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ELECTRICALLY POWERED FIELD KITCHENS

ROBERT V. DECAREAU

DISTILLATE FUEL-FIRED KITCHENS

MARK E. McCORMACK

VAULT

Electrically Powered Field Kitchens

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NATICK LABORATORIES has under development two all-electric field kitchens: the SPEED Mobile Field Kitchen, was published in the May 1968 (Vol. 9, No. 1) issue of this magazine, and the MUST Food Service System. MUST is an acronym for Medical Unit, Self-Contained, Transportable. This system consists of a kitchen, dining area with cafeteria line, and ward pantries. Both kitchens rely upon gas turbine engine generator sets for electrical power. The SPEED Kitchen turbine provides 60 kW at 400 Hz; the MUST turbine provides 90 kW at 400 Hz and 10 kW at 60 Hz.

MUST Food Service System

This system provides food service for the MUST hospital complex, a completely transportable field hospital made up of expandable hard shelters, which serve as surgeries, laboratories, dental facilities, and the like, and inflatable shelters which function as ward areas. The hard shelters are completely equipped, can be expanded to three times the transportable size and be operational within a few hours. The inflatable shelters are double-walled units with inflatable bladders to give rigidity, which are assembled together to form ward areas. All wiring for lights and other services, ducting for heat and air conditioning, and fabric floor are a part of each unit.

Power for the system is provided by a skid-mounted utility pack (U-pack). This pack which contains the gas turbine engine generator, air-conditioning and heating equipment, water heating and pumping units, and air compressor. Flexible ducts carried in the U-pack are attached to ports in the shelters to carry conditioned air into the structures.

Kitchen Structure. The MUST Kitchen is housed in one of the expandable hard shelters. In the transportable mode, this structure measures approximately 8 ft. by 7 ft. by 12 ft. When expanded, it opens up to about 8 ft. by 18 ft. by 12 ft. to give about three times the volume.

Permanently mounted in the structure's center section are the forced convection oven, tilting frypan, and a pair of steam-jacketed wells. All other components of the kitchen are stored in the center section for transporting and are relocated as soon as the kitchen has been opened up. These include a three-well deep sink, a 6 cu. ft. freezer and 6 cu. ft. refrigerator, a 10-quart steam-jacketed trunion kettle, a vertical cutter-mixer, dual hot plates, work table and cabinetry. All of the electrical components are commercial equipment modified to operate at 400 Hz.

Off to one side of the kitchen through a corridor section is a dry storage area and a 450 cu. ft. refrigerator. The dry storage unit is one of three ward shipping containers and is equipped with wire rack shelving. The 450 cu. ft. refrigerator is powered by a 5,000 Btu refrigeration unit which has both gasoline engine and electric motor drives. In transit on its own sets of transporter wheels, the refrigeration unit is powered by the gasoline engine. It is used at this time for shipping the hospital's biological supplies. The box itself has foamed-in-place insulation.

Dining Area. Off to another side of the kitchen, through a corridor-connector, is the hospital dining area. This is housed in an inflatable double-wall structure and is air-conditioned for comfort.

This article is based on a presentation Dr. Decareau made in December 1970 to the Exploring Food Systems of the Future Seminar, held by the School of Hotel Administration at Cornell University. Dr. Decareau is supervisory food technologist for the Food Systems Equipment Division of the U.S. Army Natick Laboratories at Natick, Massachusetts.

Equipped with folding aluminum picnic-type tables and attached benches, the dining area serves the needs of the 200 support personnel and ambulatory patients. A serving line at the kitchen end is equipped with a grill primarily for à la carte breakfast items, a multi-unit steam table, toaster, coffee urns, soft ice cream machine, and ice maker. The latter two items operate off 60 Hz line current.

Ward Service. Patients are served in the ward areas, and the techniques used are similar to those used by many hospitals. Food is prepared and plated in the dining area using the serving line. Disposable paperware is used, thus eliminating the need for a sanitizing facility. The trays are covered with a flexible film, placed in tray carriers designed to hold ten trays and man-carried to the ward areas. They may either be stored in the ward pantry refrigerator or served immediately.

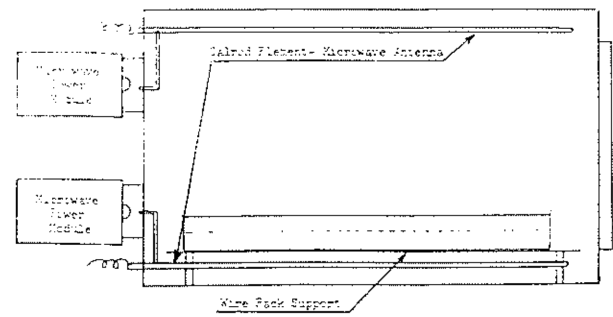
Normal practice is to heat each meal in the microwave oven to insure that food is served piping hot. This system makes it possible for patients who may be in X-ray or the laboratory undergoing tests to be assured of a hot meal when they return to the wards.

Microwave Ovens. There are two microwave ovens for each 60-patient ward complex. Each generates about 2 kW of microwave power at 2450 MHz and were developed specifically for the MUST system. Each is powered by two individual power modules located behind the control panel. They are easily removable for replacement if a failure should occur. This can be done by unskilled personnel simply by removing four screws, replacing the unit, and tightening the four screws.

Lights on the control panel signal a module failure. If a replacement were not available, the oven could be operated at half-power on the remaining module. Heating time would be doubled under such conditions. These modules are identical with those in the SPEED Microwave Oven.

The oven itself is simple to operate. A push-button timer with six preset timer selections can accommodate a variety of different food items. A menu card to the right of the push buttons identifies what each button is to be used for. The attendant simply places the item to be heated into the oven, closes the door, and presses the proper button. When the time cycle is complete, the oven turns off automatically.

Although required basically for meal heating, the oven can be used for heating towels or wet packs to place on incisions. It is also fitted with a shelf about midway between the floor and ceiling.



Schematic view of second generation microwave oven.

Since one power module couples into an antenna in the top of the oven and the other to an antenna in the bottom, it is possible to heat food on the shelf and the glass ceramic bottom plate. Most commercial ovens have only top microwave power and can heat only one tray of food.

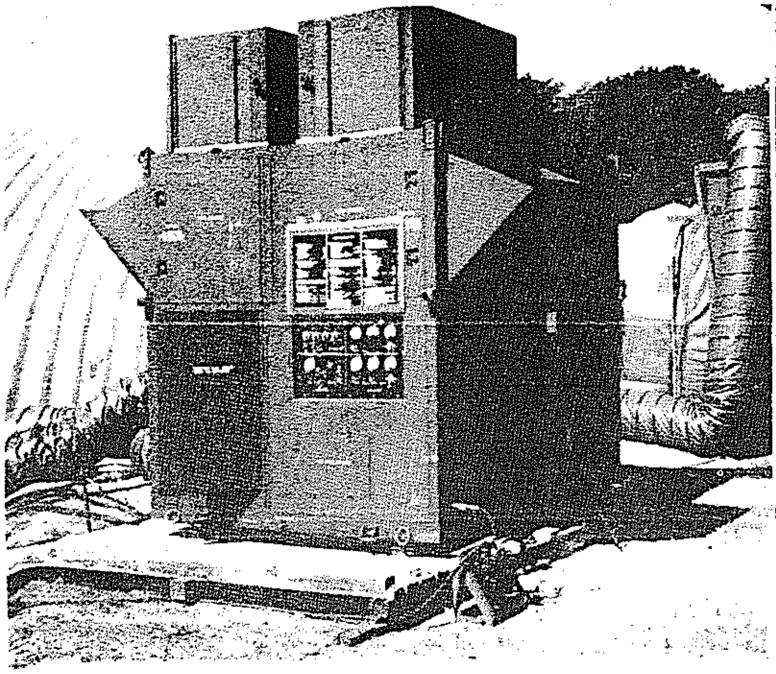
SPEED Mobile Field Kitchen

The SPEED Kitchen has undergone recent modifications following considerable usage since it was first received in the fall of 1967. The feasibility of microwave energy for quantity food preparation had been demonstrated on numerous occasions; however, certain cooking and baking operations required excessive handling, and the modifications were made to minimize such handling.

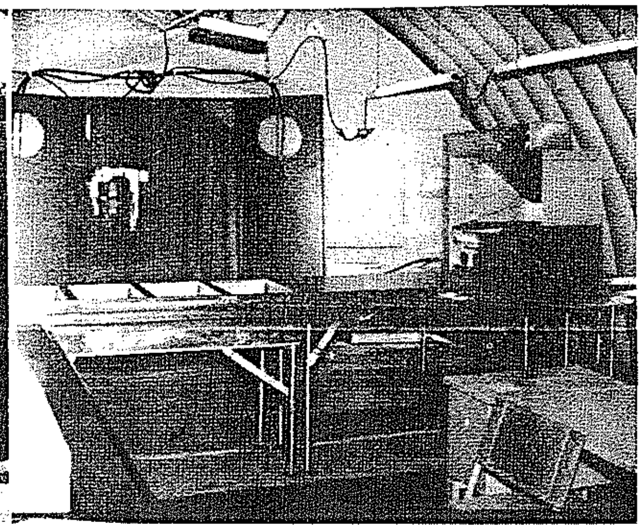
The major change made was in the microwave oven design. In the original version, top and bottom microwave heating was obtained through the use of a novel diffuser screen in the top of the oven. This screen which directed a portion of the energy input down the back of the oven and into the food load from below.

The food necessarily had to be in microwave transparent containers, capable of withstanding temperatures as high as 400°F in the case of fatty foods. To date, there has been little success in the search for materials from which such containers might be fabricated. The second generation microwave oven design employs both top and bottom microwave sources. The microwave antennas in this case also serve as a source of resistance heating simultaneously.

Temperature Control. Oven temperature is controlled by means of a thermostat so that the oven may be used as a conventional oven in certain cases not requiring microwave energy. For example, the oven may be used to keep cooked foods

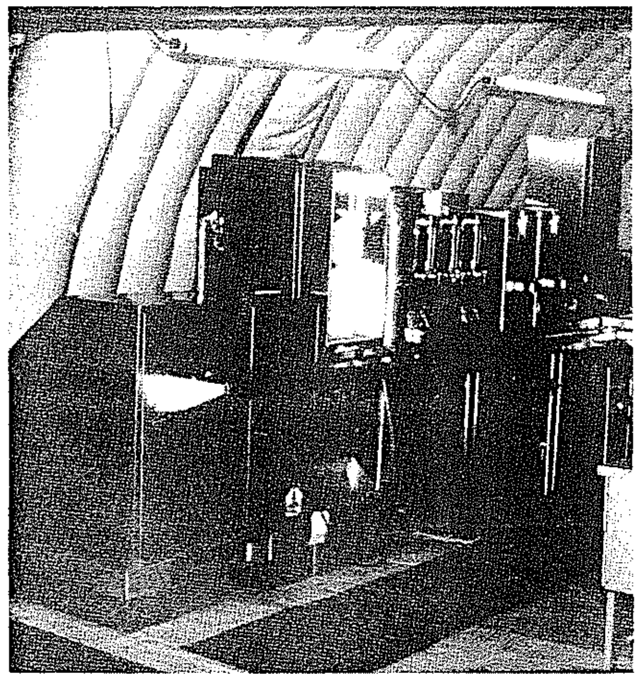


This utility pack houses a 100 kW gas turbine-generator, air-conditioning/heating equipment, and water heating and pumping equipment.



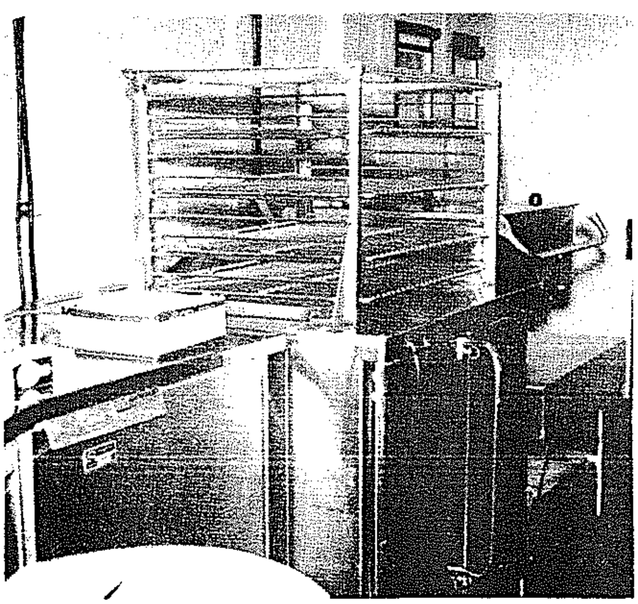
Upper right

MUST dining area serving line shows steam table at the center and grill and hood at the right.

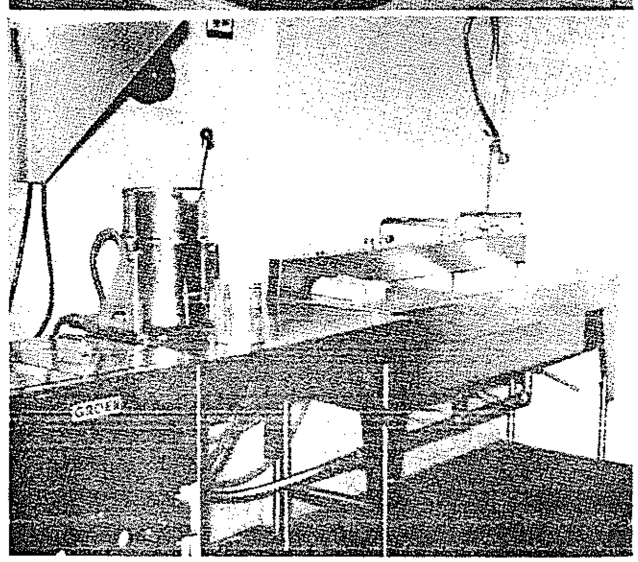


Right

Left side of MUST serving line shows (left to right) ice maker, soft service ice cream machine, and coffee urns.



Left side of kitchen shows (left to right) under-counter refrigerator and freezer, forced convection oven with rack on top and tilting frypan.



Right side of kitchen shows (left to right) two steamjacketed kettles, trunion kettle, and three-well sink.

warm, or it may be used as a toaster for bread and biscuits. As mentioned previously, the microwave power modules are identical with those in the MUST Microwave Ovens. Each has its individual W-shaped antenna element. Three modules provide approximately 1.25 kW each to the top of the oven, and three provide the same amount of power to the bottom of the oven.

Baking Tests. Initial cooking studies have indicated that metal containers can be used for many of the cooking operations. A dozen pans of bread dough in standard one-pound loaf pans were baked to completion in just seven minutes. To do this, the oven was preheated to 400°F before the pans were loaded into the oven. The dough had been proofed to within an inch of the top of the pans prior to baking. Only microwave power from the top elements was used. It was generally agreed among those present that the finished product was equal in quality to conventionally baked bread.

When the same quantity of dough was baked in Pyrex load pans, only four minutes was required, since the total microwave power of the oven was applied. The loaves were, however, much lighter in color. Biscuits baked on sheet pans with top microwave power only required three minutes for a full oven load.

One obvious advantage of combined microwave and thermal heat is that such items can be baked off during the serving period, because of the very short baking times involved. Further studies are planned to develop more exacting data.

Oven Size. The oven has an overall width of 40 inches, is almost as deep, and is 16 inches high. Usable oven space is 37 inches wide by 20 inches deep by 10 inches high. One inch of fiberglass is used as insulation. The door frame and door are of ¼ in. cast aluminum. Microwave tightness is assured through a flexible seal plate which gives excellent metal to metal contact with the door flange. Measurements made periodically with accepted instrumentation have indicated absolutely no microwave emission, even when operated at full microwave power; i.e., about 7.5 kW.

Oven height was limited in the original SPEED microwave ovens by available space in the kitchen. Two microwave ovens and a forced convection oven had to fit the available space at the end of the kitchen pod above the engine compartment. From a cooking point of view, oven height was not too serious when cooking only with microwave energy, but does become important when one considers the proximity of the food to the upper radiant elements.

Metal Pans. An unexpected problem also related to the resistance heating elements concerns the use of metal pans. Three steam table pans effectively block off the lower elements so that the heat they give off is confined and does not affect the thermostat whose sensing element is in the upper part of the oven. As a result, the oven keeps calling for heat, and the upper elements tend to remain on. The result is a tendency to overheat the food surface.

Since the top or bottom elements can be operated as a group, a partial solution is to turn off the upper elements, use the bottom elements to heat the oven, and set the thermostat at a lower temperature. When starting with a preheated oven, this has given reasonably good results. In some cases, it has proven desirable to turn on the upper elements for a short period of time.

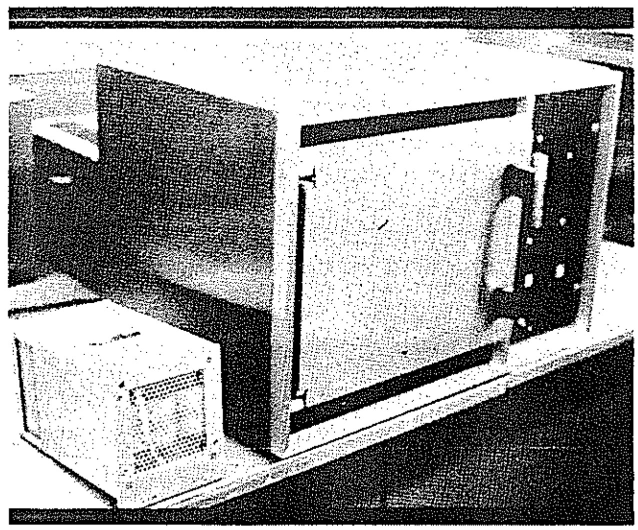
Oven Programmers. An apparent shortcoming is the inability to observe cooking in progress. The oven door is without a window. Designing a door with one is a research project of its own. Consideration is being given to some means of programming cooking operations with the microwave as well as the conventional ovens.

The Army is not always blessed with dedicated cooks, nor for that matter are the other services. Indeed, adequate incentives are not offered to be able to interest men in becoming cooks and bakers. Yet, the requirements for adequate numbers of trained men must be met. Time does not permit as much classroom training as needed and most of it necessarily must be on the job. With this in mind, an oven programmer might be a useful device to take some of the guesswork out of oven cooking operations and insure more consistent quality.

One two-stage programmer which was designed for use with a quartz tube infrared oven has been observed. The first stage, or continuous ON-stage, could be preset for 0 to 99 minutes of continuous operation. The second stage was an On-Off pulsing stage, which could be set for a like time period. The duration of the pulse was also controllable. This type of programmer is eminently suited to a quartz tube infrared or a microwave system which has essentially no thermal inertia and can be used to control oven temperature as well.

In practice then, with a cold oven load, the program might be ten minutes of continuous mi-

View in hospital ward showing microwave oven and food tray carrier.



MUST microwave oven and power module.

crowave power to bring the product up to a predetermined temperature, followed by a pulsing cycle, which over 20 minutes might apply the equivalent of 10 minutes of continuous power. The pulsing would allow some temperature equalization throughout the product.

A practical programmer is conceived as one being ultimately responsive to a punched tape or card so that the cook would merely select the program card from a file, place it in the programmer, load the oven, plug in an adjustment for product weight and initial temperature, and press the start button. After the program cook cycle has been completed, it might call for a cooling cycle to stop cooking action, then sound a buzzer to indicate the product is ready.

Steamers. Another modification to the kitchen, which may seem mundane in comparison with the microwave work, is the addition of a single steam-jacketed kettle. Up to now, it has been necessary to heat water for certain cooking operations in the microwave oven, an actually hazardous way of heating water because of the danger of spilling boiling water.

The steam-jacketed well simplifies all this. In normal operation water might be heated first for making coffee, which incidentally is being made in an insulated urn by the drip method. The kettle might then be used for cooking potatoes to be mashed and served directly from the kettle. Or possibly a vegetable might be cooked and transferred to serving pans so that the kettle could be used for potatoes. It also would serve as a mixing bowl when making meat loaves and for a variety of other chores.

Another change has been the replacement of basket storage racks with insulated holding cabinets. There is a need for storage of a considerable number of pans of cooked foods, foods to be cooked, baked goods, and goods to be baked. The cabinets serve these purposes, they also serve as storage space for clean pans. In some microwave meat cooking operations the cabinets serve to permit the completion of cooking.

Manpower. The normal complement of this kitchen is two to three men. Space does not permit more traffic and so each cook's operations must be efficiently planned. This is much simpler when prime cooking is replaced with the use of precooked frozen entrées because the workload prior to cooking is the major time consumer. If pre-

Continued on page 12

Distillate Fuel-Fired Kitchens

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Energy is becoming one of the crucial areas of the late 20th century. Development work being conducted at Natick Laboratories can be helpful in many areas of the world where fuel is scarce for normal activities and for use during emergencies and disasters. This article is based on a presentation Mr. McCormack made in December 1970 before the Exploring Food Systems of the Future Seminar, held by the School of Hotel Administration at Cornell University.

ONE MAY WELL ASK: "Now What?" "Another utility element to be considered?" "Isn't it a difficult enough problem choosing between gas and electricity without worrying about gasoline, diesel fuel or kerosene?"

The questions might be valid for conventional users of food service equipment. Our equipment, however, is geared toward military field application where natural gas doesn't exist, where liquid petroleum gas is not authorized nor available during wartime conditions, and where electricity is reserved for more essential uses when cost is secondary.

The generation of electricity in the field is expensive and could be considered a rationed commodity. The use of liquid fuels in direct application is not new, as our current policy in field equipment includes such items as liquid fuel fired lanterns, stoves, proof boxes, tent heaters, and water heaters, none of which require electricity for operation. These are still procured today and issued in large numbers for world-wide use. Many of you who are campers can attest to the use of this type equipment.

In addition, for larger fuel consumers where safety and control are required, we have electric controlled, liquid-fuel fired heaters for tents, aircraft, buildings and mobile laundries, shower-baths, and bakeries. For most all of these applications, combat gasoline is the primary fuel. Currently, there are pieces of field food service equipment that use the gasoline engine as the primary motive power for such items as field refrigerators and dough mixers.

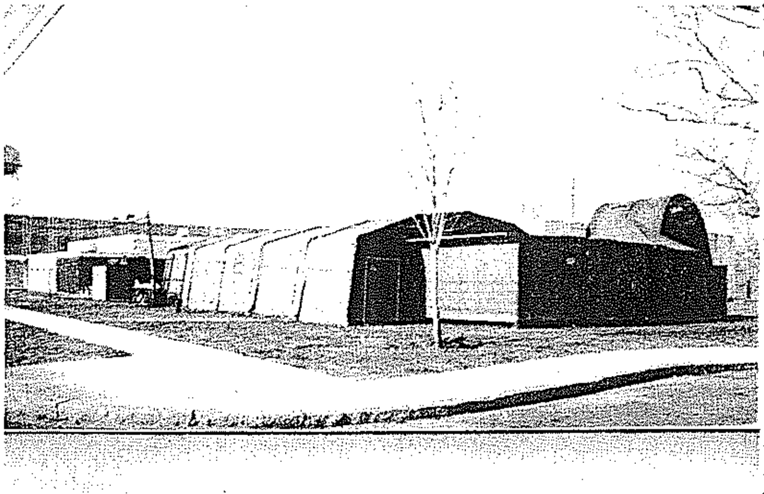
The logic of the policy is, quite simply, logistics and economy. If there was an unlimited availability of conventional energy sources, there would be no great problem in designing a field kitchen that used gas, either natural or liquid petroleum, or electricity power.

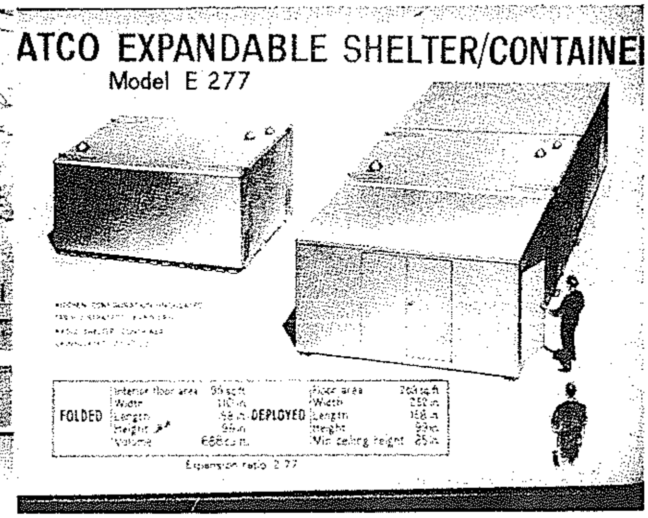
The equipment commercially exists that could be put together into a package and would probably do the job nicely. As a matter of fact, in Vietnam today we have a little of each of the types — liquid fuel fired, gas, steam, and electric. It should be noted that when the latter three types of equipment arrived in Vietnam, the queries came back in a hurry as to whether we could convert them to burn liquid fuels. At the time this would not have been an easy job, and a negative reply was furnished.

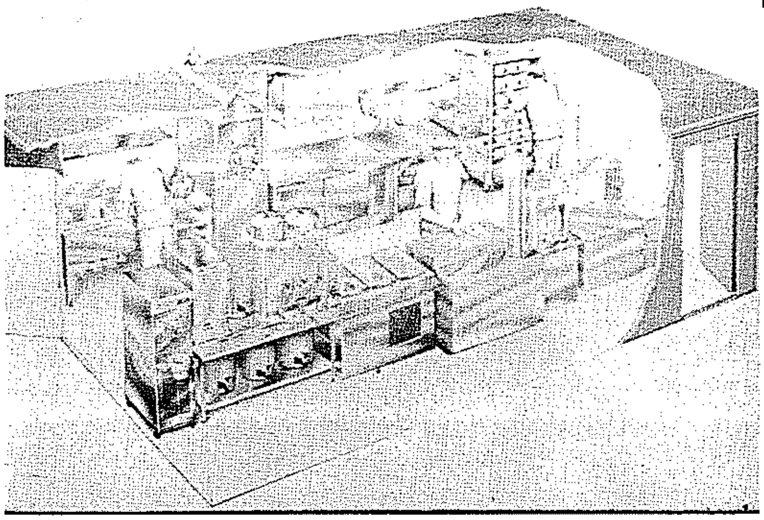
Instead, we set about designing a food service system that could utilize just about any type of liquid fuel such as combat gasoline, diesel fuel, kerosene, or aircraft fuel, and which would minimize the demand for electrical power. At the same time, the system would make full use of the advantages that electricity does offer in providing thermostatic, safety, and other controls.

I have given this brief background mainly to acquaint you with the parameters governing the design of this type of field equipment.

Two minimum electric systems evolved under this concept. The first was a semi-permanent, or portable type, prefabricated facility developed for the U.S. Air Force Bare Base Program. The second was a highly mobile, and a bit more austere, version of the first, called the "U.S. Army's Modular Mobile Field Kitchen".







Upper left
Overall view of the U.S. AFBB kitchen, dining hall, dry storage area, and 15 cu. ft. refrigerators. The MUST unit for hospitals is similar, but is surrounded with inflatable shelters which function as ward areas.

Above
Kitchen folded and deployed. In shelter/container it can be transported on wheels, by truck, or by helicopter.

Left
Cut-away of artist's concept of the AFBB kitchen.

Air Force Bare Base Program

The Air Force Bare Base Program consists of erecting, within a few days, a complete airfield anywhere in the world that has a suitable landing strip and source of potable water. The AFBB kitchen is a complete food service system including the kitchen, the attached dining hall, a dry storage area, two walk-in refrigerators of 150 cu. ft. each, and a sanitizing area.

The system is designed to provide the complete food service needs of 250 men, although at times it has fed a great deal more than that. The kitchen itself contains all of the essential food service items for the preparation of conventional meals for 250 men including bread and pastry products and ice cream.

The basic kitchen is enclosed in an expandable lightweight honeycomb panel type shelter having closed dimensions of 9 ft. wide by 13 ft. long and 8 ft. high that expands to 21 ft. wide by 13 ft. long by 8 ft. high. Total weight including all components is approximately 7,000 pounds.

Equipment. Pieces of equipment included in the shelter and shipped within the packaged dimensions are:

- Forced convection oven
- Teflon-coated aluminum griddle
- Steam generator/hot water heater with built-in pressure cooker
- Three 15-gallon rectangular steam-jacketed kettles
- Twin 10-gallon coffee urn, steam operated
- Ice maker
- Soft serve ice cream machine
- Beverage containers
- Rotary toaster
- Vertical cutter/mixer
- Proofing and hot food holding box
- Two-burner electric hot plate
- Two-well sink with spray hose
- Single-tank dishwasher
- Refrigerator
- Pots, pans, utensils, trays, silver, etc.

The four pieces of equipment listed first present the development items, with the balance being basically commercial equipment with some modifications. I would like to describe these development items in a little more detail.

Convection Oven. The forced convection oven uses the combustion of liquid fuels to provide its heat. It does this by vaporizing the fuel with compressed air from an external air compressor, igniting the vapor by a pair of electrodes, and passing the hot gases under the bottom of the oven, up the sides and across the top. The hot gases emerge into a flue passage which takes the gases up the stack through the roof of the shelter. This firing system is really very simple and not unlike a domestic type furnace, although the electrical control and safety system is a bit more sophisticated and redundant.

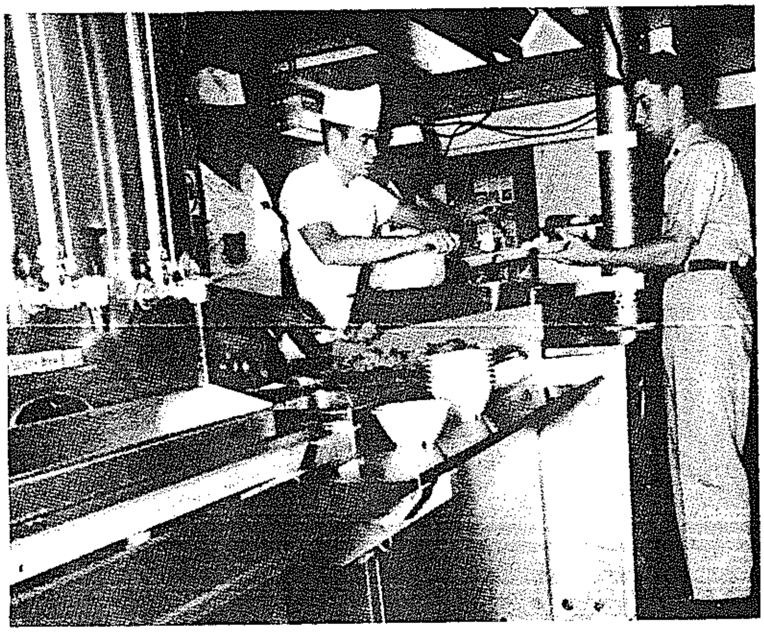
The oven is completely automatic and thermostatically controlled. The ordinary cook using it would not know that it was any different than a conventional gas or electric oven. He simply turns a toggle switch, sets the thermostat, and he is in operation.

This oven is a little different than most forced convection ovens you have seen in that we have two internal blowers driven by air motors, one on each side. Comparable commercial types have only one electrically driven blower in the rear. A better distribution of the hot air is achieved with this system, we feel. Commercial convection ovens may follow this path when the competition starts advertising the unevenness in today's convection ovens. This particular oven had the capacity for 12 full-size 12-in. by 20-in. steam table pans. In actual tests, we have baked 24 1-lb. loaves of bread in approximately 25 minutes. The heat input is approximately 40,000 Btu per hour on high fire and about half that on low fire.

Griddle. The second developmental item is the griddle, which sets on top of the oven. Its dimensions are approximately 42-in. by 27-in. The burner and controls for the griddle are identical to those for the oven, and the same principle of distribution of the hot gases beneath the griddle surface takes place.

Some novel features of the griddle are that it is aluminum, is teflon-coated, and has a milled area in the surface that drains grease away to one corner and into an empty No. 10 can that is subsequently discarded. The combination of this design with the teflon coating makes the cleanup virtually effortless.

Our cooks have really appreciated this design. However, we are still evaluating the durability of the teflon coating. The heat-up and heat-transfer time of aluminum has been excellent, and perhaps future commercial gas and electrical designs may go in this direction. Our need to use aluminum was, of course, dictated by the restraints of an overall weight limitation of the total system package.



AFBB kitchen's interior view shows serving line with steam-jacketed kettles in foreground.

Steam Generator and Water Heater. The third developmental item is the steam generator and hot water heater. This unit a real work horse with provision for generating steam at approximately 20 Psig and providing domestic hot water for the sinks and 180°F rinse water for the single tank dishwasher.

Steam is supplied to 1) the three 15-gallon jacketed kettles, 2) a built-in automatic pressure cooker, 3) the coffee urn, and 4) a univent heater for providing heat for the shelter itself during cooler weather or on a start-up.

The steam generator is constructed of stainless steel, uses liquid fuel, and is completely automatic. Burner input is approximately 240,000 Btu per hour. Condensate is returned from the unit heater, the coffee urn, and the jacketed kettles to improve efficiency and reduce scaling.

The pressure cooker is a commercial, high-compression steamer with a capacity for full-size steam table pans and is built into the cabinetry of the steam generator itself. The operation is automatic and condensate is directed to the waste line.

Steam-Jacketed Kettles. The fourth developmental item is the three 15-gallon steam-jacketed kettles. Their novelty is that they are rectangular in shape and of a size to receive a standard 12 in. by 20 in. steam table pan or smaller multiples.

The kettles have a semi-cylindrical bottom and have cove corners for ease of cleaning as well as built-in drains. To clean them in place, a pre-coiled spray hose reaches from the sink.

These units are built into one cabinet directly in the serving line and are used to cook in, to dispense from, to double as a steam table, etc. These kettles have proved very versatile and, of course, take less of our critical space than three conventional 15-gallon semispherical kettles. We have now adapted one-, two-, and three-well versions of these kettles in self-contained electric as well as direct steam for each of four kitchens currently under development at Natick.

The commercial food service items in the kitchen will not be discussed, but I will describe the other aspects of this AFBB food service system.

Dining Area

Adjoining the kitchen is a large prefab dining hall that can seat 120 persons at one time. The tables and benches fold into lightweight compact packages for storage and shipment within the accompanying refrigerator boxes. Within the dining hall and directly adjacent to the kitchen is an enclosed sanitizing area with the single tank dishwasher, tables, racks, etc. In operation, the users go from the dining hall into the kitchen, passing by the serving line within the kitchen, and back out to the dining hall by a second door. Condiments, salads, and beverages are dispensed from tables in the dining room.

Adjacent to the kitchen is an enclosed area, currently tentage, that serves as a dry stores room. Adjoining one wall of this area are two 150 cu. ft. walk-in refrigerators or freezers.

With the exception of the dining hall structure itself, all of the items used in the food service system, including the interfaces, are shipped within the collapsed kitchen and the two reefer boxes. The dining hall with its parts is stacked on one large skid. Each of these packages is designed for air transport in military aircraft and can be flown anywhere in the world and erected in less than eight hours with a trained crew.

Upon connection to a fuel source, water supply, and electric power, cooking operations can begin immediately.

Perhaps one of the most startling facts about this system is the exceptional efficiency of the kitchen itself, representing the success of the liquid fuel fired approach. The fuel was measured under actual conditions in cooking conventional meals for 250 men and averaged one gallon of diesel fuel per hour and 6 kilowatts of electric power. We think that's a job well done!

Modular Mobile Field Kitchen

This kitchen consists of essentially the same major cooking equipment as the AFBB kitchen just described, but the package and the mission are quite different. Where the AFBB facility would be set up for some relatively stable period of time and could tolerate a delay in operational capability, the Modular Mobile Field Kitchen would be constantly on the move and must be ready to serve hot foods at various sites during the day.

This system, therefore, is more suitable for a tactical mission and dictates a smaller package, limited to essential equipment only. It is not expandable and measures 7 ft. wide by 13 ft. long by 8 ft. high. It can be towed on demountable wheels, carried on the back of a 2-½ ton truck, or slung under a helicopter.

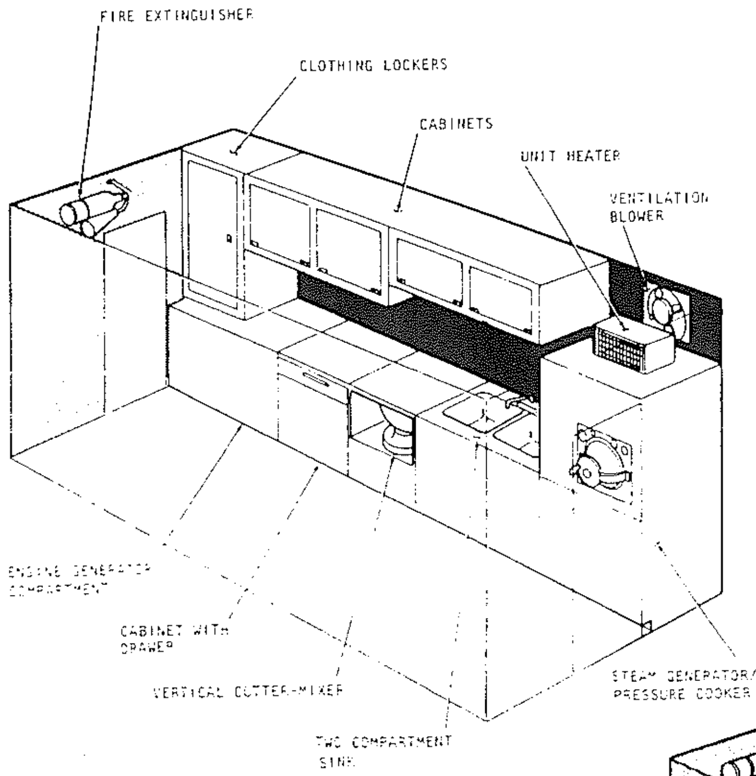
It is completely self-contained and has enough fuel, food, and water on board to prepare one meal for 200 men. Again, the major cooking elements are liquid fuel fired and consist of a forced convection oven, a Teflon-coated aluminum griddle, a steam generator/hot water heater with a built-in pressure cooker, and three 15-gallon steam-jacketed kettles.

As opposed to the larger AFBB kitchen, the MMF kitchen does not have an ice cream machine, a proofing cabinet, automatic ice maker, automatic coffee urn, rotary toaster, or a two-burner hot plate. But it does have a refrigerator, a two-well sink, a vertical cutter/mixer, and all the other essential food preparation and serving implements.

Power to operate the kitchen is provided by a small, on-board 5-kilowatt, 110 volt, 60 hertz engine generator set, which also drives an air-compressor. With the steam-jacketed wells and clamp-down covers, a method of cooking enroute of some menus is available, when road conditions permit, enabling serving immediately on arrival. The kitchen has a pressurized water system, and outside tapoffs are provided for steam and hot water.

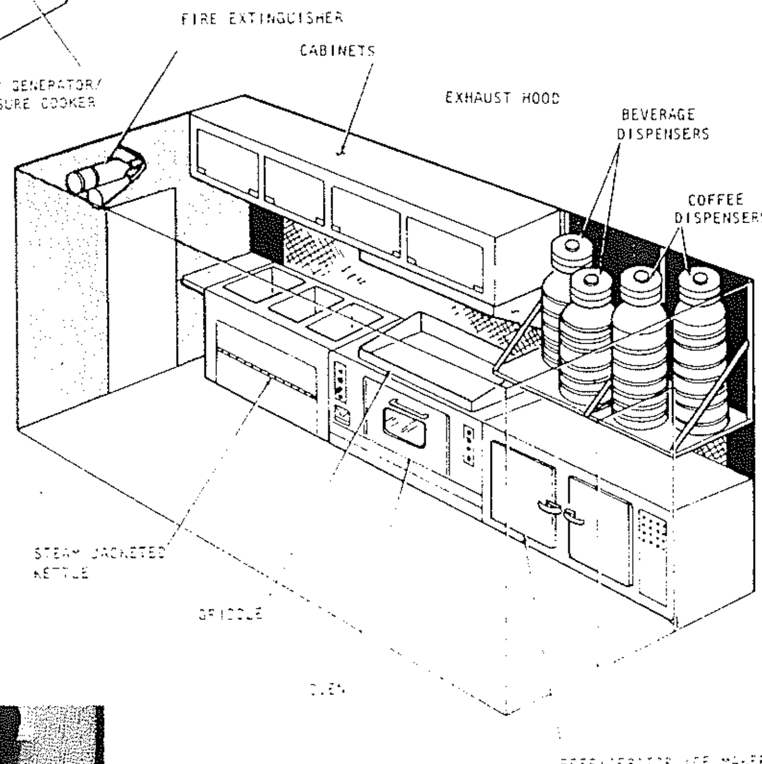
One novel feature is that the on-board reservoirs can be filled with fuel and water simply by turning a switch which creates a vacuum in the tanks to allow transfer of product from an external reservoir source. Another novel feature is that in the event of failure of the engine generator set,

MODULAR MOBILE FIELD KITCHEN

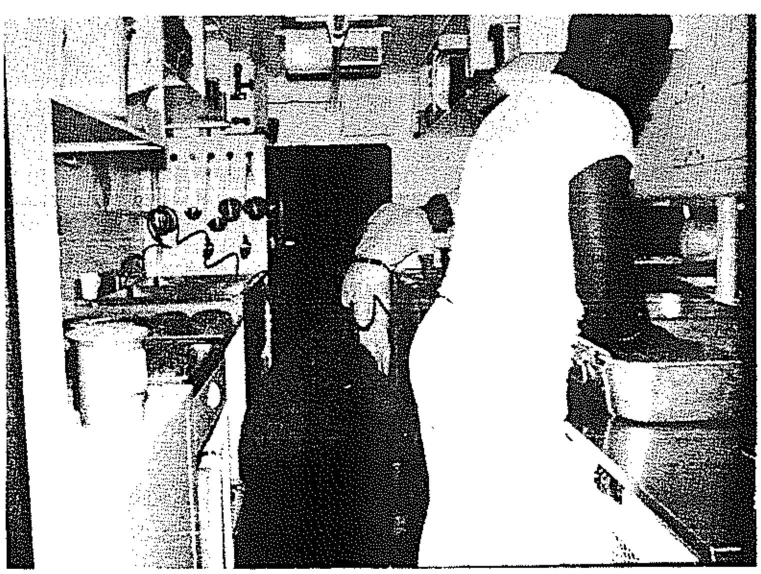


ROADSIDE VIEW

Cutaways show the location of equipment in this self-contained distillate fuel-fired kitchen.



CURBSIDE VIEW



Interior view of MMF kitchen shows one cook preparing meat loaf while the one at the rear works with the steam-jacketed kettles.

an inverter is provided that can invert the 28 DC usually available in military vehicles to 110 V AC and continue to operate the kitchen at a reduced capacity. This achieves a redundancy in reliability that is essential when electrically powered equipment is depended upon. The liquid fuel burning equipment again uses approximately one-gallon per hour, and the engine generator set consumes approximately 2 gallons per hour.

Field Tests Are Scheduled

Both of the kitchens described are in a development phase. The final design will be based on field tests to be initiated in the near future. In the case of the MMF kitchen, its operational characteristics and overall cost considerations will be compared to the SPEED electric kitchen and also to our standard non-electric field range kitchen that has not changed very much since 1937. Unless we can truly and quantitatively prove increased benefits of the new type equipment, their adoption will be questionable.

The original development work on this equipment was carried out by the American Air Filter Company of St. Louis, under research and development contracts awarded them by the Natick Laboratories. ■

Electrically Powered Field Kitchens
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cooked entrées are used, then the major workload becomes the baking operation, and perhaps this might one day be replaced with frozen or refrigerated baked goods. Sheet cakes take about 14 minutes; bread, 7; biscuits, 3; and pies about 12 minutes in the heated microwave ovens. Preparation for baking such foods for 200 or more men takes considerably longer.

Following an extensive field feeding experiment, to be completed by late spring, the fate of the SPEED kitchen should be known. If it is the most cost effective approach it could go into engineering development, engineering and service testing, be type classified, and be available for issue to the troops in about five years. If not selected, then further work will be discontinued. The knowledge gained, however, will not be lost and could benefit other food service operations and developments for years to come.