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International Association of Milk and Food Sanitarians, Inc.

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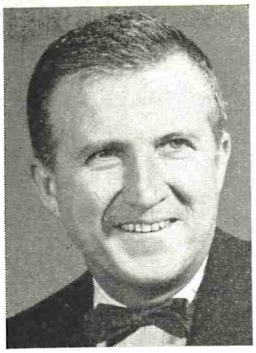

Augustus H. Fiske, Jr., Pres.

FISKE ASSOCIATES, INC.
Bethel, Connecticut

From the President:

IMPORTANT MESSAGE on FISKE CRYOSCOPES

Unauthorized use of the FISKE name and misleading statements regarding FISKE MILK CRYOSCOPES have come to my attention. These are the facts and here is a statement of our policy.

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Augustus H. Fiske Jr

Fiske

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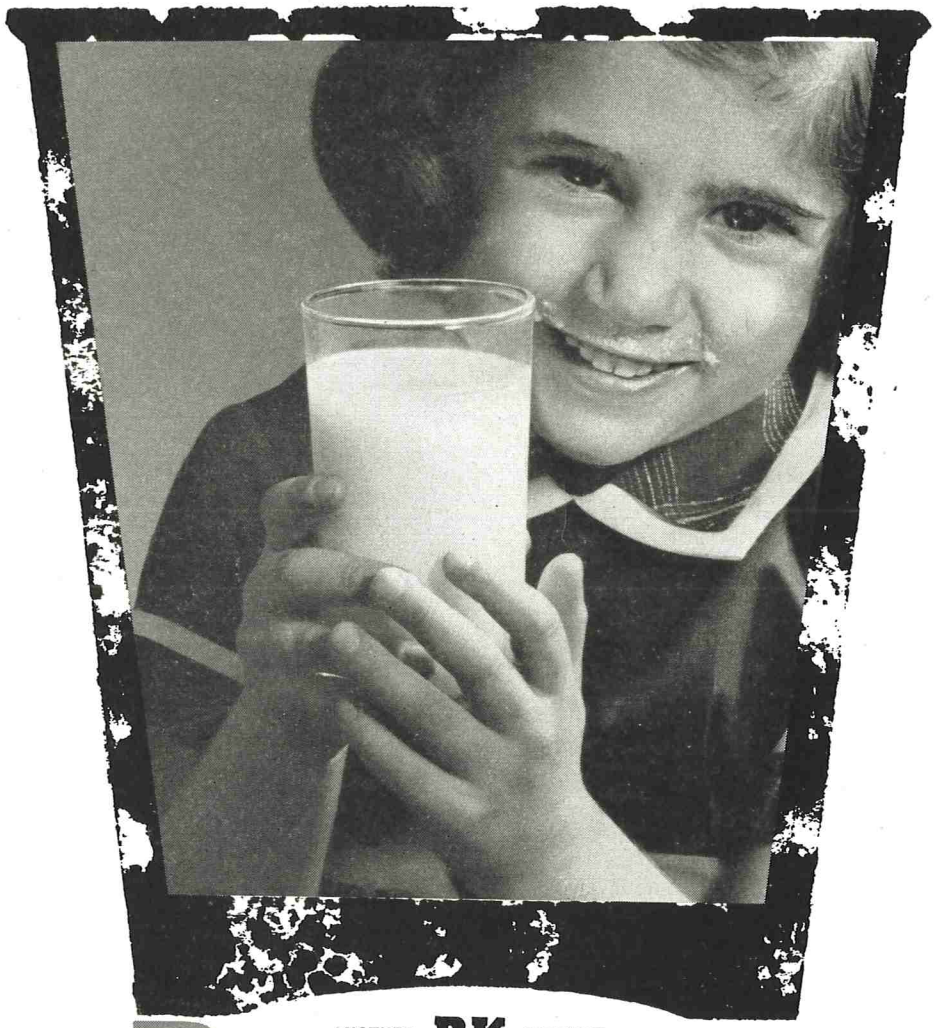

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Contents *Page*

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EDITORIAL

The Milk Sanitarian And Chemical Residues

Milk sanitarians have a role in solving the chemical residue problem which faces the dairy industry and regulatory agencies. Aside from public health protection, per se, it is the duty of sanitarians to help avoid any illegal residues in milk and dairy foods.

Inaction cannot be excused by disagreement with the controversial concept of zero tolerance. Milk and milk products must be kept above reproach in order to encourage optimum consumption and avoid consumer alarm. This is in the interest of the public health, the sanitarian and the dairy industry.

Potential sources of chemical residues in milk supplies include antibiotics, pesticides, detergents and sanitizers. Continual vigilance is necessary to keep the problem under control. Brushfire measures will not accomplish the job. In addition to the ever present potential sources of residues, there is the problem of a shrinking "zero" as more sensitive analytical procedures are developed.

The question then arises, what can the sanitarian do? One of the first is the avoidance of misconceptions and an assumption that chemical residues are of no problem in his jurisdiction. With the wide and expanding use of pesticides, sanitizers and chemical compounds in the field of agriculture, there is no area in which these are not used to some degree at least.

Other misconceptions, or assumptions which are to be avoided are these. The residue problem is already solved, or, little can be done about residues until tests are developed which are more sensitive, less expensive and more accurate. Also to be avoided is the attitude that the subject is too complex and too technical for the practical man to understand or do anything about or, that it applies only to interstate milk and milk products.

Where then does the sanitarian come into the picture and what part can he play in helping to insure milk free from chemical residues? First, and foremost is recognition of the potential problem. From this point he should become familiar with actual and potential sources of residues in this area of jurisdiction. He should recognize that dairymen are interested in the problem and are willing and anxious to do their part when alerted to it and given proper information on approved procedures. The sanitarian can assist further by cooperating with all interested agencies who are working to keep the problem under control.

While it is generally known, it is perhaps important to point again to the fact that the USDA enforces the Federal Insecticide, Fungicide and Rodenticide Act of 1947. Labels for all economic poisons must be registered with the Department before they are shipped in interstate commerce. Following the directions for use on labels of pesticides thus registered should yield products without illegal residues. Dairymen and growers of agricultural commodities have one simple rule to follow - use pesticides according to label directions - on the crops or kinds of animals specified, in the amount specifield, and at the time specified.

The Food and Drug Administration enforces the labeling provisions of the Federal Food, Drug and Cosmetic Act, which requires, among other things, adequate directions for proper use and warnings against misuse in the labeling of drugs.

Accordingly, pesticides and drugs in interstate commerce coming into the hands of farmers and dairymen for their use bear the kind of label instructions and warnings that, if followed, will insure the production of an uncontaminated milk supply.

Milk sanitarians have solved many problems over the years. When one problem seems well in hand, another crops up. This is generally credited to progress and technological change. The greatly expanded use of chemicals in the growing of farm crops is just another demonstration of man's attempt to control factors of the environment which make for better productivity and improved economic return.

The sanitarian, then, must be ever alert to new practices and new situations, to gain an understanding of them and make his contribution to his primary and continuing objective of milk safety.

J. C. FLAKE
Evaporated Milk Association
Chicago, Illinois

LABORATORY AND EPIDEMIOLOGICAL ASPECTS OF FOODBORNE DISEASES[1]

MILDRED M. GALTON AND JAMES H. STEELE

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Foodborne diseases have been defined as those diseases in which illness is due to the ingestion of contaminated foods. This contamination is frequently indigenous in nature but in many instances the food is contaminated during processing or preparation and serves only as the vehicle of the etiologic agent. The illness may be a result of infection with microorganisms such as the salmonellae or it may be a result of intoxication caused by preformed products of bacteria such as the enterotoxin of staphylococci. It is generally agreed (*1*, *2*) that the term "food poisoning" is vague and misleading since it is commonly applied to outbreaks of both food infection and food intoxication. Theoretically, more accurate usage of this term would limit it to apply to bacterial intoxications. Dack (*1*) recognizes these differences but considers the explosive nature of an outbreak of gastro-intestinal illness a characteristic feature of food poisoning and uses the universally applied term to include food infection.

The diseases that have been traced by epidemiological methods to food are numerous. Among the food infections of bacterial origin, salmonellosis is by far the most common but infections caused by other enteric bacteria, such as the Arizona group, are also involved sometimes in large outbreaks. Although in a somewhat different category, the shigellae are one of the most common causes of acute endemic diarrhea and foods or water are the usual vehicles of infection. Bacterial infections that are becoming less frequent or occur only rarely include streptococcal sore throat, diphtheria, brucellosis, tuberculosis, tularemia and anthrax. Then, occasionally, specific organisms have been incriminated but their exact role is uncertain. These include *E. coli*, the Bethesda and Providence groups of organisms, *Proteus*, *Klebisella* and *Pseudomonas*. Most important of the food intoxications of bacterial origin, and equally as common as salmonella infections, is that caused by staphylococcal enterotoxin and to a much lesser extent botulism toxin. Next to be considered is foodborne disease that appears to be associated with the presence of large numbers of bacteria in the food such as *Clostridium perfringens*, alpha-type streptococci and *Bacillus cereus*.

Of the foodborne infections of parasitic origin that are indigenous in nature, trichinosis, diphyllobothriasis and taeniasis are probably the most important. Their occurrence depends largely on the local food habits and to economic, cultural and hygienic factors. Although amoebic dysentery outbreaks are usually transmitted through contaminated water, sporadic cases from contaminated foods do occur. Occasionally food is contaminated by human and animal parasites, such as *Echinococcus* and the ascarids.

With the exception of Q fever (*3*), infectious hepatitis and, more recently, tickborne encephalitis (*4*), little is known of the foodborne diseases of viral etiology. However, with the discovery of many new viral agents in animal and human infections, we should look towards the possibility of new viruses as the cause of foodborne disease.

In this report, primary emphasis will be placed upon those agents commonly involved in outbreaks of food poisoning, with only brief mention of the broad group of foodborne diseases. The more specific terms of food infection and food intoxication will be used for clarity.

SALMONELLOSIS

The actual incidence of salmonellosis in man is not known. Newell (*5*) in an excellent article on the epidemiology and control of salmonellosis has pointed out that no country possesses a reasonable picture of the occurrence of this disease or an organization that has been able to establish effective control methods. In the United States, summaries published annually by the National Office of Vital Statistics show that reported cases of typhoid fever have continued to decrease during the past 10 years while other salmonelloses increased nearly sevenfold. A fourfold increase in incidence was observed in Massachusetts by MacCready, *et al.* (*6*), from 1950 to 1955. They suggest that some of this rise has probably resulted in more complete reporting and an increased aware-

[1]Presented at the annual meeting of the INTERNATIONAL ASSOCIATION OF MILK AND FOOD SANITARIANS, INC., at Chicago, Illinois, October 26-28, 1960.

ness but that since total specimens from which their recoveries were made during the same period increased less than two-fold, a real increase of illness is apparent. Edwards (7) suggests that each factor has some influence on the increase in incidence even though the figures are admittedly inadequate.

During a comparable period in Great Britain, incidents due to salmonellae increased progressively. Salmonellae were responsible for nearly 60% of all food poisoning incidents reported; in contrast only 2% were due to staphylococcal poisoning. However, Edwards has compared the reported outbreaks in Great Britain and the United States for 1953, 1954 and 1955. He pointed out that twice as many outbreaks of staphylococcal poisoning per 100,000 population were reported in England and Wales as in the United States and that salmonella outbreaks were 28 times more numerous than in the United States. He further suggests that this great difference is not real but that it indicates more complete reporting of salmonellosis in Great Britain.

Consideration of the reported distribution of salmonella serotypes in man and animals suggests changing patterns. While S. *typhimurium* continues to be the most prevalent type, the proportion of incidents due to other salmonella types more than doubled in Great Britain between 1954 and 1958 (8). For example, S. *heidelberg* first appeared in England and Wales in 1953; in 1958, it was the second most common type; about the same time it appeared in Massachusetts (6) and Germany, and two years later in Northern Ireland (5). *Salmonella reading* was responsible for more than 300 acute sporadic cases and three outbreaks of salmonellosis in the United States during the 12 month period, September 1956-1957 (9). Prior to this time, S. *reading* had been isolated only rarely. A similar sharp rise in this type was observed in the Netherlands in 1952. The appearance of S. *schwarzengrund* and S. *infantis* has also increased markedly during the past five years. In California, S. *infantis* first seen in 1954, has continued to increase and during the first six months of 1960 there were 116 human infections or 48% more than the entire year of 1959 (10). In Florida, S. *infantis* was found in poultry processing plants in 1952 and in man in 1953 (11). In 1958, a 1233 bed hospital in the North Central United States experienced an outbreak of S. *infantis* wound infections in postoperative patients (12). These are but a few of the instances that could be cited of the rise in prevalence of particular serotypes.

The literature abounds with reports incriminating our domestic animals as a source of salmonellosis in man. A similar distribution was observed by Galton and Hardy (13) in the relative prevalence of the most common salmonella types isolated from man, hogs, fowls and dogs in Florida which suggested that salmonella infections in man and animals in Florida were spread from one to the other or derived from the same sources.

Data obtained (14) on the prevalence of salmonellae in hogs on farms and in the abattoir clearly indicated an increasing proportion of infected animals as they moved to market and slaughter. Each infected animal is a possible source for the spread of salmonella in the abattoir. In one abattoir, it was shown that by careful supervised cleansing of the dehairing machine the number of salmonellae isolated from the sides of the carcass was reduced from 91 to 3%. After termination of the supervised cleansing procedure, the proportion of positives increased to 88%. It appears, therefore, that the major cause of the problem of salmonellae in retail meat products is the spread of infection among the animals just prior to slaughter and to the wide dissemination within the abattoir. Further studies in Florida revealed salmonella contamination of fresh pork sausage ranged from 8% in samples from national producers to 58% in those from local abattoirs (15). Studies in progress in the Veterinary Public Health Laboratory Unit, Communicable Disease Center, have shown a similar distribution in fresh pork sausage samples in the Atlanta area (16).

Domestic poultry probably are the greatest single animal reservoir of salmonellae. However, bacteriological studies of the environment in poultry processing plants suggests that the presence of salmonellae in poultry meat more often is the result of contamination during processing than it is of the spread of infection in flocks.

In addition to food producing animals, salmonella infections are prevalent in domestic pets that live in close association with man. Mackel, *et al.* (17), found that 15% of 1626 normal household dogs in Florida were harboring salmonellae.

There is increasing evidence that widely distributed animal feeds may be heavily contaminated with salmonellae providing a means for the extensive spread of infection that is now apparent in many areas of the world. The presence of salmonellae in prepared dry animal feeds was first reported by Griffin (18) in 1952 in New York State following unexplained explosive outbreaks of infection with S. *newport* in guinea pig and mouse breeding colonies. Not only was S. *newport* isolated from the dog feed cubes but S. *muenster*, S. *minnesota*, S. *tennessee* and S. *senftenberg* were obtained also. About the same time, Galton, Harless and Hardy (19) isolated 17 salmonellae types from 26.5% of the dehydrated dog meal sam-

ples from 9 to 11 manufacturers. Just prior to this study, salmonellae were obtained from 22% of the samples examined from hospitalized dogs *(20)* and 44% of the specimens from kennel dogs *(21)*.

Further evidence that dogs may acquire infection through food was reported by Caraway, *et al.* (*22*). Salmonellae were isolated from 18 to 23 sentry dogs following varying degrees of diarrhea over a period of several months. Multiple types including 18 different serotypes were obtained from most of the animals. Later, salmonellae were isolated from samples taken in the plant that processed the frozen horse meat fed to these dogs. Five of the types isolated from the horse meat were identical to five types from the dogs.

Recent evidence indicates that salmonellae are present in a high per cent of poultry feed and feed additives. Boyer, Bruner and Brown (*23*) isolated S. *thomasville* from turkey feed during an outbreak among poults in which a high mortality occurred from a bacteremia caused by this type. Salmonella were isolated also from 3 of 5 samples of "50% meat scraps," a so-called finished product from a rendering plant.

In Texas, Watkins, Flowers and Grumbles (*24*) examined poultry and animal by-products used in poultry feeds. Salmonellae were isolated from 37 (18.5%) of 200 samples with multiple types from 22 of these samples. Samples taken in the plants processing animal by-products indicated that re-contamination after cooking was primarily responsible for the presence of salmonellae in the finished product.

Both imported and domestic fish meals used extensively in poultry feeds in the United States have been found to be contaminated frequently with salmonellae. The isolation of S. *blockley* from fish meal in 1955 occurred about the same time as the first human case of S. *blockley* (*25, 26*). During this same period also a large outbreak in Georgia reported by McCroan (*27*) was due to S. *blockley* in commercially prepared chicken salad. There were approximately 300 confirmed cases and an estimated 3000 others who developed clinical symptoms. Following the S. *reading* episode in the United States, Boring (*28*) isolated 11 different salmonella types from 9 of 16 samples of fish meal obtained from plants on the east coast.

Investigation of bone meal and cow meal samples in Australia after a widespread outbreak of bovine salmonellosis revealed three serotypes common to these feeds and to cattle (*29*). These authors observed that the rodent, avian, and arthropod reservoirs of animal infections may become relatively unimportant if man does not continue to spread infection feeding contaminated stock feed supplements. Walker *(30)* found 50 (40%) of 123 samples or organic fertilizers (primarily bone meal) contained salmonellae. The finding of salmonellae in animal feeding stuffs seemed of sufficient importance, as a source of infection in animals and indirectly in man, to the Public Health Laboratory Service of Great Britain to warrant further study *(31)*. They found salmonellae in 5 to 77% of the samples of fertilizers and feeding stuffs. Even more alarming than the findings of salmonellae in animal feeds is a recent report of multiple salmonellae types in desiccated coconut imported from Ceylon. The coconut was used in bakery foods (*32, 33*) and eaten uncooked.

In spite of the distribution of salmonellae in animals and animal feeds, the importance of the human carrier in the spread of salmonellosis should not be overlooked. Although it is difficult to determine whether the food handler is the source of infection or has been infected from the same source as the victims, it appears that the carrier state occurs much more frequently in this group of individuals than in the general population. In Florida (*13*), 63 per cent of the cultures of known origin were isolated from asymptomatic carriers and many of these were obtained from food handlers. Edwards (*7*) suggests that the carrier state might be considered an occupational hazard among persons who handle uncooked meats and meat products and Newell (*5*) states further that if followed back far enough, the human to human spread often leads to an animal source and not to a human carrier.

Attempts towards prevention and control of salmonellosis should be directed at elimination of the animal cycle and the animal-vehicle-human chain of infection (*5*). Obviously knowledge of the factors which contribute to the contamination of foods by salmonellae is essential to reduce the incidence. These factors may include the feeding and killing of domestic animals, the preparation of basic foodstuffs and the final preparation of food consumed by the patient (*8*). Heat treatment of contaminated materials and protection of the final product from recontamination are essential to breaking this chain and subsequent reduction in human and animal infection.

ARIZONA GROUP OF THE ENTEROBACTERIACEAE

The first culture of this group was classified in the salmonella group because of a distinct antigenic relationship and was designated by Kauffmann as S. *arizona* (*34*). Later, it was concluded that they were *Enterobacteriaceae* but not identical with any of the recognized genera. They have since been classified as the Arizona group (*35, 36, 37, 38*). The excellent work of Edwards and his co-workers leaves no doubt that they are pathogenic for animals.

Many cultures were obtained by Hinshaw and McNeil (*39, 40*) during studies of infections among

reptiles and turkeys. The symptoms and pathology in birds infected with organisms of the Arizona group are comparable to those which occur in salmonellosis in fowls. The organisms have been isolated from heart blood, and all organs, indicating a definite septicemia. Young fowls, particularly poults, appear more susceptible. Mortality in flocks was comparable to that found in salmonella infections. The spread of the infections by hatcheries and through eggs has been clearly established (*39, 40, 41*).

In man they have appeared in both sporadic cases and in well defined outbreaks of the disease. Verder (*42*) isolated cultures of the Arizona group 1, 2:1, 2, 5 from 70% of patients cultured during an outbreak of gastroenteritis involving 51 student nurses. The organism was not obtained from 16 normal students cultured. Buttiaux and Kesteloot (*43*) reported the isolation of paracolon bacilli similar to the Arizona group from six patients, three with acute enteric disease, two with chronic colitis and one with a typhoid-like illness. In 1950, Murphy and Morris (*44*) described two small outbreaks of gastroenteritis, both associated with a member of the Arizona paracolon group. In both episodes, evidence relating to source of infection, incubation period, and symptoms of individuals involved, resembled the pattern observed in food infections due to salmonellae. Bacteriological findings indicated the paracolon bacillus was the etiologic agent.

More recently, Edwards (*45*) has reported on the occurrence of Arizona cultures in man. Of 87 cultures isolated from man, 23 were obtained from blood or localized infections, 56 from patients with diarrhea, gastroenteritis and enteric fever and only 8 from asymptomatic persons. More than 50% of the cultures belonged to 2 serotypes, 7:1, 2, 6 and 10:1, 2, 5.

The Kentucky State Department of Health reported to the National Office of Vital Statistics, January 19, 1957, an outbreak of gastroenteritis affecting 650 of 950 persons eating in a high school cafeteria. Boiled turkey was the food epidemiologically implicated as the cause of the outbreak. The dinner was prepared from frozen turkeys. They were cooked inadequately, according to the investigators. From one turkey which was not used in the preparation of the meal and was still frozen, paracolon organisms of the Arizona group were isolated. A similar outbreak was reported to the National Office of Vital Statistics by the New Mexico Health Department for the week ending January 26, 1957. Of 519 children and teachers in a school, 323 became ill from two to ten hours after a lunch of turkey and dressing. Bacteriologic examination of turkey meat revealed a heavy growth of a paracolon organism, possibly of the Arizona group. The same organism was also found in stool specimens from three of the patients.

The frequent isolations of Arizona types from ill and well fowl, as well as from cases of human gastroenteritis, certainly constitute strong evidence that poultry is a very prominent reservoir of paracolons pathogenic to man. The few well documented outbreaks of human gastroenteritis known to have been caused by ingestion of poultry meat should serve as a stimulus for further and more intensive efforts to trace original sources of gastroenteritis caused by this group of organisms.

STAPHYLOCOCCAL ENTEROTOXIN FOOD POISONING

No doubt, the next most important bacterial cause of foodborne diseases is that of staphylococcal origin. Indeed, 40% of the outbreaks reported to the National Office of Vital Statistics in the United States are caused by staphylococcal enterotoxin. Again, as with salmonella infections, reported incidence of staphylococcal food poisoning represents but a small fraction of the true incidence. Usually only the outbreaks in which large numbers of persons are involved come to the attention of health authorities.

Although Barber (*46*) in 1914 isolated staphylococci from milk which was responsible for sporadic cases of acute gastroenteritis, the actual role of staphylococci as a cause of food poisoning was not established until 1930 when Dack (*47*) and his coworkers produced severe symptoms in human volunteers with a filtrate of a culture of staphylococci isolated from cream filled cake. Eleven persons who ate the cake had been ill. These investigators feel that the ubiquitous nature of *staphylococcus* contributed to the delay in recognition of its importance in food poisoning.

In the epidemiology of staphylococcal food poisoning, there are two important sources of contamination (*a*) the human nasal carrier or individual with lesions such as boils, furuncles or infected cuts, and (*b*) food products such as raw milk from infected animals or cheese prepared from raw milk. When foods which favor the growth of staphylococci are allowed to stand at room temperature after preparation, the organisms multiply rapidly and some strains will produce a powerful enterotoxin which is comparatively heat resistant. It is this preformed enterotoxin which produces illness in man.

Innumerable types of foods have been involved in staphylococcal outbreaks such as ham, prepared "ready-to-eat" meats, dried beef, sausage, milk, cheese, prepared salads and particularly cream or custard filled bakery products. In many instances,

staphylococci are resistant to the salts used to preserve some meats (*48*).

Bovine mastitis of staphylococcal etiology is a world problem. Recent reports in the literature indicated that it has become much more prevalent during the past few years (*49, 50*). The widespread use of antibiotics in the treatment of mastitis, no doubt, favors the development of antibiotic resistant strains of staphylococci.

Although the actual interrelationship of human and animal strains of staphylococci have not been established with certainty, important information is being accumulated to indicate that both animal to human and human to animal transmission occurs. In a comparative study of the properties of 263 coagulase positive staphylococci from butter or cheese and from human clinical sites, Thatcher and Simon (*51*) found that the isolates from dairy products were predominantly phage type 42D, but this type was rarely encountered among the isolates from clinical sites. However, this so-called bovine form has been recovered from severe cases of human enteritis that developed as a sequel to antibiotic therapy and it has also been established as capable of causing food poisoning in man (*52*). The application of phage typing to the epidemiological study of staphylococci isolated from bovine milk was studied by Williams Smith in 1947 (*53*). He found that 93% were typable and that 42D was the most common type. However, phage typing did not distinguish strains isolated from cows with mastitis from those found in milk from apparently normal udders. He found also that two phage types may occur in the milk from one animal and therefore considered that phage typing may be limited as an epidemiologic tool in the study of bovine mastitis.

A review of the weekly reports of the National Office of Vital Statistics and other published work shows that outbreaks of staphylococcal food poisoning associated with fluid milk, dried milk, and cheese, have been recognized for many years. Anderson and Stone (*54*) reported eight explosive outbreaks of food poisoning that occurred in school canteens in England during 1953 involving 1,190 known cases. In all instances the food causing the outbreaks was prepared from spray-dried skim milk powder. It was not subsequently heat-treated and was usually consumed 3-4 hours after preparation. Examination of the spray-dried milk powder revealed high bacteria counts including large numbers of staphylococci. Since the food was usually consumed within 3-4 hours after reconstitution of the milk powder, which was not sufficient time for the staphylococci to grow, it was concluded that the poisoning must have been due to preformed toxin. More recently, a series of 19 outbreaks of gastroenteritis associated with spray-dried milk occurred during a one month period among school children in Puerto Rico (*55*). Epidemiologic studies and a human volunteer experiment implicated the spray-dried milk solids. Although bacteriologic and toxicologic tests were negative, clinical and epidemiologic evidence indicated that staphylococcal enterotoxin was the probable agent. These outbreaks are the first such instances of food poisoning related to spray-dried milk reported in the United States.

Two rather large outbreaks involving cheese occurred in 1958. In one outbreak reported by Allen and Stovall (*56*), more than 60 cases occurred in Indiana and Michigan. Investigation revealed that cheese of the Colby type produced from raw milk in one cheese factory in Wisconsin was involved. Three family outbreaks were also observed in Wisconsin. Coagulase positive staphylococci of the same phage type were isolated from the distributing plant, the factory and from milk from dairy herds supplying milk to the cheese factory.

The second outbreak reported by Hendricks, *et al.* (*57*), and Hausler, *et al.* (*58*), occurred among 200 persons in a state institution in Iowa. All individuals who became ill had eaten natural American cheddar cheese made at a local factory. The cheese was prepared from raw milk. Coagulase positive *Staphylococcus aureus* of similar phage type was isolated from the cheese and from the milk of 2 of 8 herds supplying milk to the cheese factories.

The first evidence of phage type 80/81 staphylococci in milk and in the dairy employees was obtained by Wallace, *et al.* (*59*). During a survey of staphylococcus phage types in milk, they isolated type 80/81 from bulk milk and from the milk from three cows in the dairy herd. Further investigation revealed staphylococcal infection in one dairy employee and his family caused by the same phage type.

There is recent epidemiologic evidence to further indicate that the animal to human chain of transmission of staphylococci is reversible. Zinn, Skaggs and Anderson (*60*) studied persistent furunculosis in a herd of dairy cows. The initially infected herd on this farm had been disposed of since all attempts at treatment had failed and a replacement herd purchased. The second herd became infected shortly after arrival at the farm and was studied by these authors for approximately one year. Phage type 80/81 staphylococci was isolated repeatedly from furuncles on the cow's udders, the milk, the milking machine inflations and from bulk milk. Two dairy attendants were found to be nasal carriers of phage type 80/81 and this same type was isolated from

skin lesions on these individuals. One of the dairy attendants was undergoing clinical treatment at about the same time that the disease appeared in the initial herd. Both cattle and human isolates were resistant to penicillin, dihydrostreptomycin and chlortetracycline.

There are certain problems involved in the laboratory confirmation of staphylococcal food poisoning. The isolation of large numbers of coagulase positive staphylococci of the same phage type from the suspected food and from the vomitus and stools of patients supported by typical clinical and epidemiologic picture is highly suggestive. However, final confirmation should include demonstration of the presence of enterotoxin in the culture filtrates. As yet, no simple *in vivo* or *in vitro* test for the detection of enterotoxin is available. Cats, kittens, frogs and monkeys have been used but the results with these animals are not always reliable. Valuable information has been obtained with human volunteers but this obviously is not a practical procedure for a diagnostic laboratory. Sugiyama, Bergdoll and Dack (*61*) recently made encouraging progress with *in vitro* studies on staphylococcal enterotoxin production. The method involves the formation of specific antigen-antibody lines in agar plates as a criterion of the presence of enterotoxin.

The prevention and control of staphylococcal enterotoxin food poisoning is dependent largely upon the use of strict sanitary precautions, education of the food handler, and protection of food from contamination during preparation so that staphylococci should not be present when they leave the processing plant. However they may become contaminated with staphylococci, and if allowed to remain in a warm environment the organisms may grow and produce enterotoxin. Similarly, pasteurization will kill staphylococci in milk but if the contaminated raw milk has been allowed to stand unrefrigerated, pasteurization will not destroy the enterotoxin that may be present.

BOTULISM

Another less prevalent type of food intoxication is that caused by the toxins of *Clostridium botulinum*. This potent toxin produces acute and often fatal illness characterized by extensive involvement of the central nervous system. In 1953 Meyer (*2*) summarized reports on 1324 cases that occurred from 1899 through 1952. Of these, 846 (62%) died. During the next five years summaries of "Disease Outbreaks in the United States," published annually, reported only 80 cases. In the United States, under-processed home canned vegetables and fruits have been responsible for most cases. With possibly one exception (*62*) commercially canned foods processed in the United States have caused no outbreaks of botulism since 1925. In other areas of the world, many cases have occurred after eating preserved meat, fish and fish eggs (*63*) containing the toxin. There are five types of these toxins designated as *Cl. botulinum* or *parabotulinum*, types A, B, C, D and E. They may be identified by mouse protection tests with the specific antitoxins. The organisms are widely distributed in the soil and it is not unusual to find vegetables contaminated with *Cl. botulinum* spores.

Here again prevention of botulism is dependent upon education of the public and those who prepare foods in which these organisms will grow. Safe processing of canned foods is probably responsible for the decrease in outbreaks in the United States. Unfortunately, in the more acid foods in which *Cl. botulinum* has grown, a detectable fowl odor may not be produced and thus no warning. The toxins are, however, fairly susceptible to heat. Although as certain types require more heat than others, thorough boiling is recommended.

FOODBORNE DISEASE ASSOCIATED WITH THE PRESENCE OF LARGE NUMBERS OF BACTERIA IN FOOD

During the past 20 years increasing evidence has accumulated to indicate that when large numbers of *Cl. perfringens* (*welchii*) are present in food, they may produce a mild gastroenteritis in persons eating the food. Very few outbreaks have been reported in the United States, but in England and Wales, 9% of the general outbreaks reported during the period 1949-1958 were attributed to *Cl. perfringens*. The British workers have given considerable attention (*48, 64, 65, 66*) to the study of this organism as a cause of "food poisoning." Hobbs (*48*) states that the actual cause of the enteritis is not known but that presence of the actively growing organism seems to be necessary for an infection, which the incubation period suggests, or for a toxic illness as suggested by the symptoms. They were able to demonstrate the pathogenicity of a large dose of organisms in meat and soup when fed to human volunteers but cell free filtrates produced no evidence of toxins. Heat resistant, Type A strains are almost always involved. When Dack (*67*) fed volunteers whole veal-infusion broth cultures in milk or whole chicken broth cultures of *Cl. perfringens*, no illness resulted. He states, however, that Hobbs suggested that the negative findings may be due to the lack of whole meat in the cultures. In a table outlining the characteristics of food poisoning caused by bacteria or their products, Dack (*1*) classifies the illness caused by *Cl. perfringens* as an infection. The

Procedure for the Investigation of Foodborne Disease Outbreaks prepared by the Committee on Communicable Diseases Affecting Man of the International Association of Milk and Food Sanitarians, Inc., classifies the illness as a bacterial food intoxication. It is apparent that further information is needed to explain the role of *Cl. perfringens* as an etiologic agent of foodborne disease. Since the spores of many strains of *Cl. perfringens* will survive boiling, control measures must be concerned with adequate cooking and subsequent refrigeration on storage of meats.

Another organism that has been associated with food poisoning on rare occasions is *Bacillus cereus* when present in large numbers. However, consistent evidence has not been obtained and further work is needed before it can be considered as an established cause of illness.

It is fairly well established that when food containing large numbers of *Streptococcus faecalis* organisms is ingested, infection may result. In human volunteer studies, living broth cultures of alpha-type streptococci will usually cause symptoms of food infection but culture filtrates of these organisms have failed to do so. Dack (*1*) states that better results may be obtained if the organisms are grown in the same type of foods involved in the outbreak instead of in broth. There is also evidence to suggest that only certain strains may cause illness. Certainly, *S. faecalis* should be considered when investigating outbreaks of gastrointestinal illness and laboratory studies continued in an effort to clarify the problem. It should be kept in mind also that *S. fecalis* is a normal inhabitant of the intestinal tract of man and animals.

SHIGELLOSIS

While the shigellae are not usually classified as a cause of outbreaks of food poisoning, generally considered of an explosive nature, they do cause outbreaks of severe diarrheal disease and are transmitted primarily through food or water contaminated by human carriers. In fact, shigellosis is one of the most prevalent types of acute diarrhea throughout the world (*68, 69, 70*). However, the incubation period, the clinical manifestations and the epidemiologic picture are usually distinct enough from the gastrointestinal illness caused by salmonellae and the staphylococci, to avoid confusion. For example, in shigella infections, the incubation period is usually longer, stools frequently show blood and mucous, and cases come down over a longer period.

THE RELATION OF OTHER ENTERIC ORGANISMS TO FOODBORNE DISEASE

Although reports of outbreaks of gastrointestinal illness due to *Escherichia coli*, members of the genera *Proteus, Pseudomonas, Citrobacter, Klebsiella* and the Providence group appear with varying degrees of frequency, the evidence is conflicting (*70, 71*).

When large numbers of enteropathogenic *E. coli* 0111:B[4] or 055:B[5] were fed to adult volunteers, symptoms of acute bacterial food infection developed, (*72, 73*). This evidence suggests that serologic identification of *E. coli* strains isolated from suspected foods and from related cases would be of great value in determining the etiologic relation to gastroenteritis.

The evidence to incriminate proteus and pseudomonas organisms as causes of foodborne disease is not so convincing. An investigation of an outbreak of food poisoning was made by Cooper, *et al.* (*74*), which they attributed to an enterotoxin produced by Proteus. Filtrates of cultures of *Proteus* species isolated from patients and the food they had eaten were injected into kittens. The kittens developed symptoms but Singer and Hagan (*75*) have found kittens to be unreliable to determine toxin production. Similarly, species of *Pseudomonas* have been implicated in outbreaks of food poisoning (*76*). Feeding experiments on kittens with heat killed cultures in milk produced diarrhea and vomiting, indicating the presence of a toxin. However, as pointed out by Taylor, much more evidence is necessary to definitely establish this group of organisms as the cause of food poisoning.

The Bethesda-Ballerup (*77*) and Providence groups of paracolon organisms (*78*) have been associated with outbreaks of diarrhea and with sporadic cases, but they are also found commonly in the stools of healthy persons and animals and for this reason their role as etiologic agents of foodborne illness is uncertain.

TRICHINOSIS

Of the parasitic infections, trichinosis is probably the only one in which symptoms similar to those in bacterial food poisoning may appear within a few hours after ingestion of large numbers of parasites (*79*). Trichinosis should always be considered in cases or outbreaks where there is a history of the patients eating inadequately cooked pork and the parasites looked for in samples of the suspected meat. The disease can be controlled by thorough cooking of the infected meat.

REPORTING AND CURRENT KNOWLEDGE OF PREVALENCE

It would be an understatement to say that the reporting of food poisoning and foodborne disease is incomplete in most countries. In fact, it is usually only the large outbreaks that are reported to health agencies and in many instances, the etiological agents

TABLE 1—FOODBORNE, WATERBORNE AND OTHER DISEASE OUTBREAKS IN THE UNITED STATES BY TYPE OF INFECTION[a]

Year	Typh.		Salm.		Shig.		Trich.		Botul.		Staph.		Unknown	
	O[b]	C[c]	O	C	O	C	O	C	O	C	O	C	O	C
1953	12	75	21	533	23	2230	13	134	7	10	81	4045	92	4832
1954	16	92	26	1164	19	1471	6	53	8	18	100	4868	103	5914
1955	5	36	16	971	10	475	5	92	5	14	102	4130	66	3160
1956	7	52	23	1999	8	1107	11	98	11	22	111	4313	88	6688
1957	4	70	30	1607	11	754	1	14	6	12	58	1660	135	6065
1958	1	30	27	1043	3	392	7	68	3	4	62	2291	134	6216
Total	45	355	143	7317	74	6429	43	459	40	80	514	21,307	618	32,875

[a]From: Dauer, C. C., Summary of Disease Outbreaks, Public Health Rep. **71**: 797-803, 1955; **73**: 681-688, 1958; and **74**: 715-720, 1959. [b]outbreaks; [c]cases.

are not determined adequately. Meyer (*2*) in his excellent review on "food poisoning" pointed out that for information on the known number of cases occurring in the United States, one must rely upon data compiled by governmental agencies and interested investigators. The annual summaries of disease outbreaks by type of infection obtained by the National Office of Vital Statistics for the years 1953-1958 are shown in Table 1. When broken down by vehicle of infection, there were 68 reported milkborne outbreaks and 1323 due to other foods, as shown in Table 2. Obviously, these reports are incomplete as for example, in 1958 no cases were reported from one third of the states. In 1955, the Joint FAO/WHO Expert Committee on Meat Hygiene (*79*) recommended that foodborne diseases should be made notifiable and that the physician notifying the case should provide the health department with any information available about the food suspected as the vehicle of infection. This would bring it to the attention of the health department in time for an adequate investigation to be made.

TABLE 2—SUMMARY OF FOODBORNE DISEASE OUTBREAKS REPORTED 1953-1958 BY VEHICLE OF INFECTION[a]

Year	Milkborne		Other foods	
	Outbreaks	Cases	Outbreaks	Cases
1953	4	97	194	9,914
1954	9	200	234	11,704
1955	3	302	193	9,633
1956	31	873	216	11,133
1957	8	67	250	11,085
1958	13	441	236	9,925
Total	68	1,980	1,323	63,394

[a]From: Dauer, C. C., Summary of Disease Outbreaks, Public Health Rep. **71**:797-803, 1955; **73**:681-688, 1958; and **74**:715-520, 1959.

A basic scheme of reporting directed toward a practical working procedure is presented in the manual on Control of Communicable Diseases in Man by the American Public Health Association (*80*). This scheme is designed to encourage uniformity in morbidity reporting and to allow comparison of data within a country or between different countries. Logically, the collection of basic data is recommended to begin in the local area where the case or outbreak occurs. Next, the data should be assembled at local, state and national levels. Finally, reports for international assembly should be made by national agencies to the World Health Organization. In the United States, the reports from state health agencies are received and summarized by the Public Health Service, National Office of Vital Statistics, Washington, D. C., a function being transferred to the Surveillance Section, Epidemiology Branch of the Communicable Disease Center in January 1961. It seems regrettable that in the American Public Health Association manual, food poisoning is considered in the class in which obligatory report of epidemics is recommended but no case reports are required.

Probably the most adequate reporting system currently in operation in any country is that established by the British Ministry of Health in 1949. Here, sporadic cases and outbreaks are reported by the health officers to the Ministry of Health or by the bacteriologists in public health and hospital laboratories to the Director of the Public Health Laboratory Service. The data is summarized and published annually in the Monthly Bulletin of the Ministry of Health and Public Health Laboratory Service. Cockburn (*81*) states that probably few large outbreaks are missed by this method but only a comparatively small number of sporadic cases and small outbreaks are reported. The terms used in the British system are defined as follows: *A general outbreak*, 2 or more related cases in persons in different families; *family outbreak*, 2 or more related cases in persons of the same family; *sporadic case*, one not related to another case as far as can be ascertained. Any of the three above mentioned terms is considered as an *incident*.

EPIDEMIOLOGICAL AND LABORATORY INVESTIGATIONS

To provide more reliable information on the prevalence of foodborne diseases, early and thorough epidemiological investigations are essential to establish the true etiologic agent involved, and the source of the vehicle of infection. An adequate investigation should determine first the extent of the outbreak through inquiries to the patients and others associated with the patient. A complete list of the cases should always include the ages and occupations of the patients. An adequate record of the clinical manifestations exhibited by each patient, including the exact time of onset, should be made. It may be necessary, however, to obtain information also about foods consumed up to 72 hours or more prior to onset. Details regarding the preparation and handling of certain foods before serving is very important, particularly whether they have been held at room temperature between preparation and serving. Equally important in the investigation of any foodborne illness is a complete history on all food handlers connected with the case.

Early collection of samples of food that may have been the cause of the disease for laboratory examination is an essential part of a successful investigation. The laboratory should be provided with full information concerning the outbreak. In addition, samples of vomitus and feces from the patients should be examined. In many instances none of the suspected food is available, and in such cases, it may be necessary to obtain samples of ingredients used in the food or swab samples and washings from utensils or even from materials from the area where the food was prepared. Finally, laboratory studies should include fecal samples from the food handlers if salmonellosis is suspected; if there is any indication of staphylococcal poisoning, swab samples from the nose and throat or any open lesions should be examined.

Thus the role of the laboratory in the investigation of foodborne diseases may be described as fourfold; to determine the etiologic agent; to define the magnitude of the problem; to indicate methods of approach toward control and lastly, to determine the effect of control procedures (*82*). Obviously, it is important that the epidemiologist and the microbiologist work in close collaboration if these objectives are to be attained.

COMMENTS

In the prevention and control of the spread of all foodborne disease, national and international cooperation are essential (*83*). For example, epidemiologic and laboratory investigation may incriminate imported food products as the source of salmonella infection. If reported by the local health authorities to the national agency and by this organization to the country of origin, steps could be taken to locate the source of contamination and prevent further contamination.

Another important and essential factor in the control of foodborne disease is the close collaboration between medical and veterinary officers who are conducting the epidemiologic investigation and the microbiologist examining suspected specimens.

Consideration should be given to the development of microbiological standards for foods (*84*). In June 1960, the National Academy of Sciences Medical Research Council held a conference on microbiological standards for foods. This conference was attended by representatives of research institutions, regulatory agencies and food industries in North America and Europe. In general, they agreed that there were specific goals of microbiological quality which would influence the management and regulation of food processing.

Finally, training of those concerned with food microbiology, the epidemiology for control of foodborne diseases, and education of the food handlers and processors should be a part of the programs of national and international health agencies.

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OBSERVATIONS ON THE FREEZING POINT OF VACUUM TREATED MILK

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Non-steam injection vacuum flavor removal equipment used in conjunction with high-temperature, short-time pasteurizers results in an elevation of the freezing point at low levels and a depression at high levels of concentration of fluid milk. Regression lines calculated from data representing concentration and freezing point elevation or depression appear to be the best criterion at present to assist with the detection of water adulteration of vacuum treated milk.

The removal of off-flavors from milk is being accomplished, in part, by the use of non-steam injection vacuum equipment in conjunction with high-temperature, short-time (HTST) pasteurizers. The basic principle of this type of equipment is the removal of volatile flavor components by boiling the milk under reduced pressures. A concomitant loss of water results in a concentration of the milk, which increases as the amount of vacuum applied is increased (*5, 6*). The concentration results in a greater solute concentration; thus a depression of the freezing point value should be evidenced in the vacuum treated milk. However, the research of Roberts (*2*) and Henningson and Lazar (*1*) showed an elevation of the freezing point of vacuum treated milk. Preliminary studies by the present authors indicated that this elevation occurs at low levels of concentration of the product. Any deviation from the normal freezing point, when milk is subjected to vacuum treatment, could create a problem for regulatory officials attempting to detect adulterations of milk with water.

A realization of the importance of vacuum treatment equipment to the dairy industry and the apparent changes in freezing point values for milk, which has been vacuum treated, prompted the present study. The basic objective was to determine freezing point ranges for milk subjected to various levels of vacuum treatment in several non-stream injection vacuum systems. The results should be of assistance to regulatory officials attempting to detect watering of vacuum treated milk.

Experimental

Mixed herd milk was pasteurized at 172°F. for 16 sec. by a HTST pasteurizer engineered for 80% regeneration and a capacity of 3450 lbs. per hour. The milk was homogenized at 2200 p.s.i. after pasteurization and vacuum treatment. Vacuum treatment was accomplished using the following modifications of a vacuum installation[1]: (*a*) a single vacuum chamber (with and without a condenser) located between raw regeneration and the timing pump; (*b*) a single vacuum chamber located after the flow-diversion value; and (*c*) a double vacuum chamber with the first chamber located between raw regeneration and the timing pump and the second chamber after the flow-diversion valve. The condenser, in the single instance used, was a 2-in. diameter stainless steel tubular type 4 ft. long, cooled with city water circulating spirally in the outer water jacket. The condenser was installed at a rise of approximately 30° in the vacuum-vapor line as it left the top of the vacuum chamber. The flow of water through the condenser was adjusted to give a 3°F. drop in temperature of the vapors passing through the condenser.

In all installations studied the degrees of flash-cooling or degrees of treatment were determined by noting the temperature differential between the product entering and leaving the vacuum chamber. The degrees of flash-cooling were expressed as percent concentration or milk loss using previously reported formulas (*5*) for the conversion. This transformation to percent concentration was for the purpose of comparing the freezing point data with milk loss, a term which is of more importance to the dairy industry from an operating point of view.

The vacuum systems were operated as they normally would be under commercial conditions. The milk level in the vacuum chamber(s) was maintained by a valve in the product line before the chamber, and/or by adjusting the timing pump to maintain constant product level when viewed through the sight glass of the unit(s). During operation of the equipment a minimum of 15 minutes was allowed for the system to stabilize prior to collection of samples, when a change in degree of flash-cooling was made. In all cases the raw sample was obtained from the balance tank and a 2-min. time lapse allowed for the milk to

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[1]Vacu-Therm made by the DeLaval Separator Company, Poughkeepsie, New York.

travel through the system before collection of the treated sample, which was then taken from a valve in the line after the final cooling section.

Various increments of degrees of flash-cooling were used on each system to collect data over a range of operating levels. Four replicates with three to four different degrees of flash-cooling were studied on each modification. Duplicate freezing point determinations were made on the raw and treated milks with a model F Fiske cryoscope. Raw milk was used as a control instead of conventionally pasteurized milk. Preliminary studies and the work of other investigators (*1, 3, 4*) indicated that HTST pasteurizers, when properly operated, do not affect the freezing point of milk. Thus the use of raw milk samples for the control in this research was considered valid.

The method of least squares was used for determining the linear relationship between freezing point difference and percent of milk loss. In cases where the relationship was curvilinear the square root of the percent of milk loss was used to make the relationship nearly linear. The standard error of estimate was used as a measure of accuracy of the line (*7*).

RESULTS

The flexibility of flavor removal equipment permits the selection of treatments (flash-cooling degrees) consistent with the intensity of off-flavors to be removed. This flexibility also may be accomplished by the use of various adaptations of the vacuum treatment system. Thus, it was considered advisable to collect freezing point data from four modifications.

Single vacuum chamber before pasteurization

The results of the effect of a single vacuum chamber located between raw regeneration and the timing pump upon the freezing point of milk are plotted in Figure 1. The term freezing point difference used in Figure 1 refers to the elevation or depression obtained from the difference in the freezing point between the raw (control) sample and the vacuum treated sample. The downward trend of freezing point difference with increasing percent concentration of the milk, was represented in the following equation, where Y denotes freezing point difference, and X the percent concentration: $Y=0.0045-0.0056X$. The standard error of estimate for the equation was 0.002°C. The linear regression of these variables was significant ($P<0.01$).

Single vacuum chamber before pasteurization and with a condenser

The equation derived for the effect of a single vacuum chamber located between raw regeneration and the timing pump and with a vapor line condenser on

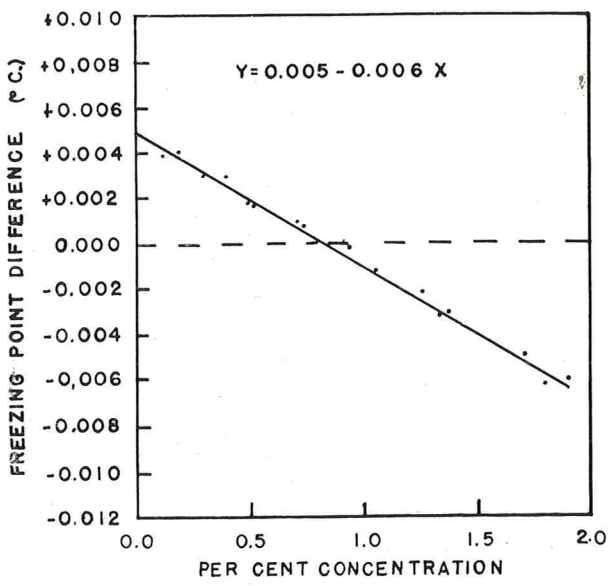

Figure 1. The effect of a single vacuum chamber after raw regeneration upon the freezing point of milk.

the freezing point of milk was $Y_1 = 0.114 - 0.064\,X$, with a standard error of estimate of 0.011°C., where Y_1 denotes the square root of the freezing point difference plus 0.007 ($Y_1 = \sqrt{Y + 0.007}$), Y the freezing point difference, and X the per cent concentration. The regression line, as shown in Figure 2, was plotted from the equation $Y = 0.0060 - 0.0146\,X + 0.0041\,X^2$ which was obtained from the equation for Y_1 by squaring and substracting 0.007. The nonlinear relationship with this vacuum system is due to the effect of the vapor line condenser. The con-

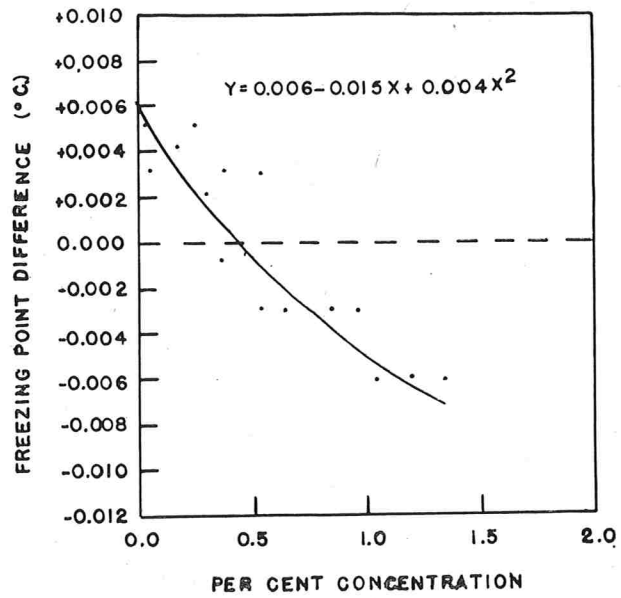

Figure 2. The effect of a single vacuum chamber with a condenser and after raw regeneration upon the freezing point of milk.

densing of some of the vapors and the returning of these condensed vapors to the product resulted in a non-linear relationship between the percent concentration and degrees of flash-cooling (5). Thus, a similar relationship would be expected in plotting such a non-linear concentration effect against freezing point difference.

Single vacuum chamber after final heating

The effect of a single vacuum chamber located after the flow-diversion valve upon the freezing point values of milk is shown in Figure 3. The derived equation was $Y = 0.0031 - 0.0052\,X$, where Y represents the freezing point difference and X the percent concentration. The standard error of estimate was 0.001°C. The freezing point difference associated with percent concentration was significant ($P<0.01$).

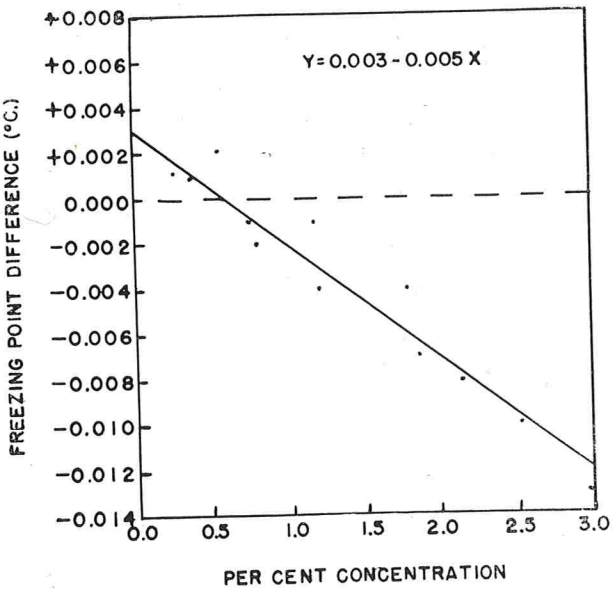

Figure 3. The effect of a single vacuum chamber after the flow-diversion value upon the freezing point of milk.

Double vacuum chamber

The double vacuum chamber unit regression line, as shown in Figure 4, is curvilinear because of the effect of the first vacuum chamber. The travel of vapors in this system is from the second chamber, where milk enters at a temperature controlled by the flow diversion value, to the first chamber, where some condensation of the vapors takes place, and thence to the vapor line to be exhausted. This results in a non-linear concentration effect and when such an effect is plotted against freezing point difference, a non-linear relationship would be expected (5). The regression equation for the double vacuum chamber unit was represented by $Y_1 = 0.157 - 0.044X$, with a standard error of estimate of 0.007°C., where Y_1 denotes the square root of the freezing point difference plus 0.017 ($Y_1 = \sqrt{Y + 0.017}$), Y the freezing point difference, and X the per cent concentration. The regression line, as shown in Figure 4, was plotted from the equation $Y = 0.0076 - 0.0138\,X + 0.0019\,X^2$ which was obtained from the equation for Y_1 by squaring and substracting 0.017.

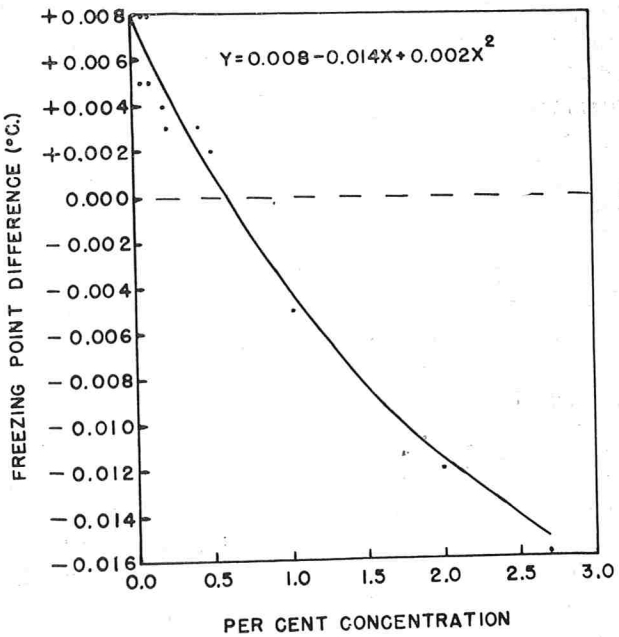

Figure 4. The effect of a double vacuum chamber upon the freezing point of milk.

DISCUSSION

It is apparent from inspection of Figures 1, 2, 3, and 4, that the elevation of the freezing point at zero concentration differs by 0.005°C. between the systems studied. These figures also indicate that the regression lines for the four systems studied are not identical. These variations could be due, in part, to the allowable error of the Fiske cryoscope. However, a more logical explanation is that each system is operated at a different temperature and vacuum for a given percent of milk loss. The theory that the removal of dissolved gases may be a factor in the freezing point elevation at low levels of concentration also offers an explanation for the variation between systems. Carbon dioxide should be removed to a greater or lesser extent depending on the temperature and vacuum applied and the carbon dioxide content of the original milk. The above discussion indicates that a common regression line for all vacuum systems would not be accurate.

In all of the systems studied (Figures 1, 2, 3, 4) the freezing point elevation was overcome as the per cent concentration increased. The levels of concentration which did result in the freezing point eleva-

tion were those most likely to occur in a commercial milk plant. The freezing point elevation creates a problem in that regulatory officials may determine a sample of vacuum treated milk to be adulterated when actually water has not been added to the product. This would be true particularly in cases where the original freezing point value of the raw milk is close to the adulteration point prior to vacuum processing. The realization that with the higher levels of concentration it would be possible to add water to the treated product and obtain a freezing point which approaches that of the original raw product is also important.

The availability of regression lines, similar to those in the Figures, for all types of vacuum systems, should assist in alleviating the problem of detecting small amounts of adulteration with water in vacuum treated milk. The fact that the raw product is not available to the regultory official when a violation is observed could be discounted, as the degrees of flash-cooling used during processing, if known, could be used to determine the percent concentration of the milk (5). The percent concentration could then be used to determine the freezing point elevation or depression from the regression line for the particular system being used. Thus, the freezing point of the vacuum treated sample could be adjusted by the amount of the elevation or depression to estimate the freezing point of the original raw product for the purpose of determining adulteration. Regression lines should be valid for different makes of non-steam injection equipment, since the placement of the unit in the high-temperature, short-time pasteurizing system is the important factor.

Further investigation is needed to more definitely establish the accuracy of freezing point regression lines for determining water in vacuum treated milk. If carbon dioxide is an important factor in the freezing point elevation of such milk, the variable carbon dioxide content of raw milk could result in its non-uniform removal and thus cause a variable elevation of the freezing point of vacuum treated milk. This would decrease the accuracy of detecting adulteration from freezing point regression lines for the purpose of litigation.

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SANITATION IN SUBURBIA[1]

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No doubt, all are well aware of the growth of our metropolitan areas and particularly the explosive expansion of so-called "satellite" suburban rings and clusters of new developments around our large cities. This current pattern of growth is drawing or forcing the attention of many private and governmental groups to its many resulting problems.

Mushrooming areas have been tagged with a variety of descriptive terms by those who have interest or concern about them. Urban fringe, urban sprawl and rurban are mentioned. Probably most descriptive is suburbia which tends to give a connotation of geography, as well as a way of life, of increasing numbers of our population. Unfortunately, amidst our pleasant thoughts of vistas of verdant land having gentle breezes and lovely homes where life is full of joy, we find that some of our suburban developments constitute potentially the slums of tomorrow. Instead of having the land of pleasant living, we may often encounter overflowing septic tanks, contaminated wells, flooded streets, smoking dumps, and foul streams to mar the picture. These are not mere panic pictures; but there are ever increasing numbers of examples of this dilemma. In an era of scientific and technical wonderment, it is strange and perplexing how man allows the environment in which he lives, works, breathes, and plays to be so contaminated.

The growth of our urban areas is a result of many things — more people, certainly; but also better transportation services, greater efficiency in farming methods providing increased agricultural production with fewer farm workers, and an ever-increasing demand for industrial workers to supply manufactured goods that satisfy the consuming public. These and other factors have resulted in drawing people near the giant urban complexes where sanitation utilities and services too frequently have been lacking or inadequate.

We are living in a challenging era of change in the American scene. Whether these changes are all for the better may not always be clear, but we can be certain that change and growth will continue to take place. Everyone seems to agree that we should be guiding this future growth, sanitation-wise, in the best way possible.

Growing metropolitan areas mean many things to public health workers, depending on our individual interests and responsibilities. If we wished to chart these growing needs, we could list almost all of the public health services and facilities with which we already are quite familiar. Expressed in millions of gallons of water or sewage, or thousands of inspections of restaurants, or tons of refuse per year, they make an impressive total but these numbers tend to lose meaning for many of us.

Instead, let us look at the meaning of metropolitan growth in terms of "right now" — the new demands that will have come about by the time you and I get back home from this three-day meeting.

Based on existing average growth conditions, United States' metropolitan communities in the past three days will have grown by some 20,000 persons.

Only about 3,000 of these are new residents of cities, the remaining 17,000 now live in suburban areas on the edge of these cities. Remember these 20,000 people are not *anticipated* — they do not exist only in a population projector's table of future statistics. They are moved in right now — new neighbors ready to meet you and to be served the customary sanitation utilities, or services that we recognize to be essential to individual and community health.

Have your city officials gotten together with your health department to prepare for them? They will require almost three million more gallons of water each day than was needed three days ago; an equal amount of sewage now needs to be collected and disposed of. Forty-six thousand new pounds of refuse needs to be satisfactorily burned, buried, or otherwise disposed of daily.

Consider the economic impact upon the government of these metropolitan areas. Twenty-five more firemen will be required by the time you get home. Thirty more miles of streets and highways will have to be constructed during these three days. Five completely new schools ought to have been built. And 5,850 new homes will have been occupied. Every third day you can repeat this cycle, week in and week out, never ceasing, ever increasing perhaps. Projections estimate that everything we have in our society

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– structures, utilities, and services will need to be doubled by the year 2000.

Of more interest to many of you in your work is the fact that these 20,000 new suburban residents want 17,000 pounds – about 8,000 quarts of fresh, whole milk every morning. They are eating over 1,700 pints of ice cream every day. If their dining habits are like those of the average family, they will eat 10,000 meals in restaurants daily.

Are we prepared to meet these new needs? Or are we still trying to catch up with the demands of last week, last month or last year?

We cannot put off lightly the cold facts that spell out more and more service demands daily. Without some evaluaton and realistic planning to anticipate future needs, we are in danger of finding that conditions have become, as one writer puts it, "inexplicibly intertwingled."

We have discussed some of the problems facing us; now let us try to analyze their causes.

One of the biggest factors is economics, as previously mentioned. Public health services and facilities cost money, just like any community needs – streets, schools, parks, police, fire departments, and all the others. Economic resources are, and always have been, scarce. This brings us to the immediate conclusion that decisions are needed for determining where limited financial resources should be spent. Is a new health center a better investment than a new library? Is another sanitarian as important as that additional policeman? Are sound policies regarding the extension of public water and sewer lines being carried out or do we continue to have more additional wells and septic tanks? These are typical decisions facing every growing community. It adds up to the fact that the community, through its' planning agency and its' various departments, needs sound facts with which to work and plan. Having these facts, essentials can be determined, priorities can be established and progress is possible.

But have we forgotten your 20,000 new neighbors somewhere? Even though most of them do not live in the central city and therefore do not support city services through their taxes, they still need many of the same services. And they would like a voice in how they are to be provided. We now see another side of the metropolitan problem – political units fragmenting the area.

If you will, visualize before you two quarts of milk. In some respects, they are like a metropolitan area. One is regular cream-line milk which is clearly divided in two components. In this respect, it is like most of our metropolitan area governments, except that they have many more divisions.

Right here in the Chicago metropolitan area, there are over 500 separate local governmental units, each with some particular function to perform. Nationally, there are over 15,000 local governmental entities and in a recent five-year period over 500 brand new special district governments were formed.

Solving area-wide problems is difficult in the face of so many different governmental units with individual plans, budgets, and goals. Our work would be made much easier if all metropolitan areas had one homogenous blend of government covering all parts of the urban complex. So far, no plan has been devised to homogenize metropolitan government like the other quart of milk that I asked you to visualize. And even if there were some system, it is doubtful that many people would like it.

This leaves us with two big causative factors contributing to metropolitan problems – economic limitations and political differences. These are not the only problems but they underlie every aspect of community development.

As public health workers, we cannot ignore them. True, our daily tasks, as members of the health team, may require us to concentrate on the immediate administrative and technical problems of milk, food, and community sanitation; or to perform routine functions intended to improve existing sanitation conditions. However, without economic and administrative support, these and many other public health activities would cease.

Planning for future needs can do much to anticipate and prevent future problems. For the most part, our plans are put into effect through community action. Community action is seen every time a new ordinance gets considered or a bond issue is voted on. Community leadership is needed behind every improvement plan, to furnish guidance and organization of effort. This task is everybody's business. As public health officials, you have a share and a stake in community planning and development. As sanitarians you can furnish facts, diagnose situations and suggest problem-solving procedures in the area of your responsibility. As private citizens, I am sure you are as much interested in what lies ahead as was Charles Kettering, who said, "I am interested in the future because there is where I'm going to spend the rest of my life."

Mobilizing and stimulating effective programs to improve our communities calls for talent in many areas and a combination of skills and knowledge. The sanitarians have an unusual opportunity to assume a leadership role in meeting the future environmental health problems of these communities.

A first step is organizing a capable team to consider problems and needs. This can include health, public works, planning and other government departments to provide the technical ability. It requires other public

officials for legal competence to determine which actions are possible; also, political and administrative specialists, who can furnish guidance in carrying out programs. Finally, the support and interest of civic organizations is vital for getting the job done through citizen action. Putting together the right combination can lead to effective results. Such a combination proceeds by collecting all pertinent facts on the community situation and its capabilities, both present and future.

After the data are in hand, they are analyzed and a course of action is determined to satisfy present deficiencies and prevent new ones. The final step is that of carrying out the recommendations. In other words, each community must find answers to the questions: "Where do we stand now?" "Where should we be going?" "How do we get there?"

The Public Health Service is now trying out this fact-finding and evaluation procedure in several metropolitan areas, as it relates to a study of environmental health conditions. These field trials are based on a procedure guide which soon should be published. From the field tests, we are developing workable programs for assisting states and communities faced with growing pains in their health programs.

As described earlier, the problems do not necessarily follow city limits or county lines. Instead, they are found wherever rapid growth and expansion takes place. In fact, many metropolitan areas already cross State borders and a new name, "megolopolis" now has been coined to describe a giant string of densely built-up areas such as exist already from Boston down to Washington, D. C.

Such areas have special problems of great complexity. Solutions here will require interstate compacts, extremely careful coordination in many fields and perhaps entirely new concepts of government to provide adequate health and closely related services of common concern to these broad areas.

In the above mentioned metropolitan planning studies being conducted by the Public Health Service, we have been firmly convinced that there is no single or magic solution to the problems of sanitation in suburban areas which can be applied to any particular community. A variety of approaches or actions are possible depending on existing state enabling legislation, the pattern of government, and the desires and wishes of the population being served. Whether the provision of future sanitation needs, particularly public water supply and sewerage, and refuse handling that lend themselves to area-wide consideration is satisfied by such procedures as annexation, extension of city services, incorporation, mutual cooperation, or by the formation of special sanitary districts, there is one fundamental, important thing which is common to all solutions. This is that dynamic community interest and leadership is necessary as a starting point. This ingredient can be supplied by people like you and I. And, it can stem from neighborhood action if the facts relating to sanitation needs are made known to them and to community leaders. Unless more public health agencies and advocates of better community health are willing to step forward and project their interests and objectives as a full member of the comprehensive community development and planning team, we can look forward to the frustrations of putting out endless brush fires instead of preventing them through sound planning.

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CLEANING AND SANITIZATION OF WELDED LINE SYSTEMS FOR HANDLING MILK[1, 2, 3]

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Commercial circulation cleaning of welded pipelines is extremely effective in removing milk solids. After normal rinsing only approximately 2.6 g of milk solids could be found in an average circuit cleaned with 165 gallons of cleaning solution. This quantity of milk solids relative to the volume of the equipment involved had little if any effect on the growth of microorganisms. The small amount of milk solids left in pipelines after cleaning was not high enough to cause any dissipation of chlorine. A new approach to sanitizing a pipeline system by leaving in the lines overnight a chlorine solution of 1.0 - 2.5 ppm concentration is discussed.

There is considerable commercial interest in the use of welded lines for conveying dairy products. Welded lines alleviate the troubles of gaskets of the conventional cleaned in place (CIP) system, and should provide a more efficient and economical system of installation and operation in a dairy plant. Such a system is less subject to the vagaries of a typical dairy plant employee. Welded lines also may have merit from a sanitation standpoint, because essentially it is a closed system of operation.

The conventional CIP system of lines with specially constructed joints has been proven satisfactory from a sanitation standpoint both by laboratory investigations *(3, 8)* and from extensive commercial use. Recent work of Kaufmann *et al. (5)* indicated the extreme effectiveness of circulation cleaning. They also showed that with the same treatment the less highly polished finishes can be cleaned bacteriologically to the same degree as the most highly polished finishes.

Welding of lines was introduced to replace as many of the clamp joints as possible. Havighorst *(4)* pointed out many of the advantages of such a system. In comparing a welded line system with a demountable system he observed that the welded system could be cleaned and sanitized satisfactorily. Olson *et al. (9)* published results on a plant employing welded lines from which the results indicated a satisfactory degree of sanitation. All of the previous work with welded lines was done on individual plants using only the general standards of sanitation as a control. Thus, additional work was undertaken to evaluate a commercial operation and to compare the results to controlled laboratory data where the conventional system could be compared to a welded system.

Experimental

A completely new commercial dairy plant of the Safeway Stores Company was used for this work. It was designed to utilize as far as possible butt welded joints in place of the conventional clamp joints. Since the acceptability of the plant from the sanitary standpoint was primarily the responsibility of the Omaha-Douglas County Health Department, the plant was permitted to utilize the welded pipelines on a temporary basis. During the construction of the plant the welding of the lines was under close observation of a representative of the health department and a representative of the Dairy Husbandry Department of the University of Nebraska. Where there was doubt as to the quality of a finished weld, it was cut out and replaced.

Natural openings at such points as plug valves and some special openings constructed in ells (Figure 1) which were welded into the system served as the inspection ports. These were examined by the swabbing technique for bacteriological cleanliness. Swabs were taken approximately once each month for a period of nearly two years in cooperation with the Omaha-Douglas County Health Department. These swabs were taken prior to sanitizing in the morning. The equipment had been washed with a 0.67% alkaline washing solution for 30 minutes at 170°F the previous afternoon. Additional swabs were taken after sanitization of the equipment. Counts were run on standard plate count agar and on a coliform count medium.

The equipment was examined visually for cleanliness at least once each month utilizing the natural openings and the specially constructed ports. In addition, some questionable welds were cut for a more thorough inspection.

For comparative effectiveness in cleanability two laboratory units were constructed. One had 18 conventional CIP joints, and the other one, similar in length, had 22 welded joints. The unit assembled with welded joints is shown in Figure 2.

Finished milk products were taken from the cold

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[1]Published with the approval of the Director as paper No. 1074, Journal Series, Nebraska Agricultural Experiment Station.
[2]Supported in part by a grant from Safeway Stores, Inc.
[3]First in a series of papers given in a panel discussion on "Industrial Uses of Welded Pipelines," presented at the 47th Annual Meeting of the International Association of Milk and Food Sanitarians, Inc., October 26-29, 1960, Chicago, Illinois.

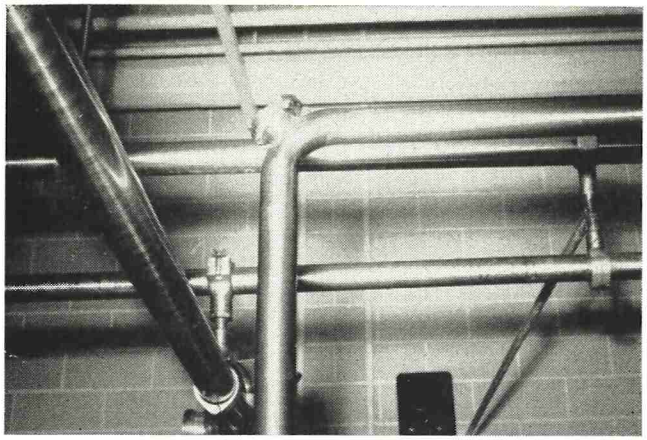

Figure 1. A Section of Piping Showing a Specially Constructed Inspection Port.

room of the producing plant for standard plate counts and for coliform counts. These counts were made according to Standard Methods *(1)*.

Quality of the Finished Product

The finished products from the plant of this study were under the surveillance of the plant laboratory, the company's central laboratory, the local health group, and approximately 25 out-city health departments where the products were distributed. The results from all these organizations were essentially the same.

For simplicity only the results of the Omaha-Douglas County Health Department are given. Furthermore, the counts are limited to milk. The results of 20 examination periods are presented in Table 1. In each period 4 or 5 milk samples were examined amounting to a total of 94 samples over a period of nearly two years. These bacteriological results indicated that a high quality product was produced by this plant with welded lines.

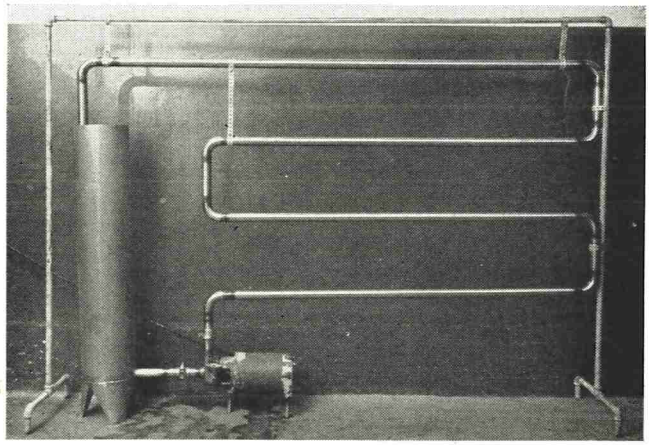

Figure 2. A Laboratory Unit with Welded Lines Used in the Comparative Study of Welded Joints and Conventional C.I.P. Joints.

TABLE 1. BACTERIOLOGICAL EVALUATION OF SAMPLES OF THE FINISHED MILK PRODUCTS FROM A COMMERCIAL PLANT WITH WELDED LINES

Date	Standard plate count		Coliform count[a]	
	<3,000/ml	3,000 to 10,000/ml	<1/ml	1 to 10/ml
12- 5-58	4	0	4	0
1- 9-59	4	0	3	1
2- 9-59	4	0	3	1
3-10-59	4	0	3	1
4-13-59	5	0	5	0
5- 8-59	4	1	5	0
6- 5-59	2	3	4	1
7-13-59	1	4	5	0
8-20-59	5	0	5	0
9-10-59	4	0	4	0
10-12-59	3	2	5	0
11-10-59	5	0	5	0
12- 9-59	5	0	5	0
1- 7-60	5	0	3	2
2- 8-60	5	0	5	0
3- 4-60	4	0	4	0
4-11-60	5	0	5	0
5- 9-60	5	0	4	1
7-26-60	5	0	4	1
9- 1-60	5	0	3	2
Total	84	10	84	10

[a]One of the samples of 1-9-59 showed 20 coliform organisms per ml.

For comparative purposes the results of examinations of milk samples from another commercial plant are presented in Table 2. This plant is considered comparable in every important feature (size, equipment, general cleanliness, etc.) except that conventional CIP joints are used in the pipeline system. It is apparent that the bacteriological results on the samples from the plant with welded lines indicate a higher degree of sanitation than the plant with conventional CIP joints.

Bacteriological Cleanliness of the Commercial Equipment

During approximately eighteen months 335 swab counts were made on the equipment consisting of welded lines that were cleaned by circulation. The results on the total counts are given in Table 3. The average total count on 8 sq in. was 7.9 organisms before sanitization and 1.3 organisms after sanitization. The equipment had far less organisms than the interpretive suggestion of Standard Methods *(1)*. The coliform counts also were made on all the samples. They are not included in this table, however, since the results were negative in all except two cases.

For comparative purposes some equipment was

TABLE 2. BACTERIOLOGICAL EVALUATION OF SAMPLES OF THE FINISHED MILK PRODUCTS FROM A COMPARABLE PLANT WITH CONVENTIONAL C.I.P. JOINTS

Date	Standard plate count[a]			Coliform count		
	<3,000/ml	3,000 to 10,000/ml	10,000 to 30,000/ml	<1/ml	1 to 10/ml	More than 10/ml
1- 6-59	4	2	0	4	1	1
2-10-59	5	2	0	5	1	1
3- 4-59	1	5	0	3	3	0
4- 1-59	8	0	0	5	2	1
5-12-59	4	4	0	6	0	2
6- 2-59	1	1	4	2	3	2
7- 7-59	4	2	1	0	2	4
8- 4-59	7	1	0	5	1	2
9- 1-59	6	0	0	4	1	1
10- 7-59	7	2	0	8	0	1
11-10-59	8	0	0	4	1	3
12- 8-59	6	0	1	5	2	0
1-19-60	8	0	0	4	4	0
2- 9-60	5	2	0	0	5	2
3- 7-60	5	1	1	7	0	0
4-18-60	7	1	0	5	3	0
5 -9-60	8	1	0	4	3	1
6- 8-60	8	0	0	5	3	0
Total	102	24	7	76	35	21

[a]One of the samples of 6-2-59 had 35,000 per ml.

hand washed and stored open to the air in order for it to dry before the next use. This equipment was swabbed during each inspection. The results of 26 such examinations showed an average of 17.2 colonies per 8 sq in., or more than twice as many as on the equipment cleaned by circulation cleaning.

The counts on the finished products and especially the counts on the swabs were extremely low, therefore, work was undertaken to determine the bactericidal efficacy of the cleaners used. The cleaning solution consisted of 0.67% of an alkaline commercial cleaning solution. During the course of this work a variety of commercial cleaning compounds were used. Samples of the used cleaning solution were neutralized and plated on standard plate count agar to determine the extent of microbial contamination. It was found that the cleaning solution was sterile in two out of three trials and in the third trial it had an average of only 16 organisms per milliliter. This could be expected since the temperature of the cleaning solution during use was approximately 170°F. These results corroborate the earlier work of Meyer *(7)*, who pointed out the high germicidal properties of some alkaline cleaning solutions.

Physical Cleanliness

At the time of each bacteriological examination of the equipment by swabbing a visual inspection was made of the inside of the equipment at the inspection ports. The equipment always was found to be free from objectionable accumulation of milk residues. The oxidized film on the inside of the line resulting from welding soon was removed by normal CIP cleaning. In order to pursue this evaluation further, however, both chemical and microbiological techniques for analyses were utilized.

Chemical Cleanliness

With an aim toward determining the presence within the equipment of any residue that was not visible to the eye, an indirect approach was taken. It was reasoned that the extent of removal of milk solids from the equipment could be estimated from the increase in milk solids in the cleaning solution. This estimation was made by determining the increase in nitrogen content of the cleaning solution as a result of the cleaning process.

A modified Kjeldahl test involving both micro and macro techniques was used for determining nitrogen. The sample size was 100 ml of cleaning solution. The materials for digestion and the procedure were according to A.O.A.C. *(2)*. The distillation was made into 5 ml of 4% boric acid with the indicator system consisting of brom cresol green, p-nitrophenol, and new coccine as suggested by Sher *(10)*. The entrapped ammonia was titrated with 0.01 N sulfuric acid. The standard for calculating the quantity of milk solids involved was established by testing known quantities of milk in the presence of an alkaline cleaning solution of 0.67% concentration.

TABLE 3. THE RESULTS OF SWAB TESTS ON THE INSPECTION STATIONS OF THE COMMERCIAL PLANT WITH WELDED LINES

Date	Before sanitization		After sanitization	
	No. of stations swabbed	Average count on 8 sq in	No. of stations swabbed	Average count on 8 sq in
1-20-59	11	1.9	11	.2
2-24-59	12	11.8	13	.3
4-14-59	12	.3	13	.2
6- 4-59	12	5.1	10	.5
7-21-59	11	14.6	11	1.2
8-25-59	11	3.4	11	.2
9-22-59	11	5.5	11	.7
10-27-59	11	2.0	12	.2
12- 1-59	11	12.2	12	2.0
1-12-60	12	18.0	12	.4
2- 8-60	12	6.6	13	.6
3 -8-60	10	.8	11	.1
4- 5-60	15	18.2	15	4.4
6 -3-60	14	6.2	15	5.1
	165	7.9	170	1.3

TABLE 4. MILK SOLIDS REMOVED DURING COMMERCIAL CLEANING OPERATIONS

Trial	Number of circuits cleaned	Milk solids removed per circuit in grams	Contamination of the cleaning solution in ppm of milk solids[a]
1	3	1.5	2.8
2	2	1.3	2.2
3	3	0.4	0.7
4	3	3.7	6.0
5	2	0.0	0.0
6	2	0.0	0.0
7	2	0.7	1.0
8	10	3.6	5.8
9	13	3.6	5.8
	Average	2.6	4.2

[a]The volume of cleaning solution was 165 gallons.

The above method was applied to determine the extent of milk solids in the cleaning solution from the commercial operation with the welded pipeline system. Tests were run on the cleaning solution before use and after a number of series of pipe, etc. had been cleaned. For experimental purposes, the same cleaning solution was used to clean as many as 13 circuits with 165 gallons of solution. The data are presented in Table 4. It was observed that a typical cleaning operation removed only approximately 2.6 g of milk solids per circuit, amounting to approximately 4.2 ppm of milk solids in the cleaning solution.

Rapid Chemical Test

In addition to the above tests work was undertaken to develop a more rapid method for estimating milk solids in a cleaning solution. Lowry's *(6)* colorimetric method for proteins was modified for this purpose. The method was found applicable for routine approximations of protein in cleaning solutions. The method involves digesting the protein with sodium hydroxide for 30 minutes and developing the blue color with phenol reagent. The optical density was measured at 620 mμ. To determine the reliability of the test, varying quantities of milk solids were added to a cleaning solution, and the protein content was determined by the colorimetric method. The color development was in direct proportion to the protein content. It was observed that the test had a sensitivity of approximately 4.0 ppm of milk solids. The method also was compared to the Kjeldahl method using a variety of milk samples with water dilutions as well as with cleaner dilutions. The results are presented in Figure 3. Fairly good agreement between the two methods was obtained.

Bacteriological Test for Residual Soil

The low concentration of solids as found in the lines naturally raises the question whether this small quantity would support the growth of microorganisms. Exploratory work using *Streptococcus lactis* in erlenmeyer flasks showed that concentrations of less than 5 ppm of milk solids in tap water had little or no effect on the growth rate of the organisms. However, the less fastidious organism, *E. coli*, showed a greater response to small quantities of milk solids in tap water.

As a continuation of these observations, a microbiological technique was standardized for estimating

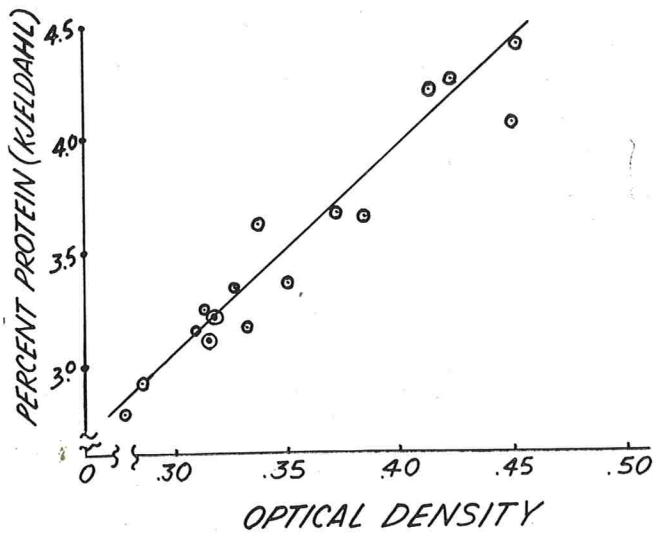

Figure 3. The Relationship Between the Kjeldahl and the Lowry Method of Determining Protein Concentration.

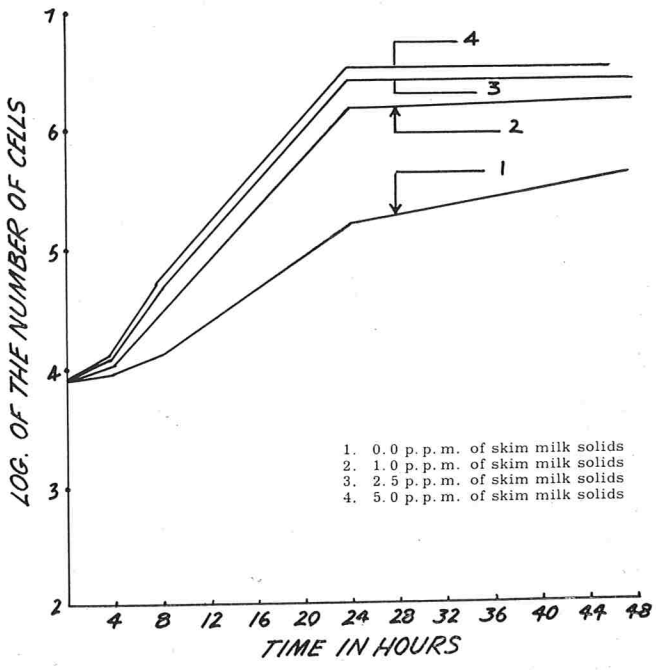

Figure 4. The Stimulatory Effect of Milk Solids on the Growth of *E. coli* in Tap Water at 30°C.

the quantity of skim milk solids in a solution of this low concentration. The procedure consisted of neutralizing the free chlorine of tap water with sodium thiosulfate in erlenmeyer flasks. Varying quantities of skimmilk solids were added to the water in the flasks before sterilization. The milk solutions were inoculated with approximately 8,000 cells of *E. coli* per ml in the medium. The flasks were incubated at 30°C for varying times and growth was determined by the standard plate count. The results are given in Figure 4. As little as 1 ppm of skimmilk solids gave a detectable stimulation to the growth of *E. coli.* The greatest response was noticed in the samples incubated 8 to 24 hr.

A similar approach was used in a pilot laboratory welded pipeline system (Figure 2). Essentially the same response to milk solids added to tap water neutralized with sodium thiosulfate was obtained with this assembly as was obtained in the erlenmeyer flasks. Thus, the technique seemed applicable for comparable studies on various laboratory assemblies to determine the residual milk solids by this microbiological technique.

The above microbiological technique and duplicate assemblies were used to compare the cleanability of the welded line system and of the conventional joint system. The systems were contaminated by circulating whole milk at room temperature continuously for five hours. The equipment was then cleaned with an alkaline cleaning solution according to generally accepted commercial practices. Tap water neutralized with sodium thiosulfate was inoculated with *E. coli* and the system was allowed to stand overnight, at approximately 86°F. The bacterial counts at the beginning of the period were compared with those obtained 17 hr later. The section of welded lines and the section of clamp joints were used on alternate days.

The comparative results are given in Table 5. The 14 trials indicated that there was no appreciable difference between the cleanability of welded lines and clip joints with these laboratory systems.

When the results of these trials were compared to those given in Figure 4, it was apparent that there was not enough milk solids left in the equipment to give a noticeable stimulus to the growth of *E. coli.*

Continuous Sanitization

The general method for handling pipelines is to sanitize with chlorine solution containing 100 to 200 ppm of available chlorine immediately prior to use. Several workers have reported that high concentrations of milk solids in the system dissipated part of the chlorine. In the present study it was observed that following the cleaning process extremely small concentrations of milk solids were left in the lines. During some of the exploratory work it was observed that the small quantities of milk solids as generally found in the lines did not dissipate even 1 ppm of chlorine. Thus, there was an apparent need for quantitative data on the quantity of milk solids required to dissipate a given quantity of chlorine.

TABLE 5. A COMPARISON OF GROWTH STIMULATING RESIDUES IN LABORATORY SYSTEMS OF WELDED LINES AND CLAMP JOINTS

	Clamp joint connections		Welded connections	
	Before incubation	After incubation	Before incubation	After incubation
	10,000	51,000	3,800	53,000
	12,000	70,000	8,400	72,000
	7,900	15,000	7,900	96,000
	8,100	144,000	6,800	100,000
	6,600	270,000	6,000	44,000
	3,400	8,700	4,600	41,000
	6,900	120,000	6,600	46,000
Arith. av.	7,800	97,000	6,300	65,000

The next phase of the study was concerned with the determination of the interaction of skim milk solids and chlorine. Varying quantities of milk solids in distilled water were reacted with different concentrations of chlorine. The reaction time was 1 hr and the temperature was 25°C. At the end of the reaction time, the residual chlorine was titrated with sodium thiosulfate and the quantity of chlorine dissipated was calculated. The results are given in Figure 5, which represents the average of three replications

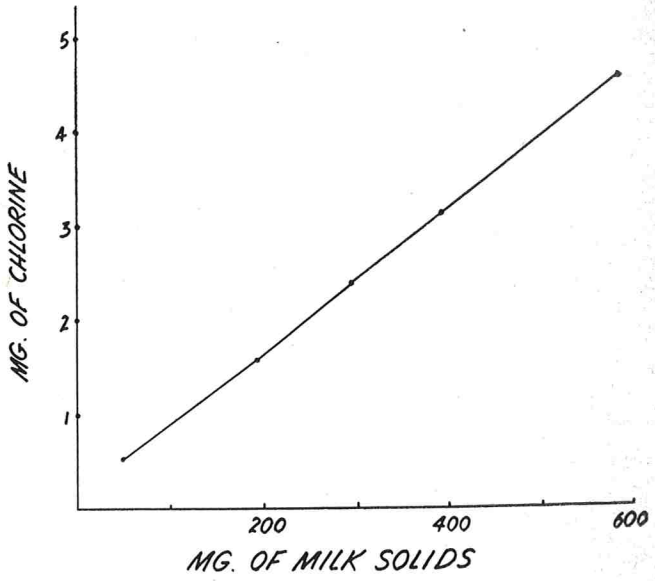

Figure 5. The Relationship of Skim Milk Solids Required to Dissipate the Chlorine of a Sanitizing Solution in 1 Hour at 25°C.

of duplicate runs. It can be seen from this graph that almost 150 parts of milk solids were required to dissipate one part of chlorine. As evidenced from the data previously presented showing that very small amounts of milk solids were present in a normally cleaned system, it is logical to conclude that the milk solids in a well cleaned CIP system would have little effect upon chlorine at any concentration.

The above observations suggested the possibility of substituting an extremely low concentration of chlorine sanitizer that could be left in the equipment overnight to achieve sanitization rather than using the 100 - 200 ppm chlorine solution. Exploratory work showed that tap water as well as solutions with added milk solids were essentially sterile after overnight storage as long as there was a residual of chlorine as indicated by the starch-iodine test. Specific instances of contamination in the pilot equipment with welded lines were set up using *E. coli* with an inoculum of approximately 12,000 per ml and chlorine content of 1.0 - 2.5 ppm in the system. The solution was examined after 16 hrs. The results showed the system was essentially sterile after overnight storage as long as there was residual chlorine.

This method of sanitizing seems to have potential merits. It should afford an added measure of safety from the public health standpoint because of the closed system of essentially sterile lines. Furthermore, this method of sanitizing may be less destructive to stainless steel equipment than the ordinary use of chlorine solutions of high concentrations. This method of sanitizing is being studied further both in the pilot operation and in a commercial plant.

DISCUSSION

A welded line system is an essentially closed system. While it cannot be inspected easily in the traditional manner, logical advantages of the closed system can be utilized. The work reported here substantiates the general belief that circulation cleaning is extremely effective in cleaning a welded line as it is in cleaning a clamp joint system, and renders the equipment essentially "chemically clean." Furthermore, from the work reported here it is apparent that an alkaline cleaning solution is essentially sterile during the cleaning operation.

Since dairy equipment cleaned under proper conditions is essentially chemically clean and sterile, it should be handled between uses in such a manner that it stays sterile. A chlorine solution could be used in much lower concentrations than now used routinely in the equipment.

The use of continuous sanitization should be less destructive to the equipment, thereby giving a longer life to the equipment and a financial saving. It would mean a better preservation of the smooth surface finish of the equipment and the maintenance of higher sanitary standards through a reduction of the use of corroded, pitted equipment resulting from the use of destructive sanitization practices.

The superivsion of the use of chlorine at this concentration should be an easy matter to control for the regulatory people as concentration could be determined accurately and rapidly.

ACKNOWLEDGEMENT

The generous cooperation of the Omaha-Douglas County Health Department is gratefully acknowledged.

We should also like to express appreciation to the Milk Department of Safeway Stores, Inc. for the facilities provided.

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INDUSTRIAL USE OF WELDED SANITARY PIPELINES[1] –

EXPERIENCES AT SEALTEST FOODS

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Welded CIP sanitary lines have been used in milk and ice cream plants in rather a limited way in this country for nearly 10 years. During the past two years interest in this method of joining sanitary stainless steel tubing has become quite popular, especially in new or remodeled plants. A number of Health Departments have cooperated and many have seen the advantages in having two pieces of stainless tubing fused together by heat instead of having gasketed fittings which are more likely to cause contamination, are more expensive, require more attention and need occasional gasket changes.

Pertinent facts concerning installation of welded cleaned in place sanitary lines are as follows:

1. They are cheaper and much easier to install than with fittings.

2. Whether or not welding is done by hand heli-arc torch or by automatic means, it must be done by an expert mechanic trained in one of these methods. Without sufficient training and experience the welds are likely to show too much of a raised bead or pits or crevices on the inside. This will defeat the purpose of welding.

3. A plan must be made of what is desired to be done. The job must be studied by all interested parties and then engineered to completion.

4. Prior to the time of welding, it is good practice to install pipe supports and lay the pipe on them, being sure that the ends of the pipe are cut straight and are free from burrs and metal filings. When laid in place the ends of the tubing may be taped (with masking tape.) Sufficient pitch of the lines should be planned to give good drainage. Whenever possible 20-ft lengths of pipe should be used to cut down the number of welds. By this planning and by laying the pipe in place, welding will be facilitated, permitting as many as 25 to 35 welds in an 8-hour day. Prefabricating of header lines in front of storage tanks is often advisable.

5. Depending upon the layout of equipment, it is possible to weld as much as 60% to 70% of the sanitary lines in an ordinary milk or ice cream plant.

6. Many installations have elbows and valves welded into the lines. Swab tests may be taken at the valves, when plugs are removed.

7. One method of inspecting the inside of the sanitary lines for cleanliness is to remove two plugs from welded-in valves and run a plastic coated "fish tape" (or "pipe snake") from one valve housing to another. To this is attached a rubber plug, (or stopper) covered with a swab and of the same inside diameter as the pipe. This is then pulled back through the line. The cleanliness of the swab will indicate the sanitary aspects of the pipe. On cold product lines using a first rinse at 125°F for 3 to 5 minutes, followed by an alkaline solution (0.1-0.15%) for 20 minutes at 125° to 140°F, and a final rinse at 125°F for 3 to 5 minutes, all at a minimum flow rate of 5 feet per second, should insure a clean swab at all times. As an extra precaution, some people believe in running an acid solution through the lines once monthly. However, in cold lines, the need for this has not as yet been proved. For hot product lines temperatures, strength of solutions and circulation times should be increased according to the needs. Daily use of an acid solution is advisable in these hot lines.

Advantages and results obtained in the use of welded CIP lines are as follows:

1. Cleaning of all CIP surfaces are positive.

2. The human element in cleaning is eliminated, which, among other things, permits use of stronger alkalis.

3. There is no danger of contamination of product from leaky gaskets, often caused by strains at the fittings due to improper supporting.

4. By never having to take sections of lines down, maintenance and replacement of fittings and gaskets are eliminated.

5. From 50% to as much as 75% of equipment cleaning labor may be saved.

6. Product losses, due to leaky fittings, is eliminated.

7. Working conditions are greatly improved which enables management to hold a higher type employee on this all-important sanitation work.

8. Welded CIP lines have helped provide consistently lower bacterial counts on finished products and coliform contamination from lines is eliminated.

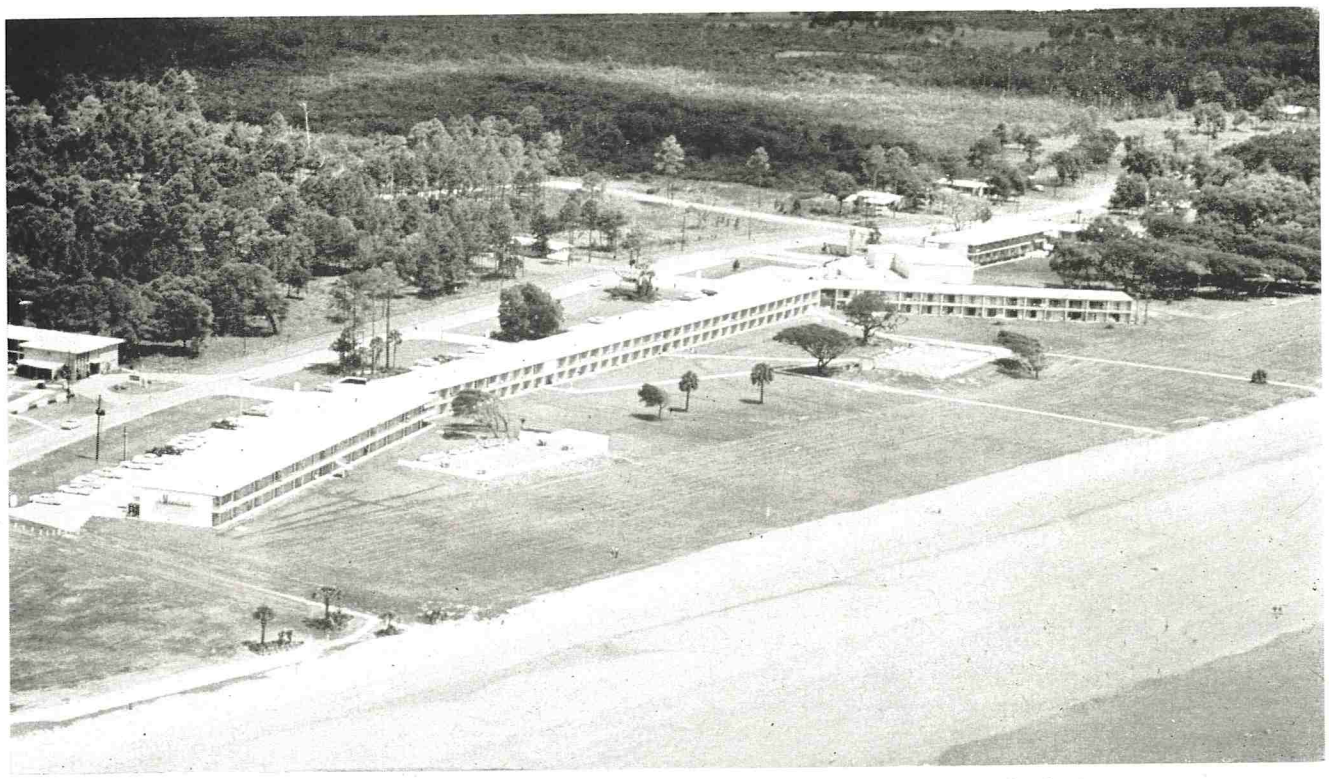
9. Shelf life of products has been extended.

After two years experience with welded CIP sani-

[1]Second in a series of papers given in a panel discussion on "Industrial Uses of Welded Pipelines," presented at the 47th Annual Meeting of the INTERNATIONAL ASSOCIATION OF MILK AND FOOD SANITARIANS, INC., October 26-29, 1960 at Chicago, Illinois.

tary lines in different locations and with different conditions, we have found no ill effects, when the system is properly engineered and installed. Coliform counts from lines consistently are zero and standard plate counts on finished products average less than 5,000 per ml.

NEWS AND EVENTS



Wanderer Resort Motel, headquarters for the 48th annual meeting, Jeykll Island, Georgia

IAMFS GOLDEN ANNIVERSARY MEETING TO BE HELD AT JEKYLL ISLAND GEORGIA IN AUGUST

For several months the front cover of the Journal has carried a reminder to all members that this year's annual meeting will be held at Jekyll Island, Georgia, August 14-17. This is no idle reminder. Mark your calendar now and make your plans. Right in the middle of vacation time, bring the family for this is a spot you will want to visit.

Making the event doubly important is the fact that this is our Golden Anniversary. International is 50 years old this year. Come and help celebrate fifty years of leadership and progress.

Jekyll Island is a garden spot. It is a romantic island unspoiled by man . . . sun bathed surf sweeps over the world's finest beaches . . . refreshing breezes sweep beneath moss covered oaks . . . yes, here nature has bestowed man with a fabulous spot for your pleasure. Bathing, fishing, golf, cook outs are yours on Jekyll. While you are at the meetings, your family can be enjoying fun at the ocean and on the beautiful sandy beaches.

Headquarters will be the beautiful Wanderer Resort Motel. (See accompanying picture) Jekyll is easy to reach. By car it is easily reached by Georgia's federally designated highways connecting with Georgia Highway No. 50 at Brunswick. By air both Delta and Eastern have service to Brunswick. Rail connections are available by Southern, Atlantic Coast Line, and Seaboard Railways.

Its time right now to make your plans and get your reservations. The Georgia affiliate, our host, extend a cordial invitation, so plan now to come.

3-A COMMITTEES HOLD SEMI-ANNUAL MEET FREEZERS, RUBBERS, PLASTICS ON AGENDA

A 3-A Sanitary Standard for Ice Cream Freezers was nearly completed at the regular semi-annual meeting of the 3-A Sanitary Standards Committee in Evanston, Illinois, March 14-16. Nearly 100 attended, representing sanitarians and regulatory officials, manufacturers of dairy supplies and equipment, and dairy processors who use these products.

It is expected that the Ice Cream Freezer Standard may be signed following the next meeting this fall. It would then be published, becoming effective one year after the date of signing.

A peneterating re-examination by sanitarians of the proposed standards for rubber and plastics necessitated some major revisions.

Processors and fabricators reviewed together tentative standards for ice cream and cottage cheese fillers, dry milk sifters, batch pasteurizers, separators and clarifiers, and sanitary fittings. All of these tentative standards were then referred back to task committees of equipment manufacturers for further revision and subsequent transmittal to sanitarians for review.

The next semi-annual meeting will be held in Washington, D.C., October 3-5, 1961.

PRINCIPLES AND PRACTICES OF SANITATION OFFERED AS COURSE AT UNIVERSITY OF NORTH CAROLINA

Beginning July 12 and running for four weeks the School of Public Health, University of North Carolina is offering a short course in the *Principles and Practices of Sanitation.*

Course content includes, Microbiology, Introduction to Public Health Practice, Sanitation Chemistry, Water Supply and Plumbing Problems, Sewage Treatment, Solid Waste Disposal, Food and Milk Sanitation and Ionizing Radiation Hazards.

Tuition for North Carolina residents is $41.00 for the course and for non-residents, $61.00. The course is open to sanitarians from health agencies, industry or other organizations whose personnel cannot undertake regular full time training. It is especially suited to newly employed persons who need orientation and training in the concepts of public health and modern sanitation practice. The enrollment is limited to 20 Four hours of extension credit may be earned.

Those wishing further information should address an inquiry to Professor Gilbert Kelso, School of Public Health, University of North Carolina, Chapel Hill, North Carolina.

USDA TO RESEARCH BULK TANK TEMPERATURES

A long time study is about to get under way at the USDA's research facilities at Beltsville, Maryland which will relate to blend temperatures in bulk tanks. It is felt there is now insufficient data to support or oppose the 3-A standard for bulk tank refrigeration. It appears there is a difference of opinion about how much refrigeration is needed. Some feel the current 3-A standard requires too much refrigeration while others take the view that milk should be cooled even faster. Milk control officals are urged to submit their views on the matter or to suggest particular points upon which research work should be directed. With bulk tank installations showing an increase, research on the matter in question should aid in reaching a definitive decision.

PENDING MILK LEGISLATION IN THE 87th CONGRESS

Representative Johnson, Wisconsin, introduced H. R. 50 known as the "National Milk Sanitation Act" in the 87th Congress. Indentical bills No. 51 through No. 60 and H. R. 1825 were also introduced in the Senate by Senators Humphrey, McCarthy, Proxmire, and Wiley (S. 212). These bills are similar to H. R. 3840 and S. 988 which were introduced in the 86th Congress.

The "National Milk Sanitation Act" would define milk sanitation control as a public health problem; would provide a means of preventing milk sanitation regulations from being used as trade barriers; and would place a legislative base under the present voluntary interstate milk shipper certification program. This proposed act defines milk and milk products, interstate milk plants, and requires that the Surgeon General promulgate a Federal Milk Sanitation Code based on the *Milk Ordinance and Code — 1953 Recommendations of the Public Health Service* which would set forth milk and milk product sanitation standards, and sanitary practices (including standards as to inspections, laboratory examinations, and other routine official supervision by local or State milk sanitation authorities). Milk and milk products from a State certified shipper would not be subject to seizure or exclusion from a receiving State if it complied with the requirements of the Federal Milk Sanitation Code, provided that the milk complied with the chemical and bacteriological Standards of the Code upon arrival in the receiving State's jurisdiction. The act authorizes the Surgeon General to establish, maintain, and publish a list of certified interstate milk plants on a quarterly basis, and to

remove such plants from the list if they do not maintain a minimum rating required for certification. The Surgeon General is also authorized to conduct research, studies, and investigations concerning the sanitary quality of milk. This proposed legislation does not abrogate the rights of States as does other legislation pending in the Congress.

Representative Quie of Minnesota and other members of Congress from Minnesota, Wisconsin, and Iowa have introduced H. R. 2058, 2059, 2060, 2061, 2062, 2740, and 2880 titled "A Bill to Extend the Armed Forces and Veterans Dairy Programs and the Special Milk Program for Children and to Amend the Agriculture Marketing Agreement Act of 1937, as Amended."

These bills would permanently extend the milk programs serving the armed forces, veterans, and school children. Under present law, the armed forces, and veterans programs, are scheduled to expire December 31, 1961, while the special school milk program terminates June 30, 1961.

Further, these bills would amend the Agricultural Marketing Act of 1937 to give the Secretary of Agriculture the power to create a Uniform Sanitation Standard for dairy products in all Federal Market Order areas. The bills provide that insofar as deemed practicable by the Secretary of Agriculture, the Uniform Sanitation Standard would follow the PHS Milk Ordinance and Code, and provides that the Secretary of Agriculture may accept the certification of a State or local government. The Secretary of Agriculture is further authorized to make inspections, investigations, and laboratory examinations as he deems necessary. Milk not certified by the Secretary of Agriculture cannot be sold in any Federal marketing area. *Thus, these bills apply to all milk sold intrastate and interstate. The Secretary of Agriculture may adopt any sanitation standard he wishes, and he may accept or reject the inspection or certification by State or local governments.*

NEW YORK STATE BANS SALE OF RAW MILK

The final chapter in a long-term program to eliminate the sale of raw milk in New York State was written April 1 when the sale of all raw milk was prohibited, Dr. Herman E. Hilleboe, State Health Commissioner, recently announced.

Effective April 1, an amendment to the New York State Sanitary Code bans the sale of raw milk except Certified raw which may be sold only under a physician's prescription.

"The State Health Department's program to prohibit the sale of raw milk dates back to 1935 when its sale was banned in cities over 15,000 population," Dr. Hilleboe said. "*Since that time, State code regulations have steadily been made more comprehensive so that in* 1960, *only* 2,139 *quarts of raw milk a day* (*less than seven quarts out of every* 10,000 *quarts of milk sold daily in New York State outside of New York City*) *were marketed.*"

The following is the chronology of State Sanitary Code limitation of raw milk and milk products:

July 1, 1932—Grade B raw milk eliminated
Jan. 1, 1935—Grade A raw milk prohibited in cities and incorporated villages over 15,000 population.
Jan. 1, 1936—Grade A raw milk required to be from brucellosis free herds
July 1, 1937—Grade A raw milk sale limited to cities and villages under 10,000 population
July 1, 1940—Grade A raw milk sale limited to cities and villages under 7,500 population
Jan. 1, 1958—Raw milk sale prohibited in cities and villages and limited to towns having less than 10,00 population
Aug. 1, 1958—All milk products, as defined by the Sanitary Code, required to be pasteurized
April 1, 1961—All raw milk prohibited, except Certified raw under a physician's prescription

GRADUATE TRAINEESHIPS IN BIOMETRY

Training programs designed to prepare students in the application of statistical and mathematical methods to biological problems, particularly those related to health and medical sciences, now exist in more than 20 universities throughout the country. Supported by training grant funds from the Public Health Service, NIH, these programs provide unusual opportunities for careers in teaching, research, and consultation. Employment opportunities for biometricians are excellent, with the demand by governmental and voluntary health agencies, medical research and educational institutions, and industry running far in excess of the available supply of trained personnel.

Programs of study are individually designed to lead to doctoral degress, and in special instances, to other academic degrees. Traineeship stipends are provided at various levels depending on previous education and experience of the trainee and include allowances for dependents. Substantially full economic support or partial support may be provided, depending upon the proportion of time spent in training.

For those unable to train during the academic year, an unusual opportunity is provided by a cooperative GRADUATE SESSION OF STATISTICS IN THE HEALTH SCIENCES sponsored by these Program Directors and made possible by a training grant from the PHS, NIH. For information concerning available stipends and course offerings at elementary, intermediate, or advanced levels for the summers of 1961 and 1962, write Dr. Jacob E. Bearman, University of Minnesota, Minneapolis, Minnestoa.

For those who can take training during the regular academic year, inquiry may be addressed to the Committee on Epidemiology and Bometry, Division of General Medical Sciences, National Institutes of Health, Bethesda 14, Md.

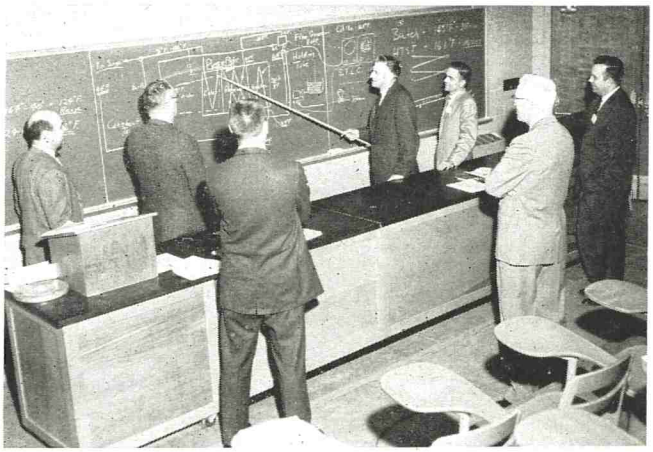
SS. HOPE MAKES MILK FROM SEA WATER

They are "farming the sea" on board the SS. Hope, an extension of Project Hope, a humanitarian People-to-People program.

Currently operating in Indonesia where she is training local medical personnel and performing the everyday miracles of modern medicine, the SS. Hope has another, smaller miracle going for her: she is making milk from sea water.

The miracle om milk from the sea is made possible through the cooperation of the dairy industry which has donated the equipment in the Hope dairy.

Five decks deep within the hull of the SS. Hope lies a modern dairy plant. Here, anhydrous milk fats, non-fat dry milk solids and purified sea water are combined into pure sweet milk for the crew, medical personnel and patients of the Hope and the thousands of children who visit her daily.



Informal discussion among several speakers participating in the 10th annual Milk Sanitation Shortcourse, Department of Dairy Technology, Ohio State University, March 20-24, 1961.

OHIO HOLDS SHORT COURSE IN MILK SANITATION

The Tenth Annual Milk Sanitation and Public Health Short Course sponsored cooperatively by the Department of Dairy Technology, The Ohio State University, and the Ohio State Departments of Health and Agriculture was held March 20-24 on the OSU Campus. Forty-eight students participated in the course which is designed to meet the need of milk sanitarians and dairy plant personnel. The subjects dealt with the fundamentals of dairy farm and dairy plant inspections, sanitation practices, dairy farm and dairy plant equipment design and operation, public health problems, legal standards and milk ordinances, and interpretation of regulations.

Coordinators of the program were D. D. Cole and I. A. Gould, Department of Dairy Technology, The Ohio State University; R. B. Watts, State Food Sanitarian, and R. Martin, State Milk Sanitarian.

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Never will one milk can go through so much with so little damage. Even after 10, 15, 20 years of hard usage a Stainless Steel milk dispenser can will still be in its prime. And it will have a perfect attendance record—not one day's work lost . . . and no leakage. It will keep milk clean and pure. That's because Stainless Steel can be thoroughly cleaned thousands of times and still retain its smooth impervious surface. You don't have to baby Stainless Steel; it's strong. Stainless Steel milk cans mean economy in the long run. Generally speaking, there are practically no replacement costs because Stainless Steel milk dispenser cans just won't wear out. If you'd like to be a canny milk can user and save money, too, check with your equipment distributor.

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United States Steel Supply—Steel Service Centers
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U. S. SCIENTISTS TO PARTICIPATE IN INTERNATIONAL DAIRY CONGRESS

Plans for U. S. participation in the Sixteenth International Dairy Congress were announced today by Dr. R. E. Hodgson, United States liaison officer for the Congress. It will be held in Copenhagen, Denmark, Sept. 3-7, 1962.

In preparation for the Congress, Dr. Hodgson is inviting scientific and technical workers in the field of dairy science to submit papers to be included in the conference program and published in the proceedings. Dr. Hodgson is director of the Animal Husbandry Division, Agricultural Research Service, U. S. Department of Agriculture. Aiding him is a committee of USDA dairy specialists.

Early notification of proposed papers is essential for use of the Organizing Secretary of the Congress, Dr. Hodgson said. Scientists who wish to propose papers for the Congress are requested to notify the committee no later than May 1, 1961. Correspondence concerning proposals may be addressed to him at the Agricultural Research Center, Beltsville, Md. Information supplied should include title of the proposed paper, authors and their positions and addresses, and the section of the Congress in which the paper should be included.

Length of papers is limited to 2,000 words, according to the official Congress prospectus. Five copies of each manuscript in final form must be submitted by Sept. 1, 1961. In addition, authors must supply on separate sheets five copies of an abstract not exceeding 200 words in each of the official languages of the Congress — English, French, and German.

Organizing Secretary is P. Kock Henriksen, XVI International Dairy Congress, Raadhuspladren 3, Aarkus, Denmark, King Frederick IX is patron of the 1962 Congress.

OBITUARIES

William Komenich, 44, chief milk sanitarian for the Calumet Region Milk Sanitation District, Indiana, died on Wednesday March 8, 1961 at the Methodist Hospital, Gary, Indiana. Bill was an active member of the Indiana Association of Sanitarians and had held office in 1957-58. He is survived by his wife, two sons and three daughters.

The Indiana Association and International convey to his associates, many friends and immediate family sincere sympathy on his sudden passing.

William E. (Bill) Polzen, 48, Chief Chemist for the Colorado Department of Agriculture died on February 8, 1961 after a lingering illness. Bill was a graduate of the Colorado State University and joined the Colorado Department in 1942. He devoted most of his professional time to dairy chemistry and microbiology and was an active collaborator in the Association of Official Agricultural Chemists. He attained national recognition in his chosen field. He was past president of the Rocky Mountian Milk and Food Sanitarians Association.

To his colleagues, many friends, professional associates and to his wife and daughter, International extends heartfelt sympathy.

DAIRY CONVENTIONS SET FOR CAPITAL IN OCTOBER

The regular autumn conventions of Milk Industry Foundation and International Association of Ice Cream Manufacturers will occur during the week of October 22, 1961, in Washington, D. C.

Members of Dairy Industries Supply Association will gather concurrently for limited activity and for staging the Collegiate Students' International Contest in Judging Dairy Products.

MIF's convention will start with an all-industry Sunday evening social affair on October 22, and continue through the morning of October 25.

IAICM's convention will start the morning of October 25 and continue through Friday, October 27.

NEW "TONGANOXIE" MILKING SYSTEM

A new pipeline milking system designed for more efficient and more sanitary production of high quality milk has been introduced by the Babson Bros. Co. of Chicago, manufacturers of Surge milking equipment. This method – known as the Tonganoxie* System– was disclosed to press, radio and television at a special news conference in St. Charles, Illinois, on March 7.

This news conference was attended by forty leading farm and dairy magazine editors and radio and television reporters. It featured reports on research in the technology of machine milking and a series of milking demonstrations with live cows. It made use of a fully equipped livestock center which had been used for several weeks in the training of Surge dealers.

The Tonganoxie system is now on the market and is in commercial use at a number of dairies. It is adaptable to several standard parlor plans without construction changes. This system eliminates the old overhead or "high" milk line; the pulsator line runs overhead but the milk line is located below the milking level. Milks flows downward from the cows' udders to the milk line, eliminating risers and the resulting mixing with air.

Another "difference" is that the milk line and the pulsator line each has its own pump and vacuum system, insuring against variations of vacuum in the milk line that are often caused when the pulsators are part of the whole system. The entire system is washed in place after every milking.

*The word "Tonganoxie" is a registered trademark of Babson Bros. Co.

HELPFUL INFORMATION

Editorial Note: Listed below are sources of information on a variety of subjects. Requests for any of the material listed should be sent by letter or postcard to the source indicated.

Mr. Dairyman, It Pays to Use Chemicals Safely. Leaflet No. 485. U. S. Dept. of Agric., Washington, D. C.

Mastitis Must Be Beaten. Pub. 1082. Research Branch, Canada Dept. Agric., Ottawa, Ont., Canada.

Appraisal of Methods for Assessing the Sanitary Quality of Milk. Pub. 1084. Research Branch, Canada Dept. Agric., Ottawa, Ont., Canada.

Cattle Lice; How to Control Them. Supt. of Documents, U. S. Gov't. Printing Office, Washington, D. C. 5c.

An Industrial Waste Guide to the Potato Chip Industry. PHS Pub. No. 756. 1960. 12 pages, 20c.

Sanitation In the Control of Insects and Rodents of Public Health Importance. Insect Control Series. PHS Pub. No. 772, part 4. Revised 1960. Wilfred H. Johnson. 46 pages, 35c.

National Goals in Air Polution Research. Report of the Surgeon Generals Ad Hoc Task Group. PHS Pub. No. 804. 1960. 39 pages.

Marketing Costs and Margins for Fresh Milk. Agric. Marketing Service, Supt. of Documents, U. S. Gov't. Printing Office, Washington, D. C. 15 pages, 10c.

Standardization and Inspection of Fresh Fruits and Vegetables. Agric. Marketing Service, Supt. of Documents, U. S. Go'vt. Printing Office, Washington, D. C. 32 pages, 15c.

Survey of Distribution Practices for Prepackaged Frozen Meat. Agric. Marketing Service, Supt. of Documents, U. S. Gov't. Printing Office, Washington, D. C. 23 pages, 20c.

Federal and State Standards for the Composition of Milk Products. Agric. Marketing Service, Supt. of Documents, U. S. Gov't. Printing Office, Washington, D. C. 15 pages.

Grading and Inspection of Eggs and Egg Products. Agric. Marketing Service, Supt. of Documents, U. S. Gov't. Printing Office, Washington, D. C. 24 pages, 15c.

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Single service milk sample tubes For further information and a catalogue please write, Dairy Technology, Inc., P. O. Box 101, Eugene, Oregon.

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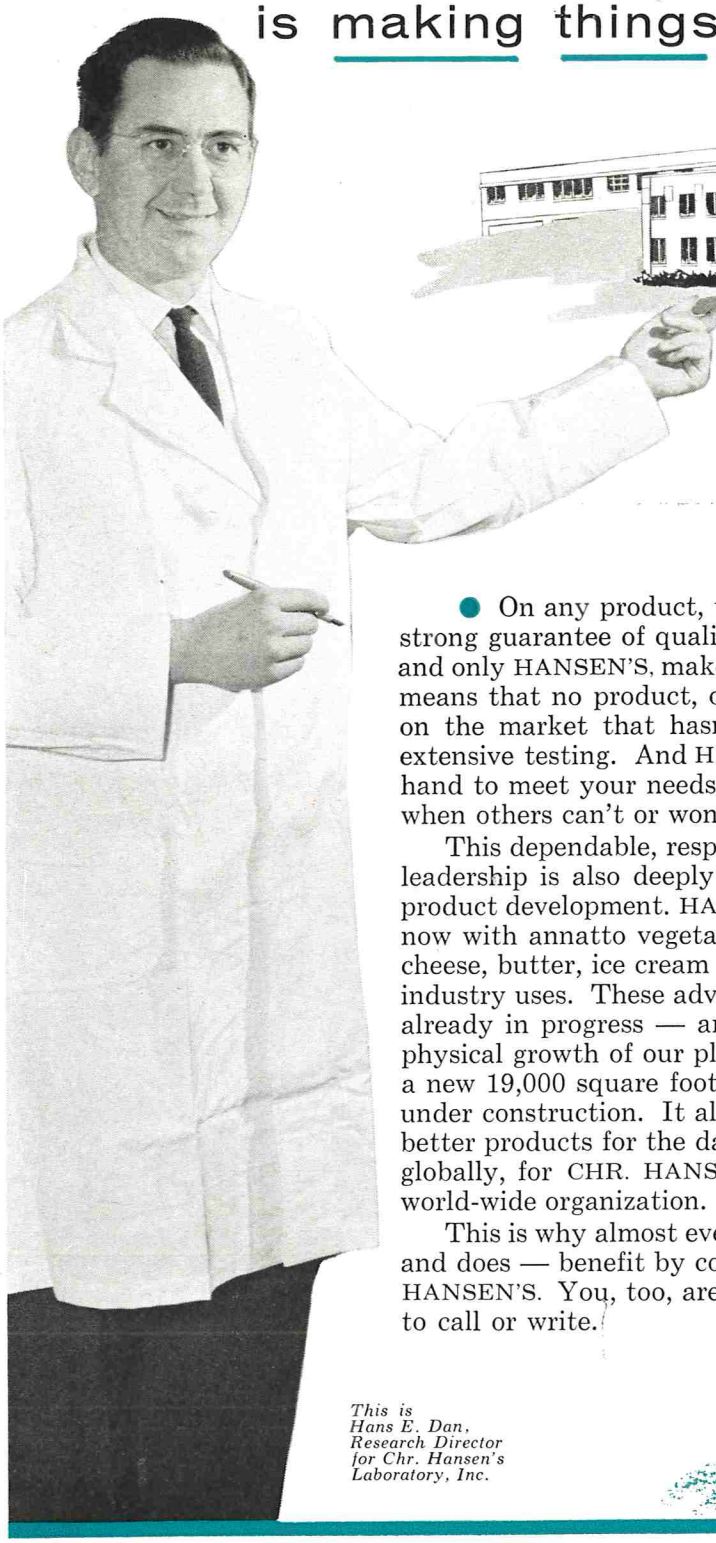

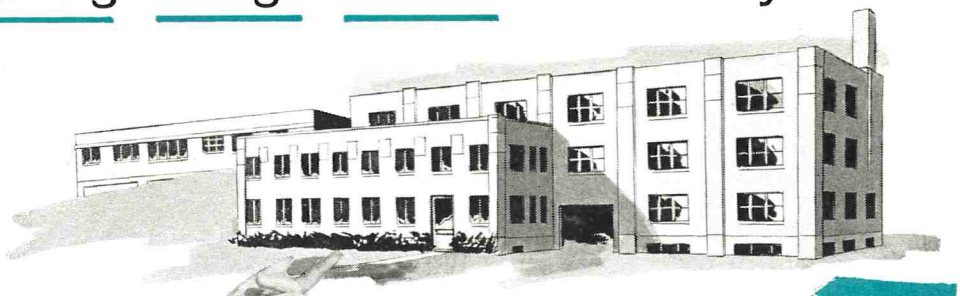

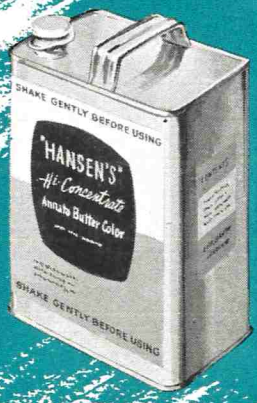

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This is Hans E. Dan, Research Director for Chr. Hansen's Laboratory, Inc.

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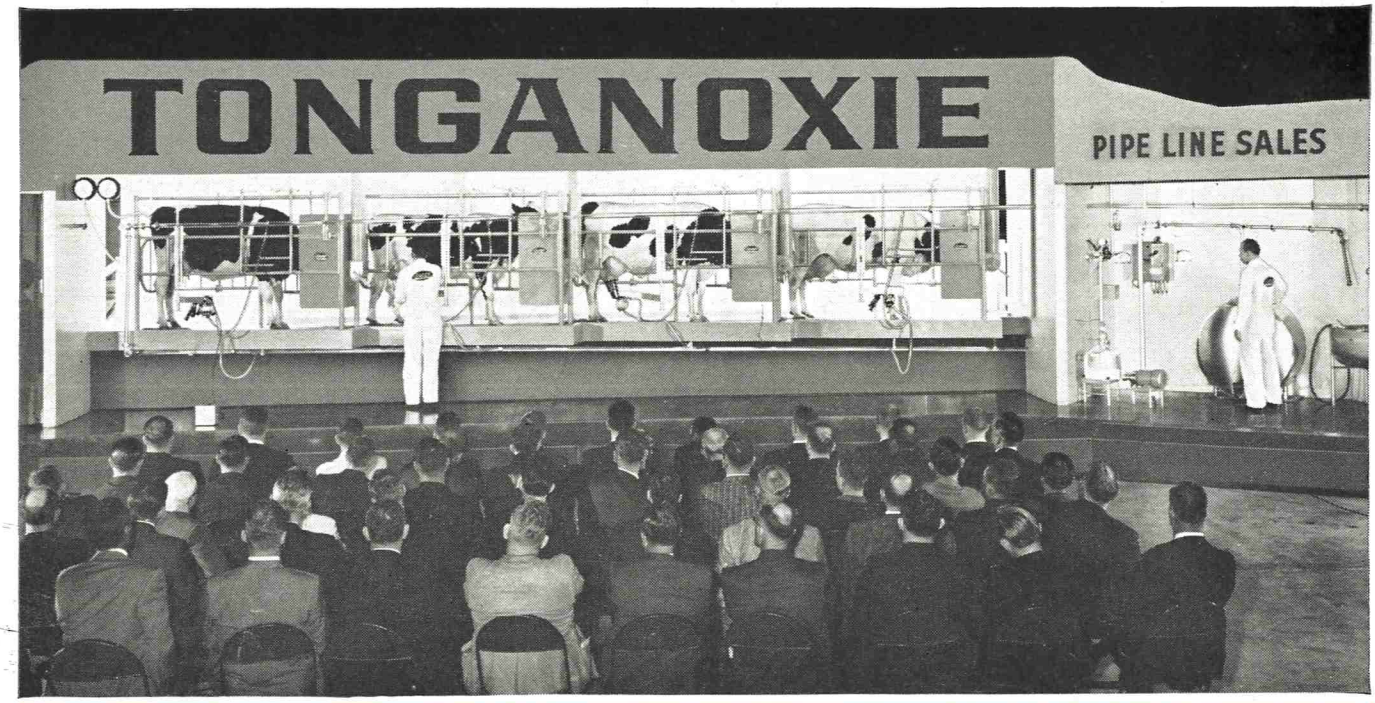

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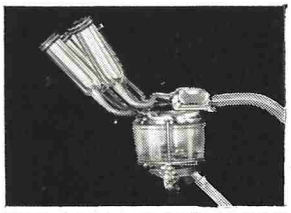
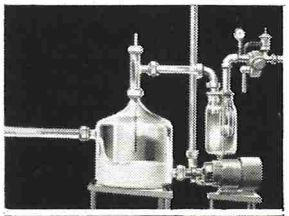
Ask the Surge dealer in your area for more information. He is ready to help you. The new password to superior cow milking is ... TONGANOXIE.



BETTER MILKING . . .

with separate vacuum systems — one for operating the pulsators, one for the milk line — this insures against variations of vacuum in the milk line caused by the pulsators.



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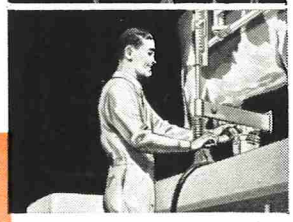

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