

D5.2 Self-cleaning slip-joints and retaining clips are an acceptable method of attaching spray cleaning devices to solution supply tubes. (See Appendix, Sections G and H.)

D6 **Mating and Bearing Surfaces**

D6.1 Product and solution contact mating surfaces or areas that provide a bearing surface for a rotating element shall permit the cleaning solution to flush the entire surface during the cleaning cycle and drainage after the cycle.

D7 **Draining**

D7.1 Product and solution contact surfaces shall be self-draining except for normal clingage when properly installed.

D8 **Radii**

D8.1 All internal angles of less than 135° on product and solution contact surfaces shall have radii of not less than 1/8 inch (3.18 mm), except that:

D8.1.1 Smaller radii may be used when they are required for essential functional reasons, such as bearing surfaces or fittings referenced in Section D5.1. In no case shall such radii be less than 1/32 inch (0.794 mm).

D8.1.1.1 Holes for retaining clips shall be not less than 1/8 in. (3.18 mm) in diameter.

D8.1.2 Radii in standard O-ring grooves shall be as specified in Appendix, Section I.

D8.1.3 Radii of spray orifices are at the discretion of the fabricator.

D9 **Gaskets**

D9.1 Gaskets having a product or solution contact surface shall be removable or bonded.

D9.2 Grooves in gaskets shall be no deeper than their width.

D9.3 Gasket retaining grooves in product or solution contact surfaces for removable gaskets shall not exceed 1/4 in. (6.35 mm) in depth or be less than 1/4 in. (6.35 mm) wide except those for standard O-rings smaller than 1/4 in. (6.35 mm), and those provided for in Section D5.1.

D10 **Threads**

D10.1 There shall be no threads on product or solution contact surfaces.

D11 **Springs**

D11.1 Any coil spring having product or solution contact surfaces shall have at least 3/32 in. (2.38 mm) openings between coils, including the ends, when the spring is in the free position.

D12 **Sterilization Systems**

D12.1 Spray cleaning devices used in a processing system to be sterilized by heat and operated at a temperature of 250°F (121°C) or higher shall comply with the following additional criteria:

D12.1.1 The construction shall be such that all product contact surfaces can be (1) sterilized by saturated steam or water under pressure (at least 15.3 psig or 106 kPa) at a temperature of at least 250°F (121°C) and (2) operated at the temperature required for processing.

D13 **Nonproduct and Nonsolution Contact Surfaces**

D13.1 Nonproduct and nonsolution contact surfaces shall have a smooth finish free of pockets and crevices, and shall be readily cleanable. Those surfaces to be coated shall be effectively prepared for coating.

D14 **Retractable Spray Cleaning Devices**

D14.1 Retractable spray cleaning devices shall be of substantially flush construction and automatically operated.

D14.2 Retractable spray cleaning devices with powered actuators shall have an open space of at least one inch, clear for inspection, between the actuator and the retractable spray cleaning device.

D14.2.1 Powered actuators shall be readily demountable from the retractable spray cleaning device and stem.

APPENDIX

E **STAINLESS STEEL MATERIALS**

Stainless steel conforming to the applicable composition ranges established by AISI for wrought products, or by ACI for cast products, should be considered in compliance with the requirements of Section C1 herein. Where welding is involved, the carbon content of the stainless steel should not exceed 0.08%. The first reference cited in C1 sets forth the chemical ranges and limits of acceptable stainless steel of the 300 Series. Cast grades of stainless steel corresponding to types 303, 304, and 316 are designated CF-16F, CF-8, and CF-8M, respectively. The chemical compositions of these cast grades are covered by ASTM specifications[7] A351/A351M, A743/A743M and A744/A744M.

F **PRODUCT CONTACT SURFACE FINISH**

Surface finish equivalent to a 150 grit or better as obtained with silicon carbide, properly applied on stainless steel sheets, is considered in compliance with the requirements of Section D1 herein. A maximum of R_a of 32µin. (0.80 µm), when measured according to the recommendations in American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)[8] B46.1- *Surface Texture*, is considered to be equivalent to a No. 4 finish.

G SPRAY DEVICE INSTALLATION AND APPLICATION

The installation of Spray Devices must be adequate to clean each application. The installation of sprays in existing tanks, of older design, may require the prior installation of nozzles, and the subsequent modification of some appurtenances such as agitator couplings and bearings to make them cleanable. A variety of fittings are illustrated in APPENDIX H and descriptions follow:

G1 Spray cleaning devices may be affixed to removable spray solution supply tubes installed through installation fittings above the product zone, or may be affixed to permanently welded-in spray solution supply tubes which enter above the product zone (See Appendix, Section H.)

G1.1 If a removable solution supply tube is installed through an installation fitting, means should be provided for effective mechanical cleaning of the resulting annular space.

G1.2 If a permanently welded-in solution supply tube is used, the equipment design, construction, and installation should provide for access to each of the solution supply tubes for purposes of removing and re-installing spray cleaning devices, either through the personnel access ports by strategic placement of the tubes, or by entering the equipment.

G2 Spray installation nozzles and solution supply tubes may penetrate equipment walls below the product zone if there is no other manner to install the spray head to achieve the required coverage.

G2.1 The installation fitting should include a close coupled valve at the interface of the internal tank wall, to eliminate dead ends, and the entire fitting should be free draining when the tank is emptied.

G3 INSTALLATION FITTINGS

G3.1 **Clamp-Type Tank Spud:** Spray supply tubes are commonly welded through clamp caps as shown in Figure 1 and drilled with three 1/16 in. (1.59 mm) holes 1 in. (25.4 mm) beneath the cap. Spray headers, spray balls, or rotating sprays are then attached to the end of the tube, from inside the tank, by use of a Slip-Joint and Retaining Clip as shown in Figures 3 and 4. This concept is widely used with single or multiple 2-1/2 in. (63.5 mm) spray cleaning devices that can be installed and removed from outside the tank.

G3.2 **Weld-In Type, with Fillet Adapter:** Weld-in supply tubes may be installed per Figure 2. "Fillet Adapters" also shown in Figure 2 may be used to avoid problems of burning holes through the supply tube within the insulated area when attempting to make fillet welds.

G4 TYPICAL SPRAY CLEANING DEVICES

G4.1 **Slip-Joint and Retaining Clip:** These components, shown as Figure 3, when machined to repeatable close tolerances, have been shown to be self-cleaning, and a satisfactory means of assembling simple or complex spray systems within the product zone of storage and processing vessels. A fixed drilled ball-type spray is welded to the slip-joint in the example.

G4.2 **Bubble Spray:** The bubble spray is an alternative spray cleaning device for dry product dairy and food equipment. (See Figures 5 and 6.) A modified design, Figure 6, provides relatively flush interior surfaces. In both bubble spray applications the provision of three or more holes in the spray supply tube, and proper clearances between the tube and adapter make the assemblies self-cleaning. The solution supply piping may be continuously purged with filtered air to prevent product entry.

G4.3 **Elbow Sprays:** Many variations of the concept shown in Figure 4 have been applied to provide coverage of the underside of evaporator tube sheets, large ductwork elbows, and many types of non-liquid processing equipment. A spray head on a standard radius elbow can be installed or removed from outside of the equipment. A second elbow may be welded to the spray tube as shown in Figure 1 to properly position the spray via the final connection to the cleaning solution supply line.

G4.4 **Rotating Spray:** An assembly is installed on the end of a supply tube as shown in Figure 7 or 8, and held in place with a stainless steel Retaining Clip similar to Figure 3.

G4.5 **Retractable Spray Nozzles:** Automatically operated, substantially flush nozzles prevent the product from moving into the cleaning solution supply piping during the production run. Figure 9 illustrates a pneumatically retractable spray cleaning device.

G5 SPECIAL CONSIDERATIONS

G5.1 **Spray Cleaning Devices Below the Product Level:** For those applications which require permanent installation of the spray cleaning device below the normal product level, compliance with close coupling requirements can be achieved by modifying an air-operated cross-type valve outlet port for installation through a clamp-type tank spud (Figure 1), in combination with a slip-joint connection (Figures 3 and

4) for the submerged spray device. The cleaning solution supply to the valve would be isolated and the supply pipe and valve body would be drained before and during the production run (Figure 10).

G5.2 **Tanks With Vertical Agitators:** With tanks using vertical agitators, at least two spray devices are required to ensure complete coverage with no pattern shadows. (See Figure 11). They should be installed through clamp type spuds to allow removal for inspection. The spray devices should mount on the supply piping using retaining pins to allow inspection.

H DIAGRAMS

The diagrams are intended to demonstrate general principles only, and are not intended to limit individual ingenuity. The design used should conform with sanitary requirements set forth in these 3-A Sanitary Standards.

I O-RING GROOVE RADII

TABLE 1
Groove Radii Dimensions for Standard O-Rings

O-Ring Cross Section, Nominal (AS 568)[9]	O-Ring Cross Section, Actual (AS 568)	O-Ring Cross Section, Actual (ISO 3601-1)[10]	Minimum Groove Radius
1/16 in.	0.070 in.	1.80 mm	0.016 in. (0.406 mm)
3/32 in.	0.103 in.	2.65 mm	0.031 in. (0.787 mm)
1/8 in.	0.139 in.	3.55 mm	0.031 in. (0.787 mm)
3/16 in.	0.210 in.	5.30 mm	0.062 in. (1.575 mm)
1/4 in.	0.275 in.	7.00 mm	0.094 in. (2.388 mm)

J ENGINEERING DESIGN AND TECHNICAL CONSTRUCTION FILE

The following is an example of an engineering design and technical construction file (EDTCF) to be maintained by the fabricator as evidence of complying with 3-A Sanitary Standards.

J1 Purpose

J1.1 To establish and document the material, fabrication, and installation (where appropriate) requirements for the engineering design and technical construction files for all products, assemblies, and sub-assemblies supplied by the manufacturer thereof to be in compliance with the sanitary criteria found in 3-A Sanitary Standards or 3-A Accepted Practices. It is recommended that the engineering and construction file or files be submitted with applications for 3-A Symbol use authorization.

J2 Scope

J2.1 This EDTCF applies to equipment specified by:

J2.1.1 List all applicable 3-A Sanitary Standards and 3-A Accepted Practices.

J3 Responsibilities

J3.1 This EDTCF is maintained by: The Engineering Manager (or other company official) {name and title of responsible official} is responsible for maintaining, publishing, and distributing this EDTCF.

J3.2 Implementation: All divisions, specifically development engineering, standards engineering, sales engineering, and product departments are responsible for implementing this EDTCF.

J4 Applicability

J4.1 The 3-A Sanitary Standards and 3-A Accepted Practices are voluntarily applied as suitable sanitary criteria for dairy and food processing equipment. 3-A Sanitary Standards are referenced in the Grade A Pasteurized Milk Ordinance: "Equipment manufactured in conformity with 3-A Sanitary Standards complies with the sanitary design and construction standards of this Ordinance."

J5 References

J5.1 List any additional regulations that apply to the equipment or system covered by this EDTCF.

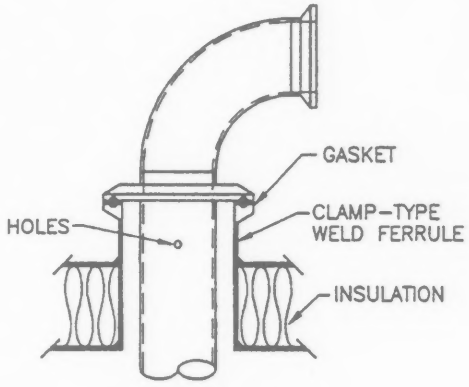
J5.2 Date of conformity or 3-A Symbol Authorization and certificate number, if authorized.

J6 Design and Technical Construction File

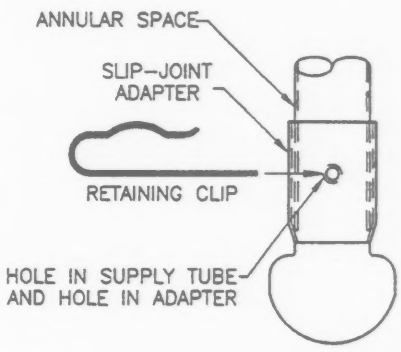
J6.1 The Engineering Design and Technical Construction File may consist of the following:

a. an overall drawing of the subject equipment;
b. full detailed drawings, accompanied by any calculations, notes, test results, etc. required to check the conformity of the equipment with the 3-A Standards or 3-A Practices;
c. a list of:
   (1) the essential requirements of the standards or practices;
   (2) other technical specifications, which were used when the equipment was designed;

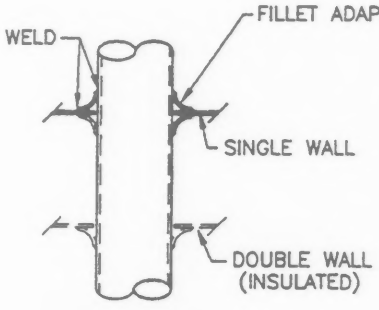
78–00
APPENDIX H



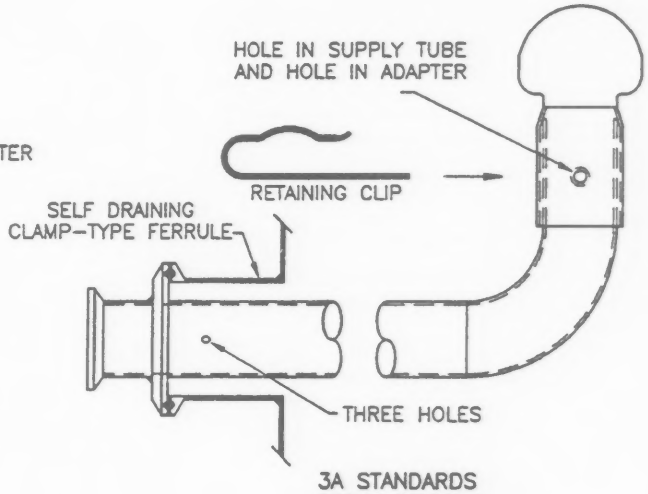
3A STANDARDS
SPRAY DEVICES
CLAMP–TYPE TANK SPUD
FIGURE 1



3A STANDARDS
SPRAY DEVICES
FIXED BALL SPRAY WITH
SLIP–JOINT AND CLIP
FIGURE 3



3A STANDARDS
SPRAY DEVICES
WELD–IN SPRAY TUBE
WITH FILLET ADAPTERS
FIGURE 2



3A STANDARDS
SPRAY DEVICES
ELBOW SPRAY
FIGURE 4

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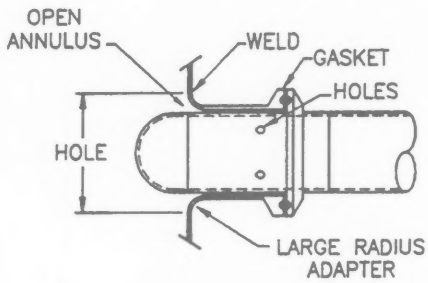
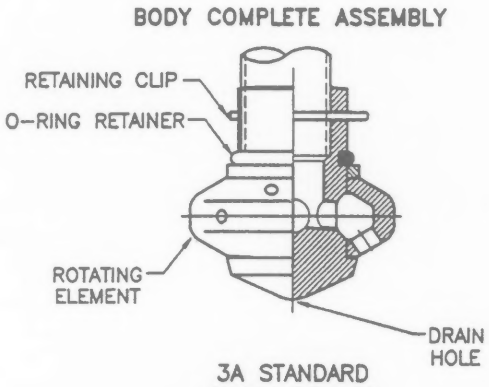
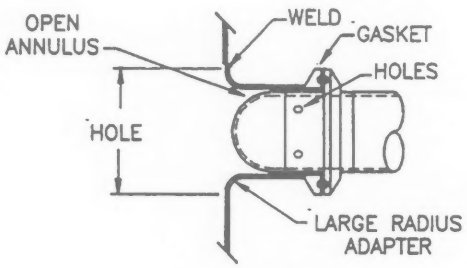
APPENDIX H



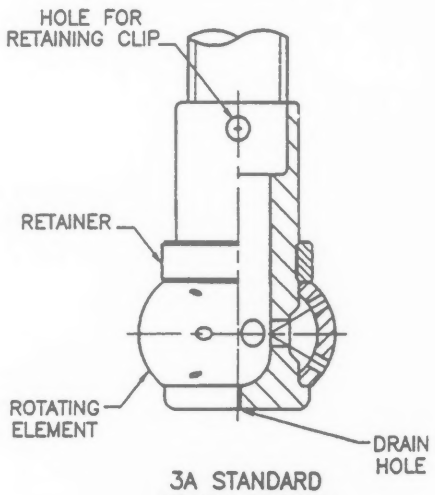
3A STANDARD
SPRAY DEVICES
BUBBLE SPRAY (PROJECTING)
FIGURE 5



3A STANDARD
SPRAY DEVICES
ROTATING SPRAY ASSEMBLY
FIGURE 7

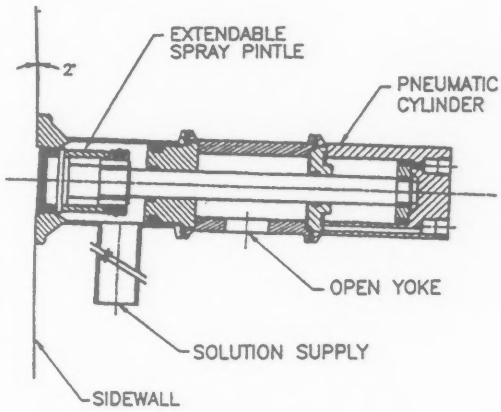


3A STANDARD
SPRAY DEVICES
BUBBLE SPRAY (FLUSH)
FIGURE 6

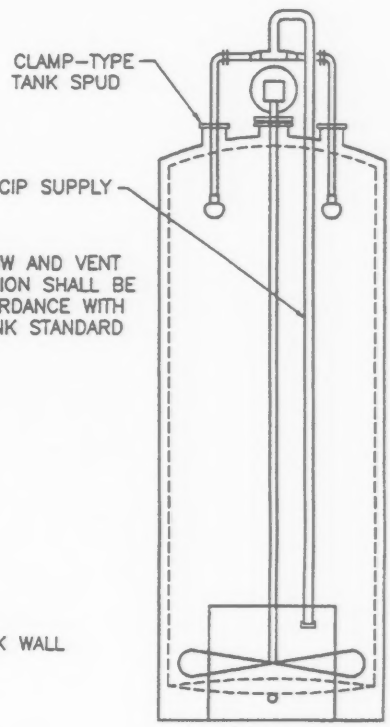


3A STANDARD
SPRAY DEVICES
ROTATING SPRAY ASSEMBLY
FIGURE 8

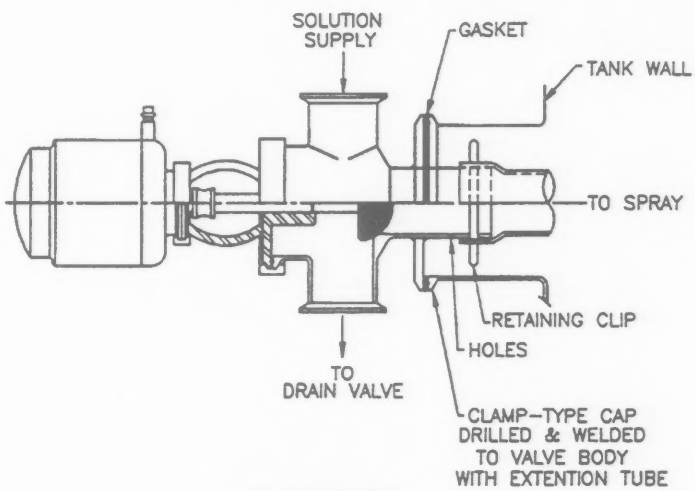
78–00
APPENDIX H



3A STANDARD
SPRAY DEVICES
RETRACTABLE SPRAY ASSEMBLY
FIGURE 9



3A STANDARD
SPRAY DEVICES
SILO TANK
WITH VERTICAL AGITATORS
FIGURE 11



3A STANDARD
SPRAY DEVICES
CROSS–TYPE SHUT–OFF VALVE
FOR CIP SUPPLY TO
SUBMERGED SPRAYS
FIGURE 10

d. if essential, any technical report or certificate obtained from a competent testing-body or laboratory;
e. any technical report giving the results of tests carried out internally by Engineering or others;
f. a determination of the foreseeable lifetime of the product (optional);
g. a copy of the instructions for the product (Instruction Manuals/Instruction Books);
h. for serial manufacturing, the internal measures that will be implemented to insure that the equipment will continue to be manufactured in conformity with the provisions of the 3-A Sanitary Standards or 3-A Accepted Practices;
i. change records;
j. any notified body technical reports and certification tests;
k. copy of the 3-A Symbol authorization, if applicable.

J6.2 The file does not have to include detailed plans or any other specific information regarding the sub-assemblies, tooling, or fixtures used for the manufacture of the product unless a knowledge of them is essential for verification of conformity with the basic sanitary requirements found in 3-A documents.

J6.3 The documentation referred to in J6.1 above need not permanently exist in a material manner in the EDTCF, but it should be possible to assemble them and make them available within a period of time commensurate with its importance (one week is considered reasonable time). As a minimum, each product EDTCF should physically contain an index of the applicable document of J6.1 above.

J6.4 The EDTCF may be in hard copy or software form.

J7 **Confidentiality**

J7.1 The EDTCF is the property of the manufacturer and is shown at their discretion, except that all or part of this file will be available to the 3-A Symbol Council or a regulatory agency for cause and upon request.

J8 **File Location**

J8.1 The EDTCF shall be maintained at {location}.

J9 **File Retention**

J9.1 The EDTCF (including all documentation referred to in J6.1) shall be retained and kept available for 12 years following the date of placing the product in use or from the last unit produced in the case of series manufacture.

This 3-A Sanitary Standard is effective November 15, 1998.

[1]Use current revisions or editions of all referenced documents cited herein.

[2]Additional information on surface modification is contained in *Advanced Materials and Processes*, Volume 137(1), January 1990; "Coatings and Coating Practices" by H. Herman, p. 59; "Surface Modification" by F. A. Smidt, p. 61. ASM International, Materials Park, OH 44073; Phone: 216.338.5151.

[3]MIL-S-13165C(1), November 1991, *Military Specification: Shot Peening of Metal Parts*. Available from Standardization, Document Order Desk (Department of Navy), 700 Robbins Ave., Building 4, Section D, Philadelphia, PA 19111-5094; Phone: 215.697.2179.

[4]The data for this series are contained in the *AISI Steel Products Manual, Stainless & Heat Resisting Steels,* November 1990, Table 2-1, pp. 17-20. Available from the American Iron and Steel Society, 410 Commonwealth Drive, Warrendale, PA 15086; Phone: 412.776.1535.

[5]Steel Founders Society of America, Cast Metal Federation Building, 455 State Street, Des Plaines, IL 60016; Phone: 708.299.9160.

[6]Adhesives shall comply with 21 CFR 175 – Indirect Food Additives: Adhesives and Components of Coatings. Document for sale by the Superintendent Documents, U.S. Government Printing Office, Washington, D.C. 20402; Phone: 202.783.3238.

[7]Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959; Phone: 610.832.9500.

[8]Available from the American Society of Mechanical Engineers, 345 E. 47th St., New York, NY 10017-2392; Phone: 212.705.7722.

Dairy, Food and Environmental Sanitation, Vol. 18, No. 10, Pages 697-703

3-A® Sanitary Standards for Auger-Type Feeders, Number 81-00

Formulated By
International Association of Milk, Food and Environmental Sanitarians
United States Public Health Service
The Dairy Industry Committee

It is the purpose of the IAMFES, USPHS, and DIC in connection with the development of the 3-A Sanitary Standards Program to allow and encourage full freedom for inventive genius or new developments. Auger-type feeder specifications heretofore or hereafter developed which so differ in design, materials, and fabrication or otherwise as not to conform to the following standards but which, in the fabricator's opinion, are equivalent or better, may be submitted for the joint consideration of the IAMFES, USPHS, and DIC at any time. The 3-A Sanitary Standards and 3-A Accepted Practices provide hygienic criteria applicable to equipment and systems used to produce, process, and package milk, milk products, and other perishable foods or comestible products.

A **SCOPE**

A1 These standards cover the sanitary aspects of auger-type feeders used to convey, at a controlled rate, dry milk, dry milk products and dry milk products and associated ingredients. Product enters the auger-type feeder hopper and exits at the auger output via a discharge tube assembly.

A2 In order to conform with these 3-A Sanitary Standards, auger-type feeders shall comply with the following design, material, and fabrication criteria and the applicable documents referenced herein[1].

B **DEFINITIONS**

B1 *Product:* Shall mean dry milk, dry milk products, and other food ingredients.

B2 *Solutions:* Shall mean water and/or those homogeneous mixtures of cleaning agents and/or sanitizers and water used for flushing, cleaning, rinsing, and sanitizing.

B3 *Auger-Type Feeder:* Shall mean equipment in which an auger(s) is used to feed or meter products and may include integral mechanisms to assist or maintain flow of product.

B4 **Surfaces**

B4.1 *Product Contact Surfaces:* Shall mean all surfaces which are exposed to the product and surfaces from which liquids or materials may drain, drop, diffuse, or be drawn into the product.

B4.2 *Nonproduct Contact Surfaces:* Shall mean all other exposed surfaces.

B5 **Cleaning**

B5.1 *Manual (COP) Cleaning:* Shall mean soil removal when the equipment is partially or totally disassembled. Soil removal is effected with chemical solutions and water rinses with the assistance of one or a combination of brushes, nonmetallic scouring pads and scrapers, high or low pressure hoses and tank(s) which may be fitted with recirculating pump(s), and with all cleaning aids manipulated by hand.

B6 **Surface Modification[2]**

B6.1 *Surface Treatments:* Shall mean a process whereby chemical compositions or mechanical properties of the existing surface are altered. There is no appreciable, typically less than 1 µm, build-up of new material; or removal of existing material.

B6.1.1 Surface treatments include:

1. Mechanical (shot peening[3], polishing)

B6.2 *Coatings:* Shall mean the results of a process where a different material is deposited to create a new surface. There is appreciable,

typically more than 1 µm build-up of new material.

B6.2.1 Coating process includes:

1. Spraying

B7 *Soil:* Shall mean the presence of unwanted organic residue or inorganic matter, with or without microorganisms, including food residue, in or on the equipment.

B8 *Sanitizing or Sanitization:* Shall mean a process applied to a cleaned surface which is capable of reducing the numbers of the most resistant human pathogens by at least 5 $\log_{10}$ reductions (99.999%) to 7 $\log_{10}$ reductions (99.99999%) by applying accumulated hot water or steam or by applying an EPA-registered sanitizer according to label directions. Sanitizing may be effected by mechanical or manual methods.

B9 *Easily or Readily Removable:* Shall mean quickly separated from the equipment with the use of simple hand tools if necessary.

B10 *Easily or Readily Accessible:* Shall mean a location which can be safely reached by an employee from the floor, platform, or other permanent work area.

B11 *Simple Hand Tools:* Shall mean implements normally used by operating and cleaning personnel such as a screwdriver, wrench, or mallet.

B12 *Nontoxic Materials:* Shall mean those substances which under the conditions of their use are in compliance with applicable requirements of the Food, Drug, and Cosmetic Act of 1938, as amended.

B13 *Dead End:* Shall mean an area or space wherein a product, ingredient, cleaning, or sanitizing agent, or other extraneous matter may be trapped, retained, or not completely displaced during operational or cleaning procedures.

B14 *Substantially Flush:* Shall mean mating surfaces or other juxtaposed surfaces shall be within 1/32 in. (0.794 mm).

B15 *Corrosion Resistant:* Shall mean the surface has the property to maintain its original surface characteristics for its predicted service period when exposed to the conditions encountered in the environment of intended use, including expected contact with product and cleaning, sanitizing, or sterilization compounds or solutions.

B16 Inspectable: Shall mean all product contact surfaces can be made available for close visual observation.

C MATERIALS

C1 Metals

C1.1 Product contact surfaces shall be of stainless steel of the American Iron and Steel Institute (AISI) 300 Series[4] or corresponding Alloy Cast Institute (ACI) types[5] (See Appendix, Section E), or metal which under conditions of intended use is at least as corrosion resistant as stainless steel of the foregoing types, and is nontoxic and nonabsorbent.

C2 Nonmetals

C2.1 Rubber and rubber-like materials may be used for coatings for augers and auger parts; and flexible hoppers, gaskets, shaft seals, O-rings, paddles, scrapers, and parts having the same functional purposes.

C2.1.1 Rubber and rubber-like materials, when used for the above-specified application(s), shall conform with the applicable provisions of the 3-A Sanitary Standards for Multiple-Use Rubber and Rubber-Like Materials Used as Product Contact Surfaces in Dairy Equipment, Number 18-.

C2.2 Plastic materials may be used for augers and auger parts, flexible hoppers, discharge tubes, O-rings, paddles, scrapers, bushings, bearing, seals, sight and/or light openings, and parts having the same functional purposes. Plastic materials may also be used for coatings for augers and auger parts, and discharge tubes and paddles.

C2.2.1 Plastic materials, when used for the above-specified application(s), shall conform with the applicable provisions of the 3-A Sanitary Standards for Multiple-Use Plastic Materials Used as Product Contact Surfaces for Dairy Equipment, Number 20-.

C2.3 Rubber and rubber-like materials and plastic materials having product contact surfaces shall be of such composition as to retain their surface and conformational characteristics when exposed to the conditions encountered in the environment of intended use and in cleaning and bactericidal treatment.

C2.4 The final bond and residual adhesive, if used, on bonded rubber and rubber-like materials and bonded plastic materials shall be nontoxic[6].

C3 Nonproduct Contact Surfaces

C3.1 All nonproduct contact surfaces shall be of corrosion-resistant material or material that is rendered corrosion resistant. All nonproduct contact surfaces shall be relatively nonabsorbent, durable, and cleanable. Parts removable for cleaning having both product contact and nonproduct contact surfaces shall not be painted.

D **FABRICATION**

D1 **Surface Texture**

D1.1 All product contact surfaces shall have a finish at least as smooth as a No. 4 ground finish on stainless steel sheets and be free of imperfections such as pits, folds, and crevices in the final fabricated form. (See Appendix, Section F.)

D2 **Permanent Joints**

D2.1 All permanent joints in metallic product contact surfaces shall be continuously welded. Welded areas on product contact surfaces shall be at least as smooth as a No. 4 ground finish on stainless steel sheets, and be free of imperfections such as pits, folds, and crevices when in the final fabricated form, except that:

D2.1.1 In such cases where welding is impractical, press-fitting may be employed where necessary for essential functional reasons such as bushings and pins. (See Appendix, Section H.)

D2.1.2 Press-fitting and shrink-fitting shall produce product contact surfaces which are at least as smooth as a No. 4 ground finish on stainless steel sheets and which are free of imperfections such as pits, folds, and crevices. See Appendix, Section H for press-fitting and shrink-fitting restrictions and limitations.

D3 **Bonded Materials**

D3.1 Bonded rubber and rubber-like materials and bonded plastic materials having product contact surfaces shall be bonded in a manner that the bond is continuous and mechanically sound, so that when exposed to the conditions encountered in the environment of intended use and in cleaning and bactericidal treatment, the rubber and rubber-like material or the plastic material does not separate from the base material to which it is bonded.

D4 **Coatings**

D4.1 Coatings, if used, shall be free from surface delamination, pitting, flaking, spalling, blistering, and distortion when exposed to the conditions encountered in the environment of intended use and in cleaning and bactericidal treatment or sterilization.

D4.2 Plastic or plastic-like materials, when used as a coating, shall be at least 0.00.5 in. (0.125 mm) thick.

D5 **Cleaning and Inspectability**

D5.1 Product contact surfaces shall be accessible for manual cleaning and inspection when in an assembled position or when removed. Demountable parts shall be readily removable.

D5.2 Appurtenances having product contact surfaces shall be readily removable, or they shall be cleanable when assembled or installed and shall be easily accessible for inspection.

D6 **Draining**

D6.1 All product contact surfaces shall be self-draining or drainable except for normal clingage.

D7 **Instruments**

D7.1 All instrument connections having product contact surfaces shall conform with the applicable provisions of the 3-A Sanitary Standards for Sensors and Sensor Fittings and Connections Used on Fluid Milk and Milk Products Equipment, Number 74-.

D7.2 All instruments provided shall conform with the applicable provisions of the 3-A Sanitary Standards for Level Sensing Devices for Dry Milk and Dry Milk Products, Number 50- or the 3-A Sanitary Standards for Refractometers and Energy Absorbing Optical Sensors for Milk and Milk Products, Number 46-.

D8 **Sanitary Tubing and Fittings**

D8.1 All metal tubing shall conform with the 3-A Sanitary Standards for Polished Metal Tubing for Dairy Products, Number 33- and the 3-A Sanitary Standards for Fittings for Milk and Milk Products, Number 63-.

D9 **Gaskets**

D9.1 Gaskets having a product contact surface shall be removable.

D9.2 Grooves in gaskets shall be no deeper than their width, unless the gasket is readily removable and reversible for cleaning.

D9.3 Gasket retaining grooves in product contact surfaces for removable gaskets shall not exceed 1/4 in. (6.35 mm) in depth or be less than 1/4 in. (6.35 mm) wide except those for standard O-rings smaller than 1/4 in. (6.35 mm).

D10 **Radii**

D10.1 All internal angles of less than 135° on product contact surfaces shall have radii of not less than 1/4 in. (6.35 mm) except that:

D10.1.1 The radii in grooves in gaskets or gasket retaining grooves shall be not less than 1/16 in. (1.59 mm), except for those for standard 1/4 in. (6.35 mm) and smaller O-rings and for those provided for in Sections D7 and D8.

D10.1.2 Radii in standard O-ring grooves shall be as specified in Appendix, Section J.

D10.1.3 When the thickness of one or both parts joined is less than 3/16 in. (4.76 mm), or when welding 1/4 in. (6.35 mm) or smaller diameter pins to shafts, the minimum radii for fillets of welds on product contact surfaces shall be not less than 1/8 in. (3.18 mm).

D11 **Threads**

D11.1 There shall be no threads on product contact surfaces.

D12 **Springs**

D12.1 Any coil spring having product contact surfaces shall have at least 3/32 in. (2.38 mm) openings between coils, including the ends, when the spring is in the free position.

D13 **Shafts and Bearings**

D13.1 Shafts of auger-type feeders shall have a seal that is of a packless type and is sanitary in design, and shall be readily accessible for cleaning and inspection.

D13.2 Where a shaft passes through a product contact surface, the portion of the opening surrounding the shaft shall be protected to prevent the entrance of contaminants.

D13.3 Bearings having a product contact surface shall be of a nonlubricated type.

D13.4 Lubricated bearings, including the permanently sealed type, shall be located outside the product contact surface with at least 1 in. (25.4 mm) clearance open for inspection between the bearing and any product contact surface.

D14 **Openings and Covers**

D14.1 Sight and light openings provided shall conform with the applicable provisions of the 3-A Sanitary Standards for Sight and/or Light Windows and Sight Indicators in Contact with Milk and Milk Products, Number 65-.

D14.2 Openings through a fixed bridge and either hinged or removable covers, to which connections are not permanently attached, shall be flanged upward at least 3/8 in. (9.52 mm). All sanitary pipelines and other appurtenances entering through the cover shall be fitted with a sanitary umbrella deflector that overlaps the edges of the opening. Other openings, with the exception of agitator openings, shall have a removable cover, which shall be downwardly flanged to make close contact with the upper edges of the upwardly flanged opening in the cover surface. When the removable cover is located in the main cover, it shall remain in position when the main cover is raised.

D15 **Agitators**

D15.1 The agitator driving mechanism, if provided, shall be securely mounted in a position that will provide a minimum distance of 1 in. (25.4 mm) of free shaft, measured from the driving mechanism housing, excluding bearing bosses and mounting bosses, to the nearest surface of the auger-type feeder and in such a manner that all surfaces of the auger-type feeder under or adjacent to the driving mechanism shall be readily accessible for cleaning and inspection.

D15.2 The side-entering type agitator and shaft, including the complete seal, shall be readily demountable for cleaning. Nonremovable parts having product surface shall be designed so that the product contact surfaces are readily cleanable from the inside of the auger-type feeder. Seals for the agitator shaft shall be of a packless type, sanitary in design, with all parts readily accessible for cleaning.

D16 **Supports**

D16.1 The means of supporting an auger-type feeder shall be one of the following:

D16.1.1 If legs are used as a support structure they shall be smooth with rounded ends or with a flat, load bearing foot suitable for sealing to the floor, and have no exposed threads. Legs made of hollow stock shall be sealed. Legs shall provide a minimum clearance between the lowest part of the base and the floor of not less than 4 in. (101.6 mm).

D16.1.2 If casters are used as a support structure they shall be of sufficient size to provide a clearance between the lowest part of the base and the floor of not less than 4 in. (101.6 mm). Casters, if provided, shall be easily cleanable, durable and of a size that will permit easy movement of the auger-type feeder.

D16.1.3 If mounted on a slab or island, the base shall be designed for sealing to the slab or island surface.

D16.1.4 If mounted on a wall or column, the point of attachment of an auger-type feeder to be mounted shall be designed for sealing. The mounting, if supplied by the manufacturer, shall be designed for sealing to the wall or column. The design of the auger-type feeder to be mounted on a wall or column shall be such that there will be at least a 4 in. (101.6 mm) clearance between the outside of the auger-type feeder and the wall or column.

D16.1.5 If mounted on a pedestal, the base of the pedestal shall comply with D16.1.3. If mounted on a slab or island, the pedestal shall be provided with adjustable legs and necessary clearance as required in D16.1.1.

D17 **Guards and Other Safety Devices**

D17.1 Guards required by a safety standard that will not permit accessibility for cleaning and inspection shall be designed so that they can be removed with the use of simple hand tools.

D18 **Nonproduct Contact Surfaces**

D18.1 Nonproduct contact surfaces shall have a smooth finish, free of pockets and crevices, and be readily cleanable and those surfaces to be coated shall be effectively prepared for coating.

APPENDIX

E STAINLESS STEEL MATERIALS

Stainless steel conforming to the applicable composition ranges established by AISI for wrought products, or by ACI for cast products, should be considered in compliance with the requirements of Section C1.1 herein. Where welding is involved, the carbon content of the stainless steel should not exceed 0.08%. The first reference cited in C1.1 sets forth the chemical ranges and limits of acceptable stainless steel of the 300 Series. Cast grades of stainless steel corresponding to types 303, 304, and 316 are designated CF-16F, CF-8, and CF-8M, respectively. The chemical compositions of these cast grades are covered by ASTM specifications[7] A351/A351M, A743/A743M and A744/A744M.

F PRODUCT CONTACT SURFACE FINISH

Surface finish equivalent to 150 grit or better as obtained with silicon carbide, properly applied on stainless steel sheets, is considered in compliance with the requirements of Section D1.1 herein. A maximum R_a of 32 µin. (0.80 µm), when measured according to the recommendations in American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)[8] B46.1 – *Surface Texture,* is considered to be equivalent to a No. 4 finish.

G SUGGESTED CLEANING PROCEDURES

An effective cleaning and sanitizing regimen shall be employed. A description of this regimen shall be available from the manufacturer. The cleaning regimen shall include one or more of the following types: dry cleaning, mechanical cleaning, and manual cleaning.

H PRESS-FITS AND SHRINK-FITS

Press-fits or shrink-fits may be used to produce crevice-free permanent joints in metallic product contact surfaces when neither welding nor soldering is practical. Joints of these types may only be used to assemble parts having circular cross sections, free of shoulders or relieved areas. For example: they may be used to assemble round pins or round bushings into round holes. In both types of fits, the outside diameter of the part being inserted is greater than the inside diameter of the hole. In the case of the press-fit, the parts are forced together by applying pressure. The pressure required is dependent upon the diameter of the parts, the amount of interference, and the distance the inner member is forced in.

In shrink-fits, the diameter of the inner member is reduced by chilling it to a low temperature. Dry ice is commonly used to shrink the inner member. Heat may also be applied to the outer member of the press-fit. Less assembly force is required for this type of fit.

The design of these fits depends on a variety of factors. The designer should follow recommended practices to assure that a crevice-free joint is produced. A recognized authoritative reference is *Machinery's Handbook,* published by Industrial Press Inc., 200 Madison Avenue, New York, NY 10157.

I O-RING GROOVE RADII

TABLE 1
Groove Radii Dimensions for Standard O-Rings

O-Ring Cross Section, Nominal (AS 568)[9]	O-Ring Cross Section, Actual (AS 568)	O-Ring Cross Section, Actual (ISO 3601-1)[10]	Minimum Groove Radius
1/16 in.	0.070 in.	1.80 mm	0.016 in. (0.406 mm)
3/32 in.	0.103 in.	2.65 mm	0.031 in. (0.787 mm)
1/8 in.	0.139 in.	3.55 mm	0.031 in. (0.787 mm)
3/16 in.	0.210 in.	5.30 mm	0.062 in. (1.575 mm)
1/4 in.	0.275 in.	7.00 mm	0.094 in. (2.388 mm)

J **ENGINEERING DESIGN AND TECHNICAL CONSTRUCTION FILE**

The following is an example of an engineering design and technical construction file (EDTCF) to be maintained by the fabricator as evidence of complying with 3-A Sanitary Standards or 3-A Accepted Practices. (The file may contain more or less information as applicable to the equipment or system.)

J1 **Purpose**

J1.1 To establish and document the material, fabrication, and installation (where appropriate) requirements for the engineering design and technical construction files for all products, assemblies, and sub-assemblies supplied by the manufacturer thereof to be in compliance with the sanitary criteria found in 3-A Sanitary Standards or 3-A Accepted Practices. It is recommended that the engineering and construction file or files be submitted with applications for 3-A Symbol use authorization.

J2 **Scope**

J2.1 This EDTCF applies to equipment specified by:

J2.1.1 3-A Sanitary Standards for Auger-Type Feeders, Number 81-.

J3 **Responsibilities**

J3.1 The Engineering Manager is responsible for maintaining, publishing, and distributing this EDTCF.

J3.2 Implementation: All divisions, specifically development engineering, standards engineering, sales engineering, and product departments are responsible for implementing this EDTCF.

J4 **Applicability**

J4.1 The 3-A Sanitary Standards and 3-A Accepted Practices are voluntarily applied as suitable sanitary criteria for dairy and food processing equipment. 3-A Sanitary Standards are referenced in the Grade A Pasteurized Milk Ordinance: "Equipment manufactured in conformity with 3-A Sanitary Standards complies with the sanitary design and construction standards of this Ordinance."

J5 **References**

J5.1 List any additional regulations that apply to the equipment or system covered by this EDTCF.

J5.2 Date of conformity or 3-A Symbol Authorization and certificate number, if authorized.

J6 **Design and Technical Construction File**

J6.1 The Engineering Design and Technical Construction File may consist of the following:

a. an overall drawing of the subject equipment;

b. full detailed drawings, accompanied by any calculations, notes, test results, etc. required to check the conformity of the equipment with the 3-A Standards or 3-A Practices;

c. a list of:

   (1) the essential requirements of the standards or practices;

   (2) other technical specifications, which were used when the equipment was designed;

d. a description of methods adopted;

e. if essential, any technical report or certificate obtained from a competent testing body or laboratory;

f. any technical report giving the results of tests carried out internally by Engineering or others;

g. documentation and test reports on any research or tests on components, assemblies and/or the complete product to determine and demonstrate that by its design and construction the product is capable of being installed, put into service, and operated in a sanitary manner (optional);

h. a determination of the foreseeable lifetime of the product (optional);

i. a copy of the instructions for the product (Instruction Manuals/Instruction Books);

j. for serial manufacturing, the internal measures that will be implemented to insure that the equipment will continue to be manufactured in conformity with the provisions of the 3-A Sanitary Standards or 3-A Accepted Practices;

k. engineering reports;

l. laboratory reports;

m. bills of material;

n. wiring diagrams, if applicable;

o. sales order engineering files;

p. hazard evaluation committee reports, if executed;

q. change records;

r. customer specifications;

s. any notified body technical reports and certification tests;

t. copy of the 3-A Symbol authorization, if applicable.

J6.2 The file does not have to include detailed plans or any other specific information regarding the sub-assemblies, tooling, or fixtures used for the manufacture of the product unless a knowledge of them is essential for verification of conformity with the basic sanitary requirements found in 3-A documents.

J6.3 The documentation referred to in J6.1 above need not permanently exist in a material manner in the EDTCF, but it must be possible to assemble them and make them available within a period of time commensurate with its importance (one week is considered reasonable time). As a minimum, each product EDTCF must physically contain an index of the applicable document of J6.1 above.

J6.4 The EDTCF may be in hard copy or software form.

J7 Confidentiality

J7.1 The EDTCF is the property of the manufacturer and is shown at their discretion, except that all or part of this file will be available to the 3-A Symbol Council or a regulatory agency for cause and upon request.

J8 File Location

J8.1 The EDTCF shall be maintained at equipment manufacturer's location.

J9 File Retention

J9.1 The EDTCF (including all documentation referred to in J6.1) shall be retained and kept available for 12 years following the date of placing the product in use or from the last unit produced in the case of series manufacture.

This 3-A Sanitary Standard is effective November 15, 1998.

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[1]Use current revisions or editions of all referenced documents cited herein.

[2]Additional information on surface modification is contained in *Advanced Materials and Processes*, Volume 137(1), January 1990; "Coatings and Coating Practices" by H. Herman, p. 59; "Surface Modification" by F. A. Smidt, p. 61. ASM International, Materials Park, OH 44073; Phone: 216.338.5151.

[3]Additional information on surface modification is contained in *Advanced Materials and Processes*, Volume 137(1), January 1990; "Coatings and Coating Practices" by H. Herman, p. 59; "Surface Modification" by F. A. Smidt, p. 61. ASM International, Materials Park, OH 44073; Phone: 216.338.5151.

[4]The data for this series are contained in the *AISI Steel Products Manual, Stainless & Heat Resisting Steels*, November 1990, Table 2-1, pp. 17-20. Available from the American Iron and Steel Society, 410 Commonwealth Drive, Warrendale, PA 15086; Phone: 412.776.1535.

[5]Steel Founders Society of America, Cast Metal Federation Building, 455 State Street, Des Plaines, IL 60016; Phone: 708.299.9160.

[6]Adhesives shall comply with 21 CFR 175 – Indirect Food Additives: Adhesives and Components of Coatings. Document for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; Phone: 202.512.1800.

[7]Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959; Phone: 610.832.9500.

[8]Available from the American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017-2392; Phone: 212.705.7722.

[9]The document establishing these standard dimensions is Aerospace Standard (AS) 568, published by SAE, 400 Commonwealth Drive, Warrendale, PA 15086; Phone: 412.776.4970.

[10]The document establishing these standard dimensions is ISO 3601-1: 1988 (E), published by the International Organization for Standardization (ISO), 1 Rue de Varembe, Case Postale 58, CH 1 1211, Geneva, Switzerland; Phone: 41.22.734.1240.

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Statement of Ownership, Management, and Circulation

(Required by 39 USC 3685)

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	(2) Paid or Requested Mail Subscriptions *(Include advertiser's proof copies and exchange copies)*	2,960	~~3,407~~ 3,407
c. Total Paid and/or Requested Circulation *(Sum of 15b(1) and 15b(2))*		2,960	3,049
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f. Total Free Distribution *(Sum of 15d and 15e)*		257	293
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h. Copies not Distributed	(1) Office Use, Leftovers, Spoiled	171	158
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17. Signature and Title of Editor, Publisher, Business Manager, or Owner: Carol F Mouchka, Managing Editor — Date: September 15, 1998

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ComingEvents

NOVEMBER

·**2-5, Better Process Control School,** Rutgers University, New Brunswick, NJ. For further information, contact Rutgers, The State University of New Jersey, P.O. Box 231, New Brunswick, NJ 08903-0231; Phone: 732.932.9271; Fax: 732.932.1187.

·**2-6, Aseptic Better Process Control Certification School and Aseptic Symposium,** at North Carolina State University, Raleigh, NC. For further information, contact Lisa Gordon at 919.515.2956; Fax: 919.515.7124; E-mail: lisa_gordon@ncsu.edu.

·**3, Ontario Food Protection Association Meeting,** Toronto, Canada. For additional information, contact Bill Boylan at 905.829.1200.

·**3-4, Statistical Process Control,** Washington, D.C. This program is designed to provide training in statistical process control. Participants will learn how to develop sampling plans that will assure the quality of incoming materials and can be used to resolve the disposition of lots on hold. They will also learn how to develop and use control charts to monitor process quality and assure that manufacturing specifications are being met. For additional information, contact FPI (SPC), Department 134, Washington, D.C. 20055-0134; Phone: 202.639.5954; Fax: 202.639.5991.

·**3-5, North Dakota Environmental Health Association Meeting,** Minot, N.D. For additional information, contact Mike Walton at 701.328.1292.

·**4-6, The Dairy Practices Council® Annual Conference,** Harrisburg East Holiday Inn, Harrisburg, PA. The DPC Annual Conference presents outstanding speakers on issues challenging the dairy industry and afternoon task force sessions are reserved for work on developing new guidelines. Participants have the opportunity to exchange information with dairy personnel from industry, regulatory agencies, and academia. For more information, contact The Dairy Practices Council®, P.O. Box 866, Barre, VT 05641-0866; Phone/Fax: 802.476.3092; E-mail: dairypc@dairypc.org; www.dairypc.org.

·**5-6, Florida Association of Milk, Food and Environmental Sanitarians, Inc. Meeting,** Haines City. For additional information, contact Buddy Levins at 850.488.3954.

·**8-12, 1998 International Exposition for Food Processors,** Chicago, IL. For more information, contact Cheryl Clark at Phone: 703.684.1080; Fax: 703.548.6563; E-mail: fpmsa@clark.net.

·**8-12, Microbial Food Contamination Workshop,** The U.S. Fish and Wildlife National Conservation Training Center, Shepherdstown, WV. The objectives of the workshop is to assemble leading experts in the U.S. and Israel for the exchange of information and the development of future strategies and policies to prevent and eliminate microbial food contamination; access and record the present state of our knowledge on food contamination; and to form collaborations between the U.S. and Israeli scientists and industry to pursue innovative technologies to combat food contamination. For additional information, contact BARD Workshop, Charles L. Wilson, USDA-ARS Appalachian Fruit and Research Station, 45 Wiltshire Road, Kearneysville, WV 25430; Phone: 304.725.3451; Fax: 304.728.2340; E-mail: cwilson@asrr.arsusda. gov.

·**9-11, Meat & Poultry Accredited HACCP Training Program,** Radisson Hotels & Suites, St. Louis, MO. For further information, contact Christine VerPlank or Sheila Brewer, ASI Food Safety Consultants, 7625 Page Blvd., St. Louis, MO 63133; Phone: 800.477.0778; Fax: 314.727.2563.

·**9-11, ASI Food Safety Consultants HACCP Workshop,** held at the Holiday Inn-Downtown Riverfront, St. Louis, MO. For further information, contact ASI Food Safety Consultants, Inc., Vorrie Strong or Christine VerPlank, Phone: 314.725.2555; 800.477.0778; Fax: 314.727.2563.

·**16-17, Membrane Applications in the Agri-Food Industry Seminar,** at the Holiday Inn South, Winnipeg, Manitoba, Canada. This course is jointly organized by the Food Development Centre, Manitoba Hydro, the National Research Council, Manitoba Food Processors Assn., Canadian Council on Electrotechnologies, and Assiniboine Community College. The purpose is to demonstrate the economic and process benefits of membrane systems using technology profiles, case study examples and pilot plant demonstrations of actual systems. For additional information, contact Markus Schmulgen, Food Development Centre, Portage la Prairie, Manitoba; Phone: 204.239.3436; 800.870.1044.

·**16-18, 1st NSF International Conference on Food Safety: HACCP — Science, Art, and Industry,** co-sponsored by IAMFES and other organizations, Hyatt Regency Albuquerque, Albuquerque, NM. For additional information, contact Wendy Raeder at Phone: 734.769.8010, ext. 205; Fax: 734.769.0109; E-mail: raeder@nsf.org.

·**22-26, 5th Latin American Congress on Food Microbiology and Hygiene, (COMBHAL 98)** held in Águas de Lindoia, São Paulo, Brazil. COMBHAL 98 is organized by the Brazilian representatives in the Latin American Subcommission (LAS) of ICMSF (International Commission on Microbiological Specifications for Foods) and is sponsored by the Brazilian Society for Microbiology (SBM), Brazilian Society for Food

Science and Technology (SBCTA) and International Life Science Institute (ILSI, Brazil). For further information, contact COMBHAL 98 Secretariat, Av. Prof. Lineu Prestes 580, 05508-900, São Paulo-SP-Brazil; Phone: 55.11. 8187991; 55.11. 8187999; Fax: 55.11. 8154410; E-mail: combhal@edu. usp.br.landgraf @usp.br.

DECEMBER

·**1-2, HACCP for Retail, Food Service & Institutional Sectors Seminar,** Guelph, Ontario. For further information, contact Guelph Food Technology Centre, 88 McGilvray St., Guelph, Ontario N1G 2W1; Phone: 519.821.1246 ext. 5028; Fax: 519.836.1281.

·**1-3, A Working Conference on Hazard Analysis Critical Control Points,** Cornell University, Ithaca, NY, sponsored by The Food Processor's Institute. For further information, contact the Food Processors Institute at 202.393.0890.

·**1-3, Technical Symposium & Workshop,** Hyatt Regency Crystal City, Arlington, VA. Sponsored by the Strategic Environmental Research and Development Program (SERDP) and the Environmental Security Technology Certification Program (ESTCP). Learn first hand about groundbreaking environmental research and innovative technologies developed by the Department of Defense (DoD), the Department of Energy, the Environmental Protection Agency, and their many public and private collaborators. For more information call 703.736.4548.

·**3, GMP Distribution and Warehousing Seminar,** Houston, TX. For further information, contact ASI Food Safety Consultants, Inc., Christine VerPlank, or Vorrie Strong, Phone: 800.477.0778; Fax: 314.727. 2563.

·**8-9, 1998 FDA Science Forum – Biotechnology: Advances, Applications, and Regulatory Challenges,** at the Washington Convention Center, Washington, D.C. The Science Forum is co-sponsored by the FDA, the American Association of Pharmaceutical Scientists, and the FDA Chapter of Sigma Xi, The Scientific Research Society. The Science Forum will bring FDA research and review scientists together with representatives of industry, academia, government agencies, consumer groups, and the public to discuss the impact of the enormous advances in biotechnology on product development and regulation. For additional information, contact the American Association of Pharmaceutical Scientists at Phone: 703.518.8429 or E-mail: meetings@aaps.org.

·**8-11, Thermal Processing Development Workshop,** presented by The Food Processors Institute, Washington, D.C. These workshops are an excellent follow-up for those who have attended a *Better Process Control School*. This includes: Quality Assurance Managers, Quality Control Managers, Process Engineers, and Specialists in Thermal Processing. Participants will generate heat penetration data in the pilot plant of NFPA's research laboratory. Working teams will examine in detail the design of thermal processes; improve skills and understanding of basic thermal process establishment and evaluation techniques, including heat penetration testing and process calculation; identify critical decision-making steps essential to thermal process establishsment; generate data during the workshop excercises; and learn both the General and Ball Formula methods of calculation. For additional information, call Customer Service at 202.639.5954.

FEBRUARY

·**6-8, United 99, United Fresh Fruit & Vegetable Association 95th Convention & Exposition,** San Diego Convention Center, San Diego, CA. For more information, call 703.836.3410; Fax: 703.836.7745.

·**16-18, Kentucky Assn. of Milk, Food & Environmental Sanitarians, Inc. Meeting,** for additional information, contact John Summers at 606.439.2361.

MARCH

·**10, Dairy HACCP Workshop,** Madison, WI. This one-day workshop will cover design and implementation of HACCP plans in dairy plants. For additional information, contact the Program Coordinators or Dept. of Food Science, University of Wisconsin-Madison, Madison, WI 53706-1565; Phone: 608.262.3046; Fax: 608.262.6872.

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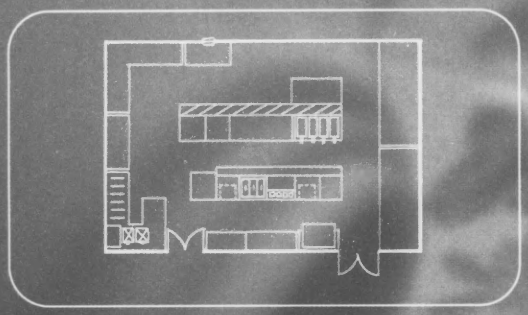

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