SANITARY DESIGN AND EVALUATION OF
FOOD SERVICE EQUIPMENT

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The design and evaluation of food service equipment has been a part of man’s cultural evolution. The cooking of a fish, deer or some other animal over the ashes of a campfire may be pleasant memories to the modern day outdoorsman, but to our ancestors such food preparation was an advanced art. Today we enjoy the advantages of environmental progress of food sanitation in luxurious surroundings for granted such progress as a part of our modern culture. There are many present here today who have had a great influence in establishing the philosophy that has brought together the forces of industry, government, and the public to develop criteria and specifications for food service equipment and operations that provide the proper environment in which to prepare, handle, and serve food.

The design of food service equipment, to be of greatest use to the operator or user, must meet a number of criteria. The operator wants the equipment to be functional, long lasting, easy to use, service and maintain, and to be as economical as possible. The Sanitarian wants it to be safe from public health hazards, easy to clean, free of built-in harborages, and built so that food protection can be attained. The designer and manufacturer is concerned with giving the purchaser as much for his money as possible and still have an attractive, functional, and public health acceptable unit. There is a possibility of conflict between the various interested parties. It is important, therefore, that the public health criteria for the design of food service equipment be acceptable to all parties concerned; otherwise the manufacturer of the equipment will experience unnecessary obstacles during the construction and installation of the equipment.

It was the recognition of these facts that led to the establishment of the Food Equipment Standards Committee of the National Sanitation Foundation. The Joint Committee on Food Equipment Standards is composed of membership from most professional public health organizations and interested associations and groups. Membership on this committee is by appointment by the specific organization being represented¹.

NATIONAL SANITATION FOUNDATION STANDARDS

The Joint Committee on Food Equipment Standards considers all aspects of the equipment as it might affect the public health. The Standards developed by the Joint Committee encompass the recognized needs for uniformity of specifications. The lack of standard or uniform equipment specifications has been confusing and expensive to industry. For many years, health authorities have prepared regulations and ordinances governing the sanitation of food establishments. These regulations and ordinances have placed the responsibility of accepting various types of food equipment upon the health departments without definitive specifications covering the equipment. Manufacturers of equipment were often plagued with differences in requirements in the various states and were inclined to question the professional qualifications of some of the sanitation officials who freely expound with conflicting opinions on what they term “essential sanitation requirements” for food service equipment. This need for uniform Sanitation Standards was recognized by many leaders in public health and through their efforts the American Public Health Association and the Conference of State and Territorial Health Officers requested the National Sanitation Foundation to “develop Standard for various phases of Sanitation”.

DESIGN OF SANITARY FOOD SERVICE EQUIPMENT

Standards and Criteria for food service equipment must be based on facts and on sound engineering and sanitation practice. In many instances additional facts are needed before a particular standard can be prepared, and research is necessary to provide the factual information. Such research must be practical and must take into consideration the interests of the entire industry and the public health official and be designed to render a service to the general public.

Any effective public health standards program must be designed with the public in mind. It can also then be useful to the manufacturers of equipment, to the users of the equipment, and to the public health agencies as the responsible enforcement departments. Everyone will benefit because uniformity of design


¹Information on organization, function and programs of the National Sanitation Foundation may be obtained on request to the author.
and construction makes compliance with fundamental sanitation regulations possible.

**Principals for the Sanitary Design of Food Service Equipment**

Many factors must be considered in the establishment of criteria for the design of food service equipment that will be uniformly acceptable to the user and public health officials alike.

Some of the general principles for the design and construction of food service equipment may be listed as follows:

1. The equipment should contain the fewest number of parts to do the required job efficiently. This should also permit the equipment to be disassembled, maintained, and easily cleaned. In some instances it is necessary that in-place cleaning be practiced due to the design of the equipment.

2. All parts of the equipment coming into contact with food products should be readily accessible for examination and cleaning or readily removable for cleaning and inspection.

3. A proper radius should be provided to permit ease of cleaning the product contact surfaces.

4. The joining of metal should be such as to effect a smooth, easily cleanable food contact surface.

5. All surfaces within the product zone must be smooth, free of pits, crevices, or other difficult-to-clean areas.

6. Food contact surfaces should be non-absorbent, nontoxic, odorless, and unaffected by the food products and cleaning compounds.

7. Toxic metals such as cadmium, lead, and (copper and its alloys and other metals which may deleteriously affect the foods) should not be used. The same consideration must be given to certain plastics which are not acceptable for food contact applications.

8. The product zones must be free of recesses, open seams and gaps, ledges, inside threads and shoulders, and bolts or rivet heads.

9. Gaskets, packing and sealing materials must be nontoxic, non-absorbent, and unaffected by food products or cleaning compounds, and so installed as to be easily cleanable.

10. Splash zone areas should be designed and constructed so as to permit frequent cleaning.

The Joint Committee has agreed that there are four basic sanitation fundamentals around which the details of NSF Food Equipment Standards are developed. These requirements specify that the construction of the equipment be of (1.) materials that are suitable, nontoxic, easily cleanable, and will not chip or crack, and get into food. The design and construction must also provide for (2) ease of cleaning, (3) the elimination of harborage of insects, dirt, or bacteria, and (4) for food protection.

**Basic Criteria for Food Service Equipment**

Utilizing the four basic sanitation fundamentals listed above, the Joint Committee on Food Equipment Standards has developed a general format for NSF Food Equipment Standards. In Basic Criteria C-2 the pattern of specifications for design of sanitary food service equipment is established. The Criteria, as are all NSF Standards, is divided into a number of sections which are briefly discussed as follows:

1. **General Provision**
   This section sets forth the coverage of the Standard or Criteria. Exceptions that might be indicated are enumerated and applicable special requirements may be listed. The first section also indicates that the criteria or standard specifications are established as minimum requirements and that "variations may be permitted when they tend to make units more resistant to wear, corrosion, or more easily cleanable". Provision is also made for compliance, under existing NSF Standards or Criteria, of units which have components or parts covered by such requirements. Alternate Materials may be permitted when they can be "proven to be equally satisfactory from the standpoint of sanitation and protection of the product".

A provision is also established for the periodic review of all NSF Standards or criteria at intervals not to exceed three years. This policy sets a basis for revision of standards to keep them up-to-date with technological advances of industry and with progress being made in public health. The Standards therefore are not stagnant and may be revised whenever either industry or public health leaders feel there is need for revision. It is interesting to note that the majority of the requests for upgrading and tightening-up of the Standards come from industry. At the present time two Standards, No. 1 and No. 3, are being revised. Standards No. 2 and No. 7 have recently undergone extensive upgrading revisions.

2. **Definitions**
   The section on definitions is designed to include words or terms used frequently throughout the specifications and with specific meaning. For example, the word "accessible" is defined as follows: "Accessible shall mean readily exposed for proper and thorough cleaning and inspection with the use of only simple tools, such as a screw driver, pliers, or open-end wrench". This definition would be specific to the standard and would not be found in a dictionary so stated. Other terms such as "zones" or "contact surfaces" are defined to be specific for use in the Standards. For example the equipment zones are divided into food zone, splash zone, and non-food zone. Each area indicates the degree of protection that must be effected by the materials used and the design and construction of the equipment.

3. **Materials**
   The section on materials sets forth the general use of materials that will permit the design and construction of equipment which will withstand normal wear, penetration of vermin, the corrosive action of
foods, cleaning compounds and such other elements as may be found in the use environments and will not impart an odor, color or taste to the food products. Specific coverage of materials that are suitable for product contact surfaces, splash contact, and non-product contact surfaces is outlined under the materials section.

This section also covers special materials that may be used in fabrication, such as welding or soldering compounds, plastic resin systems, sound damping materials, and any other special material that might find application in the manufacture of food service equipment.

4. Design and construction

Having set forth the general coverage, detailed the word usage, and established material specifications, it is now possible to specify how the equipment shall be designed and constructed to meet acceptable public health criteria. This is perhaps the most important section of a Standard. It must be adequate to assure public health protection; it must result in equipment that is functionable, usable, cleanable, and economical; otherwise the operators cannot afford to have it in their establishments.

The NSF Standards specify under design and construction the acceptable requirements in each of the zones defined under the Standard. The product contact surfaces must be designed and constructed so that they are readily accessible and easily cleanable, either in an assembled position or when removed. More critical radii and fabrication requirements are necessary for product zones in order to meet the function and cleanability requirements.

The splash and non-food contact surfaces are designed and constructed to less critical specifications, but they must be properly coordinated with the requirements for product zones.

The design and construction section must be in sufficient detail to permit the manufacturers to utilize a variety of fabrication equipment, techniques and methods of production and still comply with the Standard. In other words, one manufacturer might use body construction in which the sheet metal is so formed without general interior framing while another manufacturer might choose to use angle framing over which the sheet metal is applied. There are specific provisions each manufacturer must comply with in order to produce a comparable piece of acceptable food service equipment.

This section must detail the requirements for construction of doors, access panels, openings into tops, provide for gaskets, shelving, louvers and openings for compressors and evaporators, and take into consideration the method of mounting of the equipment whether on legs and feet, casters, or sealed to the floor or counter. There is often the necessity for temperature controls for use in heated or refrigerated equipment and consideration must be given to the protection of food from broken glass or similar contaminants from fixtures and devices within the equipment. Many items of equipment must be designed and constructed so that water and waste connections may be properly made at the time of installation. This is quite significant when related to the operation, maintenance, and cleaning of the equipment.

5. Installation

No sanitation equipment standard is complete without the inclusion of the best recommendations obtainable for installation of the equipment. Here again the knowledge and advice of all parties—designer, manufacturer, user, and sanitarian—are essential in order to obtain proper installation criteria.

It should be stated at this point that the NSF Joint Committee on Food Equipment Standards has implemented the development of a Manual on Installation of Food Service Equipment. A small committee of public health, industry, and design and layout experts are now engaged in the preparation of a final draft of the Manual which will be submitted to the Joint Committee for their consideration at the next annual meeting of the committee.

NSF Standards in Use

The same general format is followed in the development of all NSF Food Equipment Standards. The following is a list of such Standards now in use and against which evaluations of equipment are being made to permit the use of the NSF Seal of Approval:

1. Soda Fountain and Luncheonette Equipment.
2. Food Service Equipment and Appurtenances.
3. Spray-Type Dishwashing Machines.
4. Electric and Gas Commercial Cooking and Warming Equipment.
5. Hot Water Generating Equipment (Gas and Electric).
6. Dispensing Freezers.
7. Food Service Refrigerators and Food Service Storage Freezers.
8. Commercial Powered Food Preparation Equipment.

C-1. Vending Machines.
C-2. Special Equipment and/or devices.

A Standard on Automatic Ice Making Equipment was accepted by the Joint Committee at their annual meeting in April 1964. It is anticipated that equipment conforming with this Standard will be available early in 1966. There is agreement among the manufacturers that extensive redesign in the majority of ice making equipment is indicated which will require the additional time before NSF approved units will be available.
There are several other food equipment standards in various stages of consideration, covering such equipment as Pot & Pan Washers, Fly Repellant Fans, Filters for use in Ventilation Equipment, Wood Top Tables, and others.

A new Criteria on Continuous Cloth Towel Dispensers has just been released and equipment carrying the NSF Seal is now available under this Criteria.

**Evaluation of Food Service Equipment**

The NSF Testing Laboratory, a totally owned corporation of the National Sanitation Foundation, was organized at the request of Industry and Sanitation Officials to provide a research and evaluation facility for the National Sanitation Foundation. The purpose of the Testing Laboratory is to perform research in environmental health, to test and evaluate equipment and products for compliance with NSF Standards, and to govern and control the NSF Seal of Approval. The Testing Laboratory can make specific charge for testing products or it can assess a “Listing Charge” for the examination and evaluation of equipment or products for compliance with NSF Standards. The administrative and professional staff of the Testing Laboratory are all professional health sanitation personnel with many years' experience with local, state and federal health agencies, and with universities concerned with the teaching of environmental health subjects.

The Testing Laboratory does not have responsibility for the development of NSF Standards. The Executive Director of the Testing Laboratory serves as Secretary for the Joint Committee on Food Equipment Standards (as well as on other types of standards covered by the National Sanitation Foundation), and in that capacity can make suggestions to the Committee members, based on the experiences of the Laboratory Staff in using existing NSF Standards in testing and evaluating equipment or products. The primary function of the Testing Laboratory is to govern and control the NSF Seal of Approval which is currently awarded to over 500 food equipment manufacturers for use on more than 12000 items of equipment or products.

The Testing Laboratory staff visits the manufacturing plants of all companies authorized to use the NSF Seal of Approval. This authorization is for one year only. The continued use of the Seal may be granted by the Board of Directors of the Testing Laboratory following a satisfactory report of re-examination at the point of manufacture. It is necessary therefore that the authorized staff of the NSF Testing Laboratory have access to the various manufacturing plants at any time and without prior notification. The NSF Seal of Approval is issued to the equipment manufacturer upon an agreement that he will abide by the policies of the NSF Testing Laboratory governing the use of the NSF Seal of Approval.

**Performance Testing**

In several of the NSF Standards on food equipment there are sections setting forth specifications for performance. For example, the standards covering spray-type dishwashing machines, water generating equipment, refrigeration equipment, dispensing freezers, vending machines, and others provide for the performance testing of the equipment in addition to setting forth specifications for determining compliance with the materials, design and construction requirements of the Standards.

Let us for example consider the evaluation of spray-type dishwashing machines. Our laboratory staff visits the dishwashing machine manufacturing plant and selects the machines to be tested. In many instances, particularly with the smaller door-type machines, we prefer to have the units shipped to our laboratory where more definitive testing techniques utilizing radio-active tracer soil may be used. The large conveyor units, because of their size and cost of shipment are tested in each of the manufacture's laboratories.

One of the requirements for the use of the NSF Seal of Approval is that the manufacturers of equipment requiring performance testing have their own quality control. We take our own recording temperature and pressure measuring equipment to the dishwasher manufacturing laboratory to determine the performance ability of the dish machines. As the testing program has progressed we have found it necessary to have each dish machine manufacturer ship to our laboratory the various pumps and motors used on all their dishwashing machines so that we could develop pump curves on all pumps used in the industry. This now permits us to take the operating pressure of any pump on a dishwashing machine in a manufacturing plant or at an installation and determine from our pump curves the volumes of water being pumped over the dishes in any machine. The volumes and pressures of final rinse water are determined and with the recording potentiometer, to which thermocouples are attached, we are able to continuously measure the temperature build-up in the dishes or on the dish surfaces as the dishes pass through a dishwashing cycle. Specially soiled dishes containing a soil which has been baked on at 170 F for 17 hours are used to measure the ability of the dishwasher to clean dishes.

There are other performance tests such as determining the specified wash and rinse times, the area of coverage through the wash and rinse sections of the machines, and measuring the rinse water pressure...
at the dish machine. The revision to Standard No. 3 is removing the un-realistic rinse pressure requirement of 10 psi at the rinse jets. This amount of pressure, if attainable, would blast dishes out of the racks. The realistic pressure is 20 psi at the machine where the water line enters the rinse manifold. This can then be coordinated with the proper volume of rinse delivered through the rinse nozzles.

When performance evaluation has been completed, we then carry out the general evaluation of the dishwashing machines in the same manner as all equipment or products are measured against the NSF Standards. First we determine whether acceptable materials are used in each of the zones, (product, splash and non-product). Then the shop drawings and specifications of the manufacturer are examined to see whether there are variations from the details in the Standard. Next, the equipment is evaluated to determine compliance with the design and construction requirements of the Standard. It is preferable to start at the point where materials are received and then follow the lines of fabrication until the finished product is reached. In this way it is easy to determine whether there are hidden or built-in harborage areas for insects or vermin and whether the details of the Standard are being followed.

**WHAT NSF SEAL OF APPROVAL MEANS TO PUBLIC HEALTH OFFICIALS**

The NSF Seal of Approval identifies items of equipment, devices, or products meeting high standards of sanitary significance. The Seal signifies compliance with NSF Standards which have been jointly developed by all parties concerned. The NSF Seal is a copyrighted device and no manufacturer can use the Seal without proper authorization.

However, the fact that an item of equipment carries the NSF Seal does not mean that it be accepted without proper examination. For the most effective use of the Standards and Seal of Approval program, all local, state, and federal sanitation officials should make thorough examination of equipment as it is installed. Where discrepancies are noted or construction is questioned, the office of the Testing Laboratory should be notified so that it can handle the matter with the manufacturer to assure compliance with the Standards and prevent future violations.

**THE BROAD SPECTRUM**

Many sanitarians believe the NSF Program is concerned only with food equipment. Actually the scope of the program of the National Sanitation Foundation is as broad as the total field of environmental health. Other NSF Seal of Approval programs, involving a total of over 1200 manufacturers, include a testing and evaluation program on plastics for potable water use and for drain, waste and vent applications. Also, a swimming pool equipment and products approval program covers diatomite earth filters, skimmers, sand filters, and chemicals used for swimming pool application.

Several research studies including the development of a use and wear test for the evaluation of materials and finishes used in food contact applications may be of interest. Another study relates to sewage and drainage needs in Metropolitan Detroit. (A similar study dealing with water needs was completed several years ago by the Foundation). A study of background radiation covering a 50 mile radius around the power reactor at Monroe, Michigan is still in progress. Cleanability studies are continuing and a new research study soon to be started will deal with the problems of “packaged” sewage treatment plants.

Whether the problem relates to food, water, air, shelter, wastes, or some other environmental health concern, the National Sanitation Foundation utilizes the same proven methodology in dealing with the problem. By bringing together, on neutral ground, all the interested parties for thorough discussion of any environmental health problem, proper solutions can be found that will be of benefit to all concerned, including the public. This is Democracy in Action.